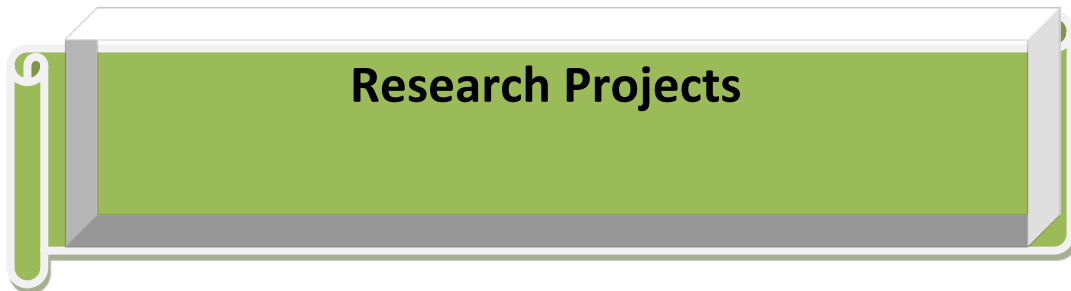




Heritage Institute of Technology

(An Autonomous Institution)



Research Projects

FILE NO. SRG/2019/001119

SCIENCE & ENGINEERING RESEARCH BOARD(SERB)

(A statutory body of the Department of Science & Technology, Government of India)

5 & 5A, Lower Ground Floor
Vasant Square Mall
Plot No. A, Community Centre
Sector-B, Pocket-5, Vasant Kunj
New Delhi-110070

Dated: 24-Dec-2019

ORDER

Subject: Financial Sanction of the research project titled "**Synthesis of New Thermoelectric Materials, Exploring Cu-S Binary**" under the guidance of Dr. Ritayan Chatterjee, Physics, Heritage Institute of Technology, East kolkatta township, chowbaga road, anandapur, kolkata, Kolkata, West bengal-700107 - Release of 1st grant.

Sanction of **Science and Engineering Research Board (SERB)** is hereby accorded to the above mentioned project at a total cost of **Rs. 3157000/- (Rs. Thirty One Lakh Fifty Seven Thousand Only)** with break-up of **Rs. 2200000/- under Capital (Non-recurring) head** and **Rs. 957000/- under General (Recurring) head** for a duration of 24 months. The items of expenditure for which the total allocation of **Rs. 3157000/-** has been approved are given below:

S. No	Head	Total (in Rs.)
A	Non-recurring	
1	Equipment -> High temperature muffle furnace -> Thermogravimetry cum Differential Scanning Calorimetry (TGDC) with oxidizing+reducing atmosphere	2200000
A'	Total (Non-Recurring)	2200000
B	Recurring Items	
1	Recurring - I : (Manpower) Recurring - II : (Consumables, Travel, Contingencies) Recurring - III : Scientific Social Responsibility	360000 300000 10000
2	Recurring - IV : (Overhead Charges)	287000
B'	Total (Recurring)	957000
C	Total cost of the project (A' + B')	3157000

2. Sanction of the **SERB** is also accorded to the payment of **Rs. 2200000/-** (Rupees Twenty Two Lakh only) under 'Grants for creation of capital assets' and **Rs. 483500/-** (Rupees Four Lakh Eighty Three Thousand Five Hundred only) under 'Grants-in-aid General' to **Principal, Heritage Institute Of Technology, East Kolkatta Township, Chowbaga Road, Anandapur, Kolkata** being the first installment of the grant for the year 2019-2020 for implementation of the said research project.

3. The expenditure involved is debitable to **Fund for Science & Engineering Research (FSER)**
This release is being made under Start-up Research Grant. (EC Engineering Sciences)

4. The Sanction has been issued to Heritage Institute Of Technology, East Kolkatta Township, Chowbaga Road, Anandapur, Kolkata with the approval of the competent authority under delegated powers on **20 December, 2019** and vide Diary No. **SERB/F/8003/2019-2020** dated **21 December, 2019**

5. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at website (www.serb.gov.in).

6. Overhead expenses are meant for the host Institute towards the cost for providing infrastructural facilities and general administrative support etc. including benefits to the staff employed in the project.

7. While providing operational flexibility among various subheads under head Recurring-II, it should be ensured that not more than Rs. 1 lakh each should be spent for travel and contingency.

8. Budget sanctioned under Scientific Social Responsibility (SSR) is meant only for activities enlisted under SSR norms and under no circumstances it can be reappropriated.

9. As per rule 211 of GFR, the accounts of project shall be open to inspection by sanctioning authority/audit whenever the institute is called upon to do so.

10. The sanctioned equipment would be procured as per GFR and its disposal of the same would be done with prior approval of SERB.

11. The release amount of **Rs. 2683500/-** (Rupees Twenty Six Lakh Eighty Three Thousand Five Hundred only) will be drawn by the Under Secretary of the SERB and will be disbursed by means of RTGS transaction as per

their Bank details given below:

PFMS Unique Code	WBPS00008689
Account Name	Heritage Institute of Technology
Account Number	1426010100000038
Bank Name & Branch	Punjab National Bank The Heritage KBT Anandapur 994 Madurdaha, Chowbaga Road Kolkata 700107
IFSC/RTGS Code	PUNB0632300
Email id of A/C Holder	cfo@heritageit.edu
Email id of PI	ritayanchatterjee@gmail.com

12. The institute will furnish to the SERB, separate Utilization certificate(UCs) financial year wise to the SERB for Recurring (Grants-in-aid General) & Non-Recurring (Grants for creation of capital assets) and an audited statement of accounts pertaining to the grant immediately after the end of each financial year.

13. The institute will maintain separate audited accounts for the project. A part or whole of the grant must be kept in an interest earning bank account which is to be reported to SERB. The interest thus earned will be treated as credit to the institute to be adjusted towards further installment of the grant.

14. The project File no. SRG/2019/001119 may also be mentioned in all research communications arising from the above project with due acknowledgement of SERB.

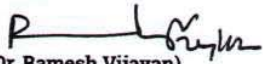
15. The manpower sanctioned in the project, if any is co-terminus with the duration of the project and SERB will have no liability to meet the fellowship and salary of supporting staff if any, beyond the duration of the project

16. As this is the first grant being released for the project, no previous U/C is required.

17. The institute may refund any unspent balance to SERB by means of a Demand Draft favoring "FUND FOR SCIENCE AND ENGINEERING RESEARCH" payable at New Delhi.

18. The organization/institute/university should ensure that the technical support/financial assistance provided to them by the Science & Engineering Research Board should invariably be highlighted/acknowledged in their media releases as well as in bold letters in the opening paragraphs of their Annual Report.

19. In addition, the investigator/host institute must also acknowledge the support provided to them in all publications, patents and any other output emanating out of the project/program funded by the Science & Engineering Research Board.


(Dr. Ramesh Vijayan)
SCIENTIST-C
drvramesh@serb.gov.in

To,
Under Secretary
SERB, New Delhi

Copy forwarded for information and necessary action to: -

1.	The Principal Director of Audit, A.G.C.R. Building, IIIrd Floor I.P. Estate, Delhi-110002
2.	Sanction Folder, SERB, New Delhi.
3.	File Copy
4.	Dr. Ritayan Chatterjee Physics Heritage Institute of Technology, East kolkatta township, chowbaga road, anandapur, kolkata, Kolkata, West bengal-700107 Email: ritayanchatterjee@gmail.com Mobile: 919433470572 (Start date of the project may be intimated by name to the undersigned. For guidance, terms & Conditions etc. Please visit www.serb.gov.in .)
5.	Principal, Heritage Institute Of Technology, East Kolkatta Township, Chowbaga Road, Anandapur, Kolkata (Receipt of Grant may be intimated by name to the undersigned)


(Dr. Ramesh Vijayan)
SCIENTIST-C
drvramesh@serb.gov.in



souvik basu <souvik.basu@heritageit.edu>

Fwd: FW: DST project: Transferring money to Heritage Institute of Technology from : iimc-itdd(1819)

3 messages

Somprakash Bandyopadhyay <somprakash@iimcal.ac.in>

Tue, Jun 23, 2020 at 3:21 PM

To: Siuli Roy <siuli.roy@gmail.com>, souvik basu <souvik.basu@heritageit.edu>

----- Forwarded message -----

From: **Supriyo Dhali** <supriyodhali@iimcal.ac.in>

Date: Tue, Jun 23, 2020 at 3:07 PM

Subject: FW: DST project: Transferring money to Heritage Institute of Technology from : iimc-itdd(1819)

To: Somprakash Bandyopadhyay <somprakash@iimcal.ac.in>

Cc: <rraman@iimcal.ac.in>, Finance & Accounts Officer <fao@iimcal.ac.in>

Respected Sir,

Please find below the bank transfer details to "Heritage Institute of Technology".

Date	Transaction Details	Amount
23-06-2020	NEFT UTR NO.SBIN420175796276 PUNB0632300 PUNJAB N HERITAGE INSTITUTE O AT 06210 IIM, JOKA	7,87,620.00

Thanks & Regards,

**Supriyo Dhali | Accounts Department**

a: INDIAN INSTITUTE OF MANAGEMENT CALCUTTA | [Diamond Harbour Road Joka, Kolkata \(Calcutta\) – 700104, West Bengal, INDIA](#) **e:** supriyodhali@iimcal.ac.in | **w:** www.iimcal.ac.in |

m: (+91) 9804966357 | **p:** (33) 2467-8300 / Ext-1047

**Creating a Digitally Enabled Social Knowledge Management Platform
for Rural SC Community to Bridge Rural-Urban
Knowledge, Information and Market Divide**

PROGRESS REPORT
1st April, 2020 to 31st March 2021

Submitted to

Science for Equity, Empowerment & Development (SEED) Division
Department of Science & Technology
Ministry of Science & Technology
Technology Bhavan,
New Mehrauli Road
New Delhi - 110 016

Submitted By

Social Informatics Research Group
Indian Institute of Management Calcutta
Joka, Kolkata – 700104

Principal Investigator:

Dr. SomprakashBandyopadhyay,
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Executive Summary

The Problem

One of the key deficiencies in many rural communities especially in SC community is the lack of linkage to local as well as the larger metropolitan area opportunity structure, including financial, technical, social and political resources. Right kinds of physical and/or virtual connectivity that are required to increase both bridging (external) and bonding (local) social capital of rural communities are grossly missing. Social capital refers to the network of social relations that may provide individuals and groups with access to resources and supports. Since rural communities are disconnected both physically and digitally from local as well as urban opportunity structures, they have (i) less access to quality educational support, training, advisory services (ii) less knowledge about the available local opportunities (community assets, sharable resources) (iii) less access to market links (buyer, seller, micro-credit etc.) and (iv) less access to any forum to discuss their problems with relevant agencies.

While the poor networking ties coupled with information, knowledge and market divide of rural Indian artisans are a known fact, the situations have **further worsened due to the ongoing pandemic scenario, which marks the urgency of our research intervention in the context of overcoming extant rural marginalization.** Due to the COVID 19 pandemic, physical sales of handicraft goods have come to a halt. Not only that, the 'new normal' has attempted in drastically changing the way socio-economic operations were performed in modern society. Lack of opportunities towards spontaneous face-to-face physical interactions have further pronounced the effectiveness of the virtual medium, where daily affairs in the changed times are increasingly getting dependent on digital channels for successful execution. Amidst such a scenario, if the rural artisans are not taught to optimally use the digital medium to attract socio-economic benefits, then the nature of their marginalization will further become more acute and the rural members will remain incapacitated in coping up with the changing socio-economic setting. **Our research intervention keeps in mind the potentials contemporary digital technologies are endowed with and wishes to use the same as a tool to usher holistic rural empowerment along socio-economic axis.**

Our Objective

The objective of this project is to demonstrate how the current internet-based social technologies¹ has the potential of building (business) knowledge capabilities and enhancing the entrepreneurial competencies of rural producers by bridging rural-urban knowledge & information divide through the creation of a *social knowledge management framework*. The project ultimately aims at creating rural business transformation using social technologies in order to eradicate sharp economic, social, and cultural difference between rural and urban producers. Rural transformation is only possible when there is livelihood enhancement and holistic development of the rural community using social technologies.

Considering the current pandemic situation and the "new normal" lifestyle that would follow the pandemic situation, we have reoriented our intervention plan using a "distributed intervention strategy" instead of a centralized intervention strategy. In this strategy, we do not need to use / install any capital equipment to create centrally-located facilities **but rely on the availability of smartphones with target user-groups.** We had an initial plan of creating three centralized internet kiosks and mobile internet kiosks and our assumptions were (i) the target participants would come to these centralized facilities physically (in case of centralized internet kiosks), or, (ii) our project personnel will go to the target participants physically (in case of mobile internet kiosks). Since this is not possible during this pandemic situation, we are now trying

¹ *social technology* is an umbrella term used to capture a wide variety of terminologies depicting internet-enabled communications, platforms and tools, e.g. web 2.0, mobile 2.0, social media, social software, etc., which has the potential to establish *collaborative connectivity* among billions of individuals over the globe.

to implement a "distributed intervention" strategy, where everything is done remotely in an online, virtual mode using online messaging tools (e.g. WhatsApp) and video conferencing tools (e.g. Zoom) and **we are approaching our rural target group using smart-phone enabled tools and platforms**, as will be illustrated below.

Target Beneficiaries

Rural artisans from all over Birbhum District of West Bengal, pursuing different art forms like kantha stitch, batik, leather, khesh work, woodcraft, handpainting, dokra work, appliqué work, terracotta, bamboo craft, jute craft and jewellery making, are our potential target beneficiaries. A special emphasis has been given in our project to select a considerable number of artisans belonging to the Scheduled Caste background. Ensuring a significant portion of SC artisans among our target group, our project attempts to create holistic impact for the most disadvantaged within the community of artisans residing in Birbhum. We have collaborated with **District Industries Center (DIC), Birbhum and DC Handicrafts, Bardhaman** of West Bengal for this purpose. A description of target beneficiaries is provided in Chapter 3 of this report.

Architecting a Social Technology Driven Social Knowledge Management Framework

In this project, our objective is to utilize the potential of social technologies and socially enabled applications in addressing problems related to marginalization and social exclusion of rural communities. We have conceptualized a *social knowledge management framework* and developed a *platform* that empowers rural communities by connecting them with urban markets, government agents, trainers, investors etc. Social knowledge management in our context is a framework for rural empowerment using knowledge creation, assimilation and dissemination through digital connections and social collaboration, enhanced by social technologies. The suggested framework aims to digitally bridge rural-urban knowledge, information and market divide, by connecting rural community members with relevant agents and opportunities online. We propose to study the connection and collaboration among various entities that enables formation of virtual communities to bridge knowledge, information and market divide of rural community. Formation of these virtual communities has the most positive effect on social capital when they can increase network density and facilitate the spread of knowledge and information.

Design Methodology: Our design methodology is motivated by Action Design Research (ADR) approach and uses the following four interwoven activities:

- *Problem Formulation:* problem perceived in practice or anticipated by researchers.
- *Building, Intervention, and Evaluation (BIE):* Testing the initial design of the IT artifact in the context of its usage. This phase “interweaves the building of the IT artifact, intervention in the organization, and evaluation”.
- *Reflection and Learning:* This is an iterative process to build and refine a solution to make it applicable to a broader class of problems.
- *Formalization of Learning:* Finalizing a solution that addresses the problem

This design methodology has been discussed in details in **Chapter 5**. Our social technology driven social knowledge management framework is an outcome of our design methods discussed above and based on the premise that just providing access to technology through computer and internet are not enough to empower rural producers as active agents. Following the ADR approach, in the initial stage of our project intervention, we have attempted in delving deeper into the problems faced by our target group. In order to have a grass-root level idea, members of our Research Organization (RO) interviewed 70 artisans from Birbhum, pursuing different art forms like kantha stitch, batik, leather, khesh work, woodcraft, hand-painting, dokra work, appliqué work, terracotta, bamboo craft, jute craft and jewellery (Appendix II). In our project, we have randomly selected artisans from different blocks all over Birbhum, namely Bolpur, Mohammad Bazar, Nanoor, Rampurhaat, Labpur, Suri and Sainthia. A special emphasis has been given in our project to select a

considerable number of artisans belonging to the Scheduled Caste background. Ensuring a significant portion of SC artisans among our target group, our project attempts to create holistic impact for the most disadvantaged within the community of artisans residing in Birbhum.

The multifaceted hindrances faced by the artisans, as evident from our qualitative interactions, can be categorized broadly into information, knowledge and market divide and poor social capital. Lack of information regarding government schemes, can be categorized as information divide or lack of purely factual data. Poor social capital of artisans gets reflected in the networking issues they face. Poor communication channels with local as well as global buyers and sellers put the rural artisans in disadvantageous positions. Knowledge divide, comprising of information divide coupled with lack in skill, experience and attitude, gets reflected in the artisans' ignorance regarding innovating new business prospects, innovating new product and design ideas and related things. Innovating business prospects and newer product and design ideas will not be possible if artisans have adequate information regarding business prospects and product and design ideas. It is only when along with adequate information, artisans develop their skills, experiences and attitudes, then only materialization in the form of concrete innovation can take place. Finally, ignorance regarding emerging selling channels and bondage to middlemen, curbing direct market access of artisans, ignorance regarding the market prospects that digital channels can offer can be categorized as market divide.

If the entire artisan community of Birbhum is to be considered as our potential beneficiary, then a group of 70 can only be understood as the subset of the whole group. However, the findings of requirement analysis, attained after conducting interviews with our initial group of 70 artisans, can be taken as a benchmark, against which our intervention can be designed. The findings as discussed above indicate that artisans of Birbhum face hindrances majorly along four-fold axes, namely, information, knowledge and market divide and poor social capital, addressing which will be the concern of our project intervention. We have designed our social knowledge management framework as a response to address the hindrances faced by our target group along the four-fold axes. The motive behind our social technology driven social knowledge management framework is to empower rural artisans and improve their socio-economic prospects by overcoming their information, knowledge and market divide and improving their social capital. And this we wish to achieve through the formation of purposive virtual communities, namely community of practice and community of purpose among rural artisans and across rural-urban entities.

This design methodology has been discussed in details in **Chapter 5**.

Technology Development: Developing a Social Knowledge Management Platform (NCoRe)

We have designed our social knowledge management framework in a way so that it can be effective in ushering holistic rural empowerment by improving social capital and mitigating information, knowledge and market divide faced by rural artisans. In order to address the four fold hindrances stated above, we have architected our social knowledge management framework by segmenting the framework into three concrete components. In **chapter 6**, we have explained our technology development initiatives and narrate the design and development of a *Community Driven Social Knowledge Management Platform to bridge Knowledge Asymmetry using Social technologies (NCoRe)*. In **Chapter 7**, we will show how the use of social media can supplement our SKM Framework. We will explain how we have cultivated Community of Practice through *WhatsApp*, enabling intra-and inter-community knowledge exchange; and, how we have cultivated Community of Purpose through *Facebook* to promote market linkage for artisans.

A Community Driven Social Knowledge Management Platform to bridge Knowledge Asymmetry using Social technologies (NCoRe): Our social knowledge management framework comes with a digital platform, NCoRe. NCoRe is designed to facilitate the formation of both community of practice and purpose among rural members and across rural urban entities. This has been discussed in details in **Chapter 6**.

The platform's offering is divided into three segments:-

- Firstly, the platform offers the opportunity to urban consumers to co-create handicraft and handloom goods by collaborating with a range of rural producers.
- Secondly, the platform acts as a classic exhibiting site for a range of products (garments, bags, jewellery, home décor items, etc.) created by artisans of Birbhum. The products are displayed in the platform, along with the stories of their respective creators. NCoRe houses online shops of a vast range of artisans from Birbhum, where stories of each artisan along with their videos and product photos are displayed.
- Thirdly, NCoRe offers both rural and urban entities unhindered opportunity to avail for skill upgradation prospects. The synchronous training facilities integrated in the platform while allows rural artisans to upgrade their skill by virtually connecting with domain experts on one hand, on the other hand, NCoRe also allows urban entities to get training from rural producers on indigenous art and craft.

Additionally, we have developed an “Artisan Profiling App” for collecting artisans’ profile in multi-media, so that we can easily create digital shops for all the artisans in our NCoRe Paltform.

Use of Social Media: Cultivating Communities of Practice and Communities of Purpose

Creating Community of Practice through Whatsapp community chat: Triggering interactions between rural artisans and across rural-urban entities by forming whatsapp groups happens to be one component of our social knowledge management framework. Through whatsapp, we have attempted in enhancing both bridging and bonding social capital of rural artisans residing in Birbhum. We have created groups in whatsapp, where rural artisans all across Birbhum have been incorporated and they get a chance to engage in purposive knowledge exchange both within and across their community. It is through whatsapp, members of our RO send rural artisans asynchronous videos to boost up their production capacity. This implies the importance of whatsapp as a tool in our research intervention to facilitate cultivation of community of practice among our selected target group. This has been discussed in details in **Chapter 7**.

Creating Community of Purpose through Facebook: One of the mottos of our social knowledge management framework is to familiarize rural artisans of Birbhum with social media sites like Facebook and Instagram and help them in using the same to derive business benefits. While through whatsapp, we have attempted in cultivating community of practice among and across rural urban entities, through social media sites like Facebook and Instagram, we have tried to transcend beyond triggering practice-oriented communication to purposive communication culminating to economic exchange. It is the cultivation of community of purpose leading to concrete business benefits that we have attempted to facilitate by taking resort to social media sites. Members of the RO have opened Facebook and Instagram accounts of individual members of the target group, where the products created by individual member artisans are exhibited, along with their stories and journeys to a range of social media users. The intention is to connect these artisans and their creations with the global pool of consumers, where purposive collaboration between the two is expected to attract concrete socio-economic benefits for the artisans. Cultivation of community of purpose via social media channels will not only improve social capital of rural members, but will also make a significant contribution in addressing their market divide. This has also been discussed in details in **Chapter 7**.

Workshops and Trainings

As a part of our pre-pilot studies, we have conducted several awareness workshops for artisans with DIC, Birbhum on (i) what is online business and how to do it (ii) digital photography and videography, (iii) innovative product design and marketing using digital channels, etc. (discussed in details in **Chapter 8**).

Subsequently, we have planned to provide a systematic training to 700-800 artisans from Birbhum over a period of one year in a batch of 15 to 20, where each batch will receive training for a period of eight weeks. The training program is divided into three components:

- (i) Online, live training sessions for 6 hours using Zoom Platform: These live training sessions (synchronous) will be for two hours each day on Monday, Wednesday and Friday (total six hours). Our weekly online training intervention operates along three major axes: *Digital Competency Training*, *Training on Photography & Videography*, and, *Innovative, Market-Oriented Product Development Training* (discussed in details in **Chapter 8**).
- (ii) Following the online training, we will help each individual artisan to create their digital shops in our online platform and Facebook and also form a WhatsApp group to enable intra-and inter-community knowledge and information exchange.
- (iii) Additionally, we will periodically distribute small video tutorials in Bengali on topics related to digital marketing and entrepreneurship development. The duration of each video tutorial is 7 to 10 minutes. In a span of eight weeks, we plan to send around 60 video tutorials (one to two tutorials per day).

Please see **Chapter 8** for details of the training program. To enable artisans to attend this 6-hours weekly online training on ZOOM, we are recharging their smartphones with data vouchers from their respective service providers, which would be sufficient to cover the internet cost for this 6 hours online training.

Expected Outcome of our SKM programme intervention (Figure 1)

The SKM framework helps the rural artisans to know the following:

- to know opportunities in local market and the dynamics of local production [through Whatsapp virtual community formation]
- to know opportunities in non-local market [by giving information of boutique owners or other non-local customers through SKM platform (NCore) and other e-commerce (e.g. Amazon) / social networking websites (e.g. Facebook)]
- to know customers' tastes and preferences through direct interactions with customers [using phone / chat] and indirect information from e-commerce / social networking sites
- to know sources of finance and related welfare schemes from Govt agencies [through advisory service]

The SKM framework also helps the rural artisans in learning the following:

- to learn use of internet to search product / market related information
- to learn about how to click attractive photos of my products and make it exhibitable on online selling channels
- to learn about new online selling channels and how to register and perform business successfully in e-commerce sites
- to learn about how to use different social networking sites (FB, Instagram) to attain business benefits
- to learn about new designs and get insights on product innovation from domain experts

This smart-phone based intervention plan will help the rural artisans to use their mobile devices in fruitful ways. Moreover, training the artisans to enhance their business prospects through smart phones will help them in the long run to stay connected with online customers and acquire knowledge regarding market operations easily. Optimal usage of smartphones for business related purposes will make our intervention sustainable, where the artisans will be able to use the digital medium from their mobile devices only, without depending on centrally-installed facilities by external entities.

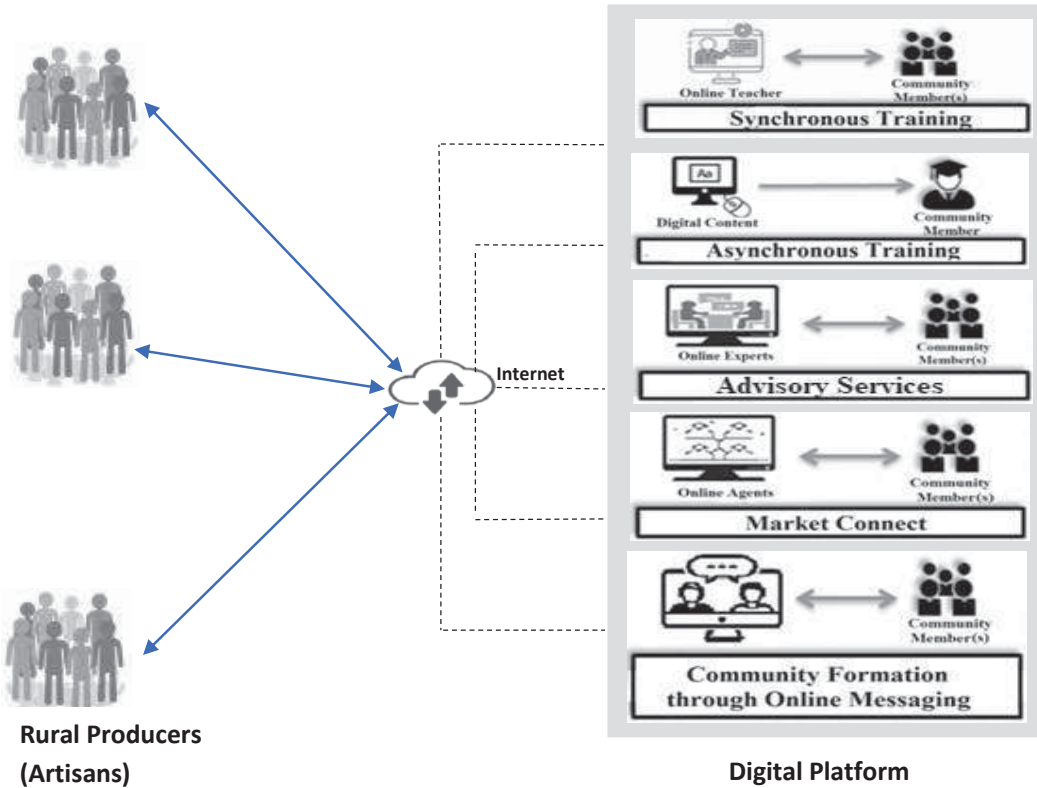
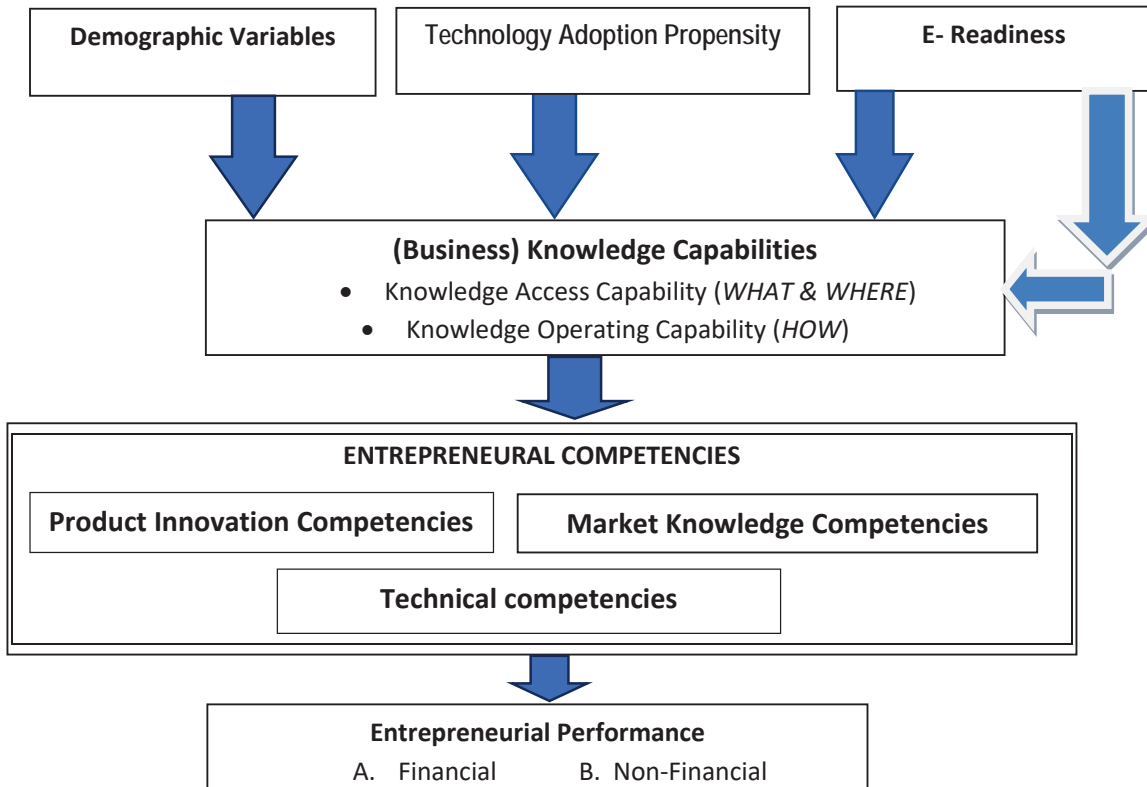


Figure 1. Functional Description of SKM Program Intervention

A Pilot Study for Analysing the Impact of Intervention: Some Preliminary Observations



In a pre-intervention pilot study, we are able to successfully form active Whatsapp communities with a group of artisans and onboard them to use a digital storefront (ncore.co.in). Using survey instruments on this pilot sample, we first develop reliable scales for measuring the key constructs. The main takeaways are:

- There is no clear relationship between gender and any of our scale items. This indicates that a successful intervention that is able to raise capability, competency and/or performance measures is likely to have similar effects regardless of gender. A similar pattern holds for caste.
- For our e-readiness, capability and performance metrics, less experienced artisans have higher scores. For competency however, there is a U-shaped relationship with years of experience.
- E-readiness and capability metrics are positively correlated with education levels. However, the relationship is less stark for competency metrics. Hence, education level appears to play a smaller role in predicting competency.

Next, we model correlations across our scales to better understand how they might be related to each other. Linear regressions show that:

- E-readiness and capability are positively correlated
- Capability and competency are positively correlated
- Competency and performance are positively correlated

The goal of our intervention is to eventually demonstrate that enhancing capability and e-readiness can have a downstream effect on competency and performance. We conduct 2 preliminary mediation analyses to examine whether this hypothesis is plausible.²

- First, we examine **the effect of capability on performance**, using competency as the mediator. We find partial mediation (67%), which indicates that 67% of the effect of capability on performance is through its effect on competency.
- Next, we examine **the effect of e-readiness on performance**, using competency as the mediator. In this case, we do not find a direct effect of e-readiness on performance, and find full mediation (92%), indicating that e-readiness affects performance ONLY through its effect on competency.

This is discussed in details in **Chapter 9**. This suggests that any intervention targeted at enhancing capabilities can have positive trickle down effects.

Some Implementation Challenges and Next Step

Some implementation challenges have been discussed in details in **Chapter 10**. In **Chapter 11**, we have discussed our scope of work from 1st April, 2021 onwards. This includes our structured intervention for 50-weeks, which is now being deployed in the field following the stepped-wedge RCT as our impact assessment methodology. The cluster randomized trial is a firmly established study design particularly useful for pragmatic evaluations of interventions, such as changes to the way services are delivered, educational interventions or public health type interventions, to name but a few³. The stepped-wedge cluster randomized trial (SW-CRT) involves the sequential transition of clusters from control to intervention conditions in randomized order, until all clusters are exposed⁴. In our context, the SW-CRT provides a means to conduct a randomized evaluation which otherwise would not be possible. As “social intermediaries”, we aim to facilitate re-tooling and community building, both of which can be self-sustaining and have the potential to bring concrete socio-economic benefits even after the intervention. In general, our findings can have large scale policy implications for bottom of pyramid (BOP) entrepreneurs by identifying mechanisms through which digital knowledge management tools can lead to greater entrepreneurial success in emerging markets.

² [https://en.wikipedia.org/wiki/Mediation_\(statistics\)](https://en.wikipedia.org/wiki/Mediation_(statistics))

³ Murray DM. Design and Analysis of Group Randomized Trials. New York, NY: Oxford University Press, 1998.

⁴ Ellenberg SS. The stepped-wedge clinical trial: evaluation by rolling deployment. JAMA 2018;319:607–08.



Team Name: The Ciphers
Institute's Name: Heritage Institute of Technology

Proposal Format

Application for Grant of Funds

1.	Name of the Institution with Full Address	Heritage Institute of Technology , Chowbaga Road, Anandapur, P.O.: East Kolkata Township, Kolkata 700 107 Ph. : +91 33 6627 0600/ 0609/ 0614/ 0622 Fax: +91 33 2443 0455 / 1794 E-mail: admin@heritageit.edu
2.	Title of the Research Proposal	Location Based Disaster Management System using IRNSS/NAVIC satellites
3.	Name of the Principal Investigator (Address/Phone/E-mail)	Reshma Roychoudhuri Assistant Professor, Department of CSE Heritage Institute of Technology Kolkata, West Bengal – 700 107 (reshma.roychoudhuri@heritageit.edu)
4.	Name(s) of other investigator(s) with the name(s) of their Institution	N/A
5.	Proposed duration of Research Project	6 months
6.	Amount of grant requested (in Rs.) 1 st Year, 2 nd Year, 3 rd Year Total	Rs. 3 Lakhs
	Manpower	Rs. 1.2 Lakhs (Stipend)
	Equipment	N/A
	Satellite Data/Data	N/A
	Consumables & Supplies	Rs. 0.6 Lakhs
	Internal Travel	Rs 1.2 Lakhs
	Contingency	N/A
	Others	N/A
	Overheads	N/A
Total	Rs. 3 Lakhs	
7.	a) Bio-data of all the Investigators (Format-A). b) Brief description of the Research Proposal with details of budget (Format-B). c) Declaration (Format-C).	
8.	I/We have carefully read the terms and conditions for ISRO Research Grants and agree to abide by them. It is certified that if the research proposal is approved for financial support by ISRO, all basic facilities including administrative support available at our Institution and needed to execute the project will be extended to the Principal Investigator and other Investigators.	



Name	Institution	Designation
Principal Investigator		
Reshma Roychoudhuri	Heritage Institute Of Technology ,Kolkata, West Bengal	Assistant Professor
Head of the Department/Area		
Subhashis Majumder	Heritage Institute Of Technology, Kolkata, West Bengal	Professor & HoD, CSE, Dean UG
Head of the Institution		
Pranay Chaudhuri	Heritage Institute Of Technology, Kolkata, West Bengal	Principal



Proposal Format

1.	Title of the research proposal	Location Based Disaster Management System using IRNSS/NAVIC signals
2.	Summary of the proposed research A Simple concise statement about the investigation, its conduct and the anticipated results in no more than 200 words	The project will send disaster warnings and signals to people residing where a disaster will or has struck. It will also let the governmental departments / military or private institutions communicate among themselves by sending encrypted messages targeted for select group of people or a single person. It will be enabled on mobile devices and will alert users if any message/alerts has come through.
3.	Objectives A brief definition of the objectives and their scientific, technical and techno-economic importance.	<ol style="list-style-type: none"> 1. Geofence the IRNSS/NavIC signals. 2. Creating a data structure for the messages. 3. Create encrypting-decrypting engine 4. Authentication of users. 5. Disaster Management by Location Targeting. 6. Target messages/alerts to concerned departments.
4.	Major Scientific fields of Interest A brief history and basis for the proposal and a demonstration of the need for such an investigation preferably with reference to the possible application of the results to ISRO's activities. A reference should also be made to the latest work being carried out in the field and the present state-of-art of the subject.	<p>Mobile signals cannot reach to every part of the country and cannot travel to areas lying in the sea. Moreover, they can't be trusted when a disaster has struck.</p> <p>The signals from satellite will come into play where the mobile signals cannot reach and guide people against the warnings for disasters.</p> <p>The major scientific fields of interest are handling satellite data, encryption, decryption, mobile technology and data structures.</p> <p>Currently ISRO is able to send short messages using the IRNSS receiver box. We aim to bring that technology in the modern smartphones and feature phones.</p>
5.	Linkages to Space Programme/Deliverables to ISRO on successful completion of the project	It will help ISRO send messages over vast area and nearly 100% delivery rate through their satellites.
6.	Approach A clear description of the concepts to be used in the investigation should be given. Details of the method and procedures for carrying out the investigation with necessary instrumentation and expected time schedules should be included. All supporting studies necessary for the investigation should be identified. The necessary	<p><u>Data Structure:</u> Design a data structure for the messages that will have certain fields corresponding to the data that will be sent by the satellite.</p> <p><u>Geofence Algorithm:</u> The algorithm will be able to create a geofence with the help of given coordinates and check if a give point is in the geofence or not.</p> <p><u>Encryption – decryption engine:</u> AES algorithm will be used to encrypt the public messages regarding Disaster Management. RSA will be used for military, governmental and private purposes. RSA will let every department assign a particular key and that can be used to send messages within that department or even cross-department.</p>



	<p>information of any collaborative arrangement, if existing with other investigators for such studies, should be furnished. The principal Investigator is expected to have worked out his collaborative arrangement himself. For the development of balloon, rocket and satellite-borne payloads it will be necessary to provide relevant details of their design. ISRO should also be informed whether the Institution has adequate facilities for such payload development or will be dependent on ISRO or some other Institution for this purpose.</p>	<p><u>Optimization and Stability of the project:</u> Optimizing the data structure and the algorithms to ensure better performance on mobile devices.</p> <p><u>Developing Android App:</u> Develop the Android app that will receive the data from IRNSS Receiver Module and alert users with the messages.</p> <p>The demo can be ready within 5 months and further improvement can be done accordingly.</p> <p>This is a new idea and has no collaboration with any other department.</p> <p>An IRNSS receiver module is needed to receive the signals and connect to a smartphone to render the messages.</p> <p>The data structure, geofence algorithm, encrypting – decrypting engine and authentication have been developed. We had shown a demo to the judges for the above during the Smart India Hackathon 2018.</p> <p><u>System Architecture :</u></p> <pre> graph TD A[Encryption Engine Geofence Generator] --> B[Message Broadcasted by Satellite] B --> C[Message received in Phone System by IRNSS Receiver Module] C --> D[Check for Point in Geofence] C --> E[Decryption engine] C --> F[Get code from our predefined library for various disasters] C --> G[Format message] D <--> E E <--> F F <--> G D <--> H[GPS Module] E <--> I[Authentication] F <--> J[Disaster Management Library] G <--> K[Notification On Phone] </pre>
7.	<p>Data base and analysis A brief description of the data base and analysis plan should be included. If any assistance is required from ISRO for data analysis purposes, it should be indicated clearly.</p>	<p>We need to plan the development according to the data of the signals sent through the satellites. We will be utilizing the messaging block in the signals, analyze how much is the bandwidth of the data and plan our encryption, decryption and message length according to that.</p> <p>We need an access to send test messages through the satellites to our devices after the demo project is implemented during the pilot phase of the project.</p>
8.	<p>Available Institutional facilities Facilities such as equipment, etc., available at the parent Institution for</p>	<ol style="list-style-type: none"> 1. Equipment 2. Access to send test messages through the satellite to our devices.



	the proposed investigation should be listed.			
9.	Fund Requirement Detailed year wise break-up for the Project budget should be given as follows:			
	Fellowships*	1stYr	2ndYr	3rdYr
	Research Scientist	N/A	N/A	N/A
	Research Associate	N/A	N/A	N/A
	Stipend for students	1,20,000	N/A	N/A
	Total	N/A	N/A	N/A
*Note: please specify the designation, qualification and rate of salary per month for each category				
		1stYr	2ndYr	3rdYr
	Equipment**	N/A	N/A	N/A
	Total	N/A	N/A	N/A
Please specify the various individual items of equipment and indicate foreign exchange requirement, if any				
		1stYr	2ndYr	3rdYr
	Satellite data/data	N/A	N/A	N/A
	Total	N/A	N/A	N/A
		1stYr	2ndYr	3rdYr
	Consumables & Supplies	60,000	N/A	N/A
	Total	N/A	N/A	N/A
		1stYr	2ndYr	3rdYr
	Internal Travel	1,20,000	N/A	N/A
	Total	N/A	N/A	N/A
		1stYr	2ndYr	3rdYr
	Contingencies	N/A	N/A	N/A
	Total	N/A	N/A	N/A
		1stYr	2ndYr	3rdYr
	Others	N/A	N/A	N/A



Total		N/A	N/A	N/A	N/A
		1stYr	2ndYr	3rdYr	Total
Overheads(Overhead Expenses of 20% of Total Project Cost not exceeding 3.00 lakhs)		N/A	N/A	N/A	N/A
Total		3,00,000	N/A	N/A	N/A
10.	Whether the same or similar proposal has been submitted to other funding agencies of Government of India. If Yes please provide details of the institution & status of the proposal.	No			

**Justify each equipment. If computer is proposed, only desktop has to be purchased not laptop

● **Time-Line and responsibility of participating team**

Particulars			Time (months)					
#	Tasks	Team Member's Name	1 st Month	2 nd Month	3 rd Month	4 th Month	5 th Month	6 th Month
1	Requirement Analysis and design	All Members	Get and upgrade requirements to fine tune and add extended feature based on instructions from ISRO. Design of the product and SRS.					
2	Backend Implementation	All Members		Setup the base for the system and add dependencies.	Setup Data structure, Encryption and data encoding.	Setup libraries for various natural events.	Setup Advanced feature and encryption for military use.	
3	Frontend Implementation	Sagar Sangam, Pritam Raj			Develop portal to encode, create, send message for Admin.	Choose encryption type and area for messages.	Feature to choose natural disaster from library, advanced encryption.	



4	UI Design	Deepak Prasad, Aman Aadersh			Design UI prototype using the Agile model for various desired changes and addition of features.	
5	Testing	All Members		Rigorous testing of the product		
6	Integration and Maintenance	All Members			Merge and implement the project.	Support and deployment.
7	Documentation	Deepak Prasad, Sagar Sangam	Documenting the manual and project whenever necessary.			

Funding

The institute will be provided with a onetime grant of INR 3 Lakhs. This money will be spent on stipends of the participants, their travel and logistics cost and satisfying any other technical or budgetary expenditure, which they may incur.

Note: The stipend amount for the teams (having 6 members) for the duration of 6 months @ INR 5,000/- per months per student, amounts to INR 1.8 Lakhs. The remaining INR 1.2 Lakhs has been provisioned for travel and logistics cost; for project related purposes and satisfying any other technical or budgetary expenditures of the concerned team. The Project Investigator/Mentor from the institution will be the approving authority for the disbursement of funds. The Project Investigator/Mentor will have to submit a detailed expenditure utilisation report along with the technical details of the project and it's status, at the end of 6 months (starting from 4th September 2017).

The INR 3 Lakh grant will be utilised for the following:

- **Stipend:** Each team member will receive a consolidated stipend of INR 5,000/- per month. The students will start receiving their stipend from the date of starting of the project, for the duration of next 6 months.

Note: Maximum of 6 students will get the above mentioned stipend. If a team has more students (we have given each team a provision to add one more team member), then the stipend per student will be reduced to accommodate extra members.

- **Long Distance Travel:** Each student will be entitled to AC-III tier train ticket fare for long distance travel. If the individual travels by any other mode, then he/she will have to bear the difference amount from his/her pocket. The amount will be reimbursed on producing the tickets.
- **Short Distance Travel:** Each student will be entitled for reimbursement of amount upto INR 500/- per day for local travel. The individual will have to justify his/her travel and provided relevant bills and receipts. If the bills/receipts are not produced, he/she won't be reimbursed the said amount. In that case, the individual will have to bear the cost from his/her pocket. Any distance within the radius of 100 Km will be considered short distance.



The central point of reference will be the individual's college. Any travel within the radius of 30 km from the college won't be considered for reimbursement.

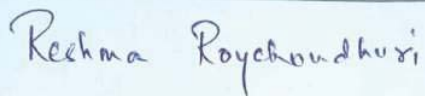


- **Stay:** Each student will be entitled to an amount of upto INR 700/- per day for stay in case of long distance travel. The amount will be considered for reimbursement on producing relevant bills and receipts.
- **Food:** Each student will be entitled to an amount of upto INR 300/- per day for food in case of long distance travel. The amount will be considered for reimbursement on producing relevant bills and receipts.
- **Cost Incurred during Field Visits:** Other than travel and stay, if any other cost is incurred during any field visit to collect data/field survey or to undertake user testing etc (wherever required), each person will be entitled to an allowance of 500/- per day. To claim this amount, a prior approval will have to be taken from AICTE/Hackathon Team for conducting the field visit.
- **Development Cost:** Any cost incurred while development of the prototype into a deployable product, like buying any form of hardware component to complement the software product, or buying user licence to use a proprietary software, etc. the cost will be borne form the grant money.



Declaration

I / We hereby agree to abide by the rules and regulations of ISRO research grants and accept to be governed by all the terms and conditions laid down for this purpose.

I / We certify that I / We have not received any grant-in-aid for the same purpose from any other Department of the Central Government / State Government / Public Sector Enterprise during the period to which the grant relates.

	Signature & Name	Designation
Principal Investigator	 REEHMA ROYCHOWDHURI	ASSISTANT PROFESSOR
Head of the Department / Area	 SUBHASHIS MAJUMDER.	Professor & FIITD, CSE, Dean UG.
Head of the Institution	 Dr. Pranay Chaudhuri Principal	Principal Heritage Institute of Technology

General Information

Title of the Project

Geofencing of data on NavIC/IRNSS Signals

Principal Investigator

Mrs. Reshma Roychoudhuri

Assistant Professor, Heritage Institute of Technology

Kolkata, West Bengal

Student Team Members

Deepak Prasad

C.P. Nagar, Kalipahari,

Maithon, Dhanbad, Jharkhand

Aman Aadersh

Chitra Gupta Nagar, Pokharia,

Ward No. 35,

Begusarai, Bihar

Sagar Sangam

C/O Rajat Kumar Singh,

Near Keshri Bhawan, L.C.T. Ghat Road,

Khalgaon, Bihar

Pritam Raj

Q no- 563/c, D.S. Colony,

Hirapur, Dhanbad, Jharkhand

College Name and Address

Heritage Institute of Technology,
Chowbaga Road, Anandapur,
Kolkata, 700107
West Bengal

ISRO Mentor

Rajat Acharya

ISRO/DOS Centre

SAC, Ahmedabad

Period of the Project

January 2019 – June 2019

Total Grant approved by ISRO

Rs. 3,00,000

Total Amount spent during project

Rs. 1,20,000 (only for stipend)

Abstract of the Report

The project intends to send Disaster Management signals/alerts to areas where disaster has struck using the IRNSS signals. The project use the algorithm of Geofencing to map a disaster-struck area and therefore, target people with messages/alerts in that area only.

A simulation of the Signal from IRNSS is developed for testing the algorithms and use cases. The data will be encrypted as per need and sensitivity and decrypted depending on the geofence intended.

The project consists of two separate parts:

- a. **Admin App:** Part where a signal is constructed, messages encrypted and sent for simulation

- b. **Users' App:** Part where a signal is received from the simulation, and decrypted as per instructions.

Admin App will be developed for Android for easy access, proper authentication

Users' End will also be developed for Android as the final product must be running on Mobile platforms. It will easily receive the signals and check for location in intended Geofence.

Summary

The project aims to provide disaster warnings and alerts in case of one to people in the affected region. The idea was to geofence the affected area so that the alerts will be received only to the affected people. To ensure security, encryption of the signals/messages were to be encrypted.

Data structure for Subframe 3 and 4 were created using Java Objects. These had all the required fields like TLM, TOWC, MESSAGE_ID, etc. Several other data structures were also created. A satellite simulation was built to replicate the IRNSS satellites. This was used to send the messages at a rate of 50 symbols per second.

An Admin App was created where the alert messages were created using by choosing a geofence and entering message data. This Admin App has Fingerprint and PIN protection for security. The message thus created was transferred to the Satellite simulation.

The Satellite simulation receives the message and sends the message to the Users App. The Satellite simulation helps in restricting the message transfer rate to 50 symbols per second, just like the transfer rate of the IRNSS satellites. It is also built for sending messages to multiple connected clients.

The Users' App can receive the message but only will decrypt the message if they are in the specified geofenced area. If they are in the geofenced/affected area, the app will notify the users. Also on clicking on the notification, the users will be able to see the related news to the alert messages if their phone have an internet connection.

The Users' app also has a primitive settings section where they can enable or disable certain types of messages that do not want to be notified of. This gives a control over what they want to be notified of and what not.

If the users are not in the affected/geofenced area, they won't get the alert.

Introduction

Background

This project aims to deliver messages to people in a disaster affected areas and alert them. The purpose is to create a robust platform that will deliver messages via satellite, using the IRNSS's text message sending capability. This will ensure that people in the affected area receive the message even if the disaster-struck area don't have mobile network signal or is in black out.

Objective

The objectives of this project are -

1. Geofence the IRNSS/NavIC signals.
2. Creating a data structure for the messages.
3. Create encrypting-decrypting engine
4. Authentication
5. Disaster Management by Location Targeting.

Software Development

Data Structure

Type

Frame Structure of Satellite signal

Purpose

- Carries the encrypted message data
- Means of communication between Admin App and Users' App

FRAME STRUCTURE

The IRNSS Master Frame is of 2400 symbols long made of four sub frames. Each sub frame is 600 symbols long. Sub frames 1 and 2 transmit fixed primary navigation parameters. Sub frames 3 and 4 transmit secondary navigation parameters in the form of messages. The master frame structure is shown in Figure 10. All subframes transmit TLM, TOWC, Alert, Autonav, Subframe ID, Spare bit, Navigation data, CRC and Tail bits. Subframe 3 and 4 in addition transmit Message ID and PRN ID.

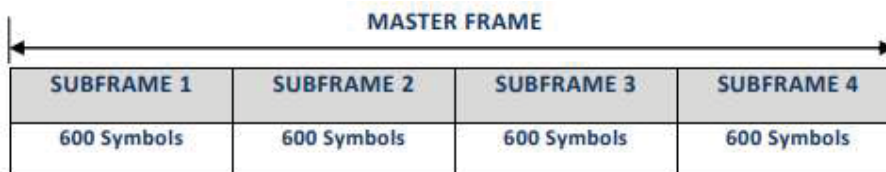


Figure 10: Master Frame Structure

Sub Frame Structure

Each Subframe is 292 bits long (without FEC encoding and Sync Word). The start of each subframe is with TLM word of 8 bits. Each subframe ends with 24 bit CRC followed by 6 tail bits.

In subframes 1 and 2 the Navigation data is allotted 232 bits starting from bit number 31. In subframes 3 and 4 the Navigation data is allotted 220 bits starting from bit number 37. The structure

of a typical subframe 1 & 2 is shown in Figure 11. The structure of a typical subframe 3 & 4 is shown in Figure 12.

1	9	26	27	28	30	31		263	287
TLM	TOWC	ALERT	AUTONAV	SUBFRAME ID	SPARE	DATA		CRC	Tail
8 BITS	17BITS	1 BIT	1 BIT	2 BIT	1 BIT	232 BITS		24BITS	6BITS

Figure 11: Structure of Subframe 1 & 2

1	9	26	27	28	30	31	37		257	263	287
TLM	TOWC	ALERT	AUTONAV	SUBFRAME ID	SPARE	MESSAGE ID	DATA		PRN ID	CRC	Tail
8 BITS	17BITS	1 BIT	1 BIT	2 BIT	1 BIT	6 BITS	220 BITS		6	24 BITS	6 BITS

Figure 12: Structure of Subframe 3 & 4

TLM

The 8 bits of TLM word are reserved for future.

Time of Week Count (TOWC)

Following the TLM word is 17 bits of Time Of Week Count (TOWC). The value of TOWC is multiplied with 12 to obtain the time in seconds corresponding to the start of the next subframe.

Alert Flag

Bit 26 is allotted to the Alert Flag. The Alert flag signifies to users that the utilization of navigation data from that particular satellite shall be at the users' own risk.

AutoNav

Bit 27 is allotted to the AutoNav. Satellites store 7 days ephemeris and clock parameter sets as AutoNav data sets. Satellite can support broadcast of primary navigation parameters from AutoNav data sets with no uplink from ground for maximum of 7 days. During AutoNav mode, the AutoNav flag is set to 1.



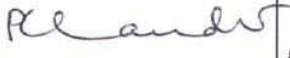

Subframe ID

Each subframe in the master frame can be identified by the 2 bit subframe ID allotted in bit number 28 and 29. The mapping between 2-bit subframe identifier and subframe number is provided in Table 10.



UTILISATION CERTIFICATE

Certified that a sum of Rs. 1, 00,000/- (Rupees One Lakh Only) is received from the BIRAC-SRISTI in favour of **Heritage Institute of Technology** for the research project entitled “**Cost Effective Self-stabilizing Smart Hand Held Platform (spoon/pen) For Elderly Or Parkinson's Disease Patients**” via sanction letter dated 14.03.2017, of which Rs. 16,926/- has been utilised for the purpose for which it was sanctioned, in accordance with the terms and conditions laid down by BIRAC-SRISTI.

			
Signature of the Principal Investigator/ Awardee	Signature of the Supervisor	PRINCIPAL (head of the Institute)	Signature of the Competent Financial authority

Principal
Professor *[Name]*
Applied Electronics & Instrumentation
Heritage Institute of Technology, Kolkata

Chief Financial Officer
HERITAGE INSTITUTE OF TECHNOLOGY

Heritage Institute of Technology

(An Autonomous Institute under MAKAUT, WB)
(An Initiative of Kalyan Bharti Trust)



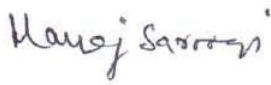


STATEMENT OF EXPENDITURE

Cost Effective Self-stabilizing Smart Hand Held Platform (spoon/pen) For Elderly or Parkinson's Disease Patients

BIRAC SRISTI PMU 2017

S. No.	Sanctioned Head	Total Funds Allocated	Expenditure Incurred First Six months (14.03.17 to 31.08.17)	Total Expenditure till 31.08.17	Balance as on 31.08.17
1.	Scholarship	30,000/-	Nil	Nil	30,000/-
2.	Consumables & Materials	40,000/-	Nil	Nil	40,000/-
3.	Internal Travel	20,000/-	16,926/-	16,926/-	3,074/-
4.	Outsourcing	10,000/-	Nil	Nil	10,000/-

		
Signature of the Principal Investigator/ Awardee	Signature of the Supervisor	Signature of the Competent Financial authority

Professor & HOD
Applied Electronics & Instrumentation
Heritage Institute of Technology, Kolkata

Chief Financial Officer
HERITAGE INSTITUTE OF TECHNOLOGY

Heritage Institute of Technology
(An Autonomous Institute under MAKAUT, WB)
(An Initiative of Kalyan Bharti Trust)

To

22/09/2017

BIRAC SRISTI PMU,
AES Boy's Hostel Campus,
Nr. Gujarat University Library and SBI Bank,
Navrangpura,
Ahmedabad-380 009
India

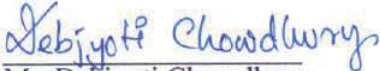
Sub: Submission of **Utilization Certificate** for research project "**Cost Effective Self-stabilizing Smart Hand Held Platform (spoon/pen) For Elderly for Parkinson's Disease Patients**"

Respected Sir/Mam,

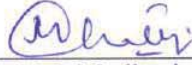
With reference to subject mentioned above, I am submitting herewith the utilization certificate, statement of expenditure and brief project report relating to the research project entitled "Cost Effective Self-stabilizing Smart Hand Held Platform (spoon/pen) For Elderly for Parkinson's Disease Patients".

Thanking you,

Yours faithfully


Mr. Debjyoti Chowdhury

(Awardee)
Assistant Professor,
AEIE Dept.,
Heritage Inst. of Tech,
Kolkata-107


Prof. (Dr.) Madhurima Chattopadhyay

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Cost Effective Self-stabilizing Smart Hand Held Platform (spoon/pen) For Elderly for Parkinson's Disease Patients

Starting date: 14th March, 2017
Project Duration: 1 year



Prof. (Dr.) Madhurima Chattopadhyay
(supervisor)



Mr. Debjyoti Chowdhury
(awardee)

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Kolkata, Pin-700107

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1. Introduction:

Parkinson's disease is a persistent and progressive neurodegenerative disorder, affecting 3% of the population over the age of 65 years and there are more than 10 million people worldwide are living with Parkinson's disease. Parkinson's involves malfunction of neurons in an area of the brain called the substantia nigra which produce dopamine that helps nerve cells to communicate. The motor symptoms of the Parkinson's disease are hand tremor, bradykinesia, rigidity and impair postural balance. The frequency range of hand tremor falls in range of 4Hz to 6Hz. The patients suffering from hand tremor of Parkinson's disease are unable to do their normal work. The main problem faced by the patient with Parkinson's disease is while eating their food. This paper deals with a real time development of MEMS accelerometer based self-stabilized spoon which enables the Parkinson's disease patients to have their food without any hindrance. The proposed system consists of a three degree of freedom (DOF) MEMS accelerometer which detects the direction and acceleration of hand tremor. A low power microcontroller determines the stage of the tremor and drives a spoon connected to a 9gm servomotor. The rotational direction of the 9gm servomotor is opposite to that of the detected hand tremor, these helps to stabilize the spoon. The on board processor uses two bidirectional i²c based open drain Serial Data Line (SDA) and Serial Clock Line (SCL), internal bus lines to communicate with the MEMS accelerometer, the PWM register and the servomotor for driving the motor.

2. Objectives of the specific phase:

- a. **Development of low power spoon actuator:** The current device uses servo motor for spoon actuation, this motor draws a lot of current (>500mA). This reduces battery longevity so custom EM (Electro-Magnetic) actuator that consumes less power needed.
- b. **Redesign the spoon PCB with SMD components:** To give the spoon much more ergonomic design the existing discrete components will be replaced by SMD (Surface Mount Device) components on a redesigned PCB (Printed Circuit Board).

3. Summary of phase (% of the milestones achieved in that phase):

- a. **Actuator:** The initial goal to develop a 2 DOF EM actuator was replaced with a roll-pitch servo arrangement shown in Fig.1, this increases the spoon's ability to counteract both lateral and transverse hand tremors. This agility comes at the cost of increased power consumption in the device; hence, the standard AA battery in the spoon is replaced with a 7.4Wh rechargeable Li-ion battery.



Fig.1 The yaw-roll servo arrangement in the newly designed spoon actuator

- b. Redesigned PCB:** The initial prototype was made out of a 28-pin DIP packaged AVR i.e. Atmega 328p shown in Fig. 2, this included an off the shelf SMD Accelerometer MPU6050.

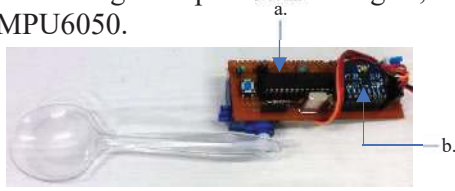


Fig. 2 The initial prototype with discrete AVR, with a) Discrete Atmega 328p and b) MEMS accelerometer



Fig.3 The SMD version of the circuit board

4. Detailed Report with all the results and outputs:

- a. Kalman Filter** The implementation of Kalman Filter for the hand held self-stabilizing spoon is based on. Equation 1 represents the state space implementation of the Kalman filter for this purpose.

$$\begin{pmatrix} \alpha \\ \beta \end{pmatrix}_{k+1} = \begin{pmatrix} 1 & -dt \\ 0 & 1 \end{pmatrix} \begin{pmatrix} \alpha \\ \beta \end{pmatrix}_{k+1} + \begin{pmatrix} dt \\ 0 \end{pmatrix} u_k \quad (1)$$

Where, U_k is reading from the accelerometer, α and β are chosen arbitrary for the first sample. Parameter α is estimated acceleration and β is accelerometer bias. Since the developed hand held device is built around a general-purpose microcontroller, the matrices operation is converted into several ordinary mathematics equations. Therefore, above Eq. 1 can be written as Eq. 2 and Eq.3.

$$\alpha_{k+1} = \alpha_k - b \cdot dt + u_k dt \quad (2)$$

$$b_{k+1} = b_k \quad (3)$$

The above Eq.2 and Eq.3 can also be written as Eq.4.

$$\alpha_{k+1} = \alpha_k - (u_k - b_k) dt \quad (4)$$

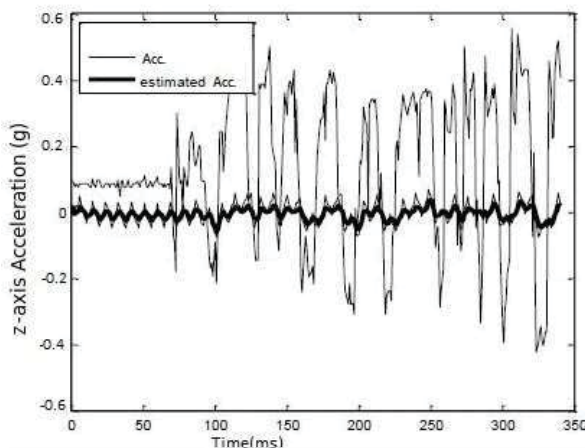


Fig.4 Estimated acceleration from the Kalman Filter with 0.0001 as measurement covariance noise

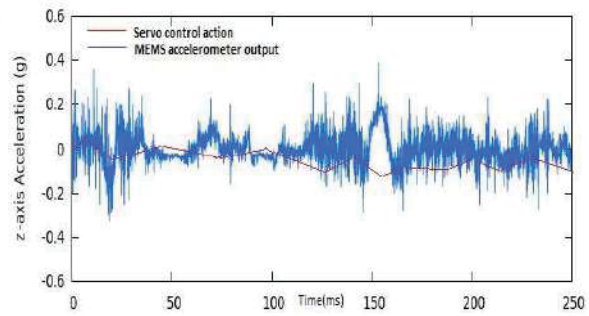


Fig.5 The Servo action for change in MEMS accelerometer read out

Figure 4, including the filtered signal from the IMU, shows the output from the MEMS accelerometer. The real time implemented device comes as a hand held device, with the tri-axial MEMS accelerometer MPU6050 mounted on the handle of the spoon. An on-board processor, Atmega 328 reads the accelerometer data and sends it over for Kalman filtering. The on board processor uses two bidirectional i2c (Inter-Integrated Circuit) based open drain Serial Data Line (SDA) and Serial Clock Line (SCL), internal bus lines to communicate with the slave MEMS peripheral sensor.

5. Plan for the next phase (Milestones to be achieved in the next phase):

- a. Retuning of the Kalman Filter:** The Kalman filter is used to reduce the noise from the MEMS accelerometer, so after remaking the PCB because the MEMS accelerometer will be repositioned the Kalman will have to be re-tuned.
- b. Test with patients:** The spoon with new actuator and PCB design will have to be tested with patients.
- c. Development of a 3D printed enclosure:** Once the new PCB passes the initial viability test, a 3D printed enclosure will be fabricated for the final prototype
- d. Test with patients:** The final prototype will be tested with patients.

6. Expected output (At the end of the project):

The final product to be developed will have a 3D printed enclosure and detachable spoon adapter.

7. Expected date of completion: 14/03/2018

8. Overall Conclusion:

In this work, the proposed hand held self-stabilizing device consists of a MEMS accelerometer system, which generates a stream of acceleration data for the hands tremors recorded in Parkinson's disease patients. The analysis on acceleration data is done on the device itself that is then used to actuate the servo motor.

Date: 12.02.2020

To,
The Senior Scientific Officer,
Department of Science Of Technology,
Government of West Bengal,
Vigyan Chetana Bhavan,
Plot No. 26/B. Block DD. Sector – I,
Salt Lake, Kolkata – 64.

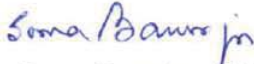
Sub: Submission of annual report (Third year)

Respected Sir,

This is to state that myself, Dr. Soma Banerjee, is the Principal Investigator of the project “Screening of potential biofilm producer isolates from clinical samples and in vitro determination of killing kinetics by application of some herbal agents with known anti-inflammatory action and application in animal model.(9G-38)” funded by WBDST. I am here by submitting the Annual report for the last and final year 2018-19 (Third year).

I will be grateful to you if you do the needful in this regard.

Thanking you,
Yours sincerely,


Dr. Soma Banerjee (PI-9G-38)
Assistant Professor,
Heritage Institute of Technology,
Kolkata- 107

Dr. Soma Banerjee
Principal Investigator
WB-DST 9G-38, HITK

Enclosures:

1. Report (2 copies),
2. Utilization certificate (5 copies)

Annexure - A
UTILISATION CERTIFICATE IN RESPECT OF GRANT-IN-AID

No.

Date: 09.12.2019

1. Name of the Grantee Institute (s) : **HERITAGE INSTITUTE OF TECHNOLOGY**
[Attach separate list for more than one Grantee Institution]

2. Sanctioning Authority: **SCIENCE & TECHNOLOGY and BIOTECHNOLOGY**

3. Sanction Order Number & Date : **979(Sanc.)/ST/P/S&T/9G-38/2013**

4. Amount Sanctioned: **Rs. 3, 81,900.00**

5. Drawing & Disbursing Officer: **REGISTRAR, SCIENCE & TECHNOLOGY and
BIOTECHNOLOGY DEPT.**

6. Treasury/PAO: **PAY & ACCOUNTS OFFICE – III, PAO - III**
[From where the bill was drawn]

7. Bill No. & Date :

8. T. V. No. & Date :

9. Amount Drawn : **Rs. 3, 81,900.00**

10. Unspent Balance of Previous year, if any : **NIL**

11. Amount Utilized : **Rs. 3, 81,900.00**

12. Unspent Balance, if any, in Current year : **NIL**

13. Purpose of Utilization: **RESEARCH AND DEVELOPMENT**



Soma Banerjee
Signature of Principal Investigator

Dr. Soma Banerjee
Principal Investigator
WB-DST 9G-38, HITK

R. R. R.
Signature of Principal

Principal
Heritage Institute of Technology

Manoj Sarangi
Signature of Accounts Head

Chief Financial Officer
HERITAGE INSTITUTE OF TECHNOLOGY

Third year report

Screening of potential biofilm producer isolates from clinical samples and *in vitro* determination of killing kinetics by application of some herbal agents with known anti-inflammatory action and application in animal model. (9G-38)

Principal Investigator:

Dr. Soma Banerjee*

Co-Investigator(s)

Prof. (Dr.) Prasanta.Kumar Maiti¹

Dr.Anjan Adhikari²

Institution:

***Department of Biotechnology, Heritage Institute of Technology**

Chowbaga Road Anandapur, P.O. East Kolkata Township , Kolkata-700107.

1. Department of Microbiology, IPGMER Medical College, 244 A.J.C. Bose Road, Kolkata – 700020

2. Department of Pharmacology, RG Kar Medical College, 1 Khudiram Bose Sarani Kolkata-700004.

INTRODUCTION

Biofilm is a community of cells attached to either a biotic or abiotic surface enclosed in a complex exopolymeric substance (EPS). It is a sessile community of microorganisms which are attached to an interface or to each other and are embedded in an exo-polysaccharide (EPS) matrix. It manifests an altered growth rate and transcribes genes that free floating organisms do not transcribe. Here surface adhesion of the bacteria is an essential step and is required for the bacteria to arrange themselves favourably in their environment. After adherence to a surface, these microorganisms adapt to the environment of the biofilm by increasing the secretion of EPS. The complex nature of biofilm formation causes its regulation through different stages via diverse mechanisms. The most studied regulatory mechanism that has been found to control the production of EPS, biofilm formation and differentiation is the quorum sensing (QS) regulation.[1]

They have been found to cause a wide variety of biofilm associated microbial infections in the body, such as in urinary tract infections, catheter infections, middle-ear infections, formation of dental plaques and several others which are caused by several microbes including both Gram positive and Gram negative bacteria those have the capacity to form biofilms. Bacteria commonly involved include *Staphylococcus aureus*, *Escherichia coli*, *Enterococcus faecalis*, *Klebsiella pneumonia*. [2] To prevent biofilm formation certain strategies have been developed that targets different biofilm developmental stages i.e the by inhibiting the adhesion of bacteria to living or non-living surfaces at the initial stage, which reduces the chance of further development and establishment of biofilm; disruption of biofilm architecture during maturation process; inhibition of QS by signal interference approach. Cell aggregation and biofilm accumulation are mediated by the products of a gene locus.[3]

There are many factors responsible for microbial resistance is the biofilm formation by the microbes that allow them to withstand antimicrobial agents and extreme environmental conditions due to the lack of penetration of antimicrobial agents. The conventional mode of biofilm abolition is by higher dose of antibiotics treatment, but increased tolerance of biofilm to antibiotics makes the eradication difficult. Therefore, there is a need to search for alternative therapies for the treatment of various infections with negligible side effects where plants now proved to be a good choice. Plants are enriched with many phytochemicals i.e. secondary metabolites such as peptides,

unsaturated long-chain aldehydes, alkaloidal constituents, essential oils, phenols [4] which show antibacterial properties against a number of human pathogens.

In first year screening of 107 clinical isolates were done following different methods out of which 53 isolates were found to be biofilm formers. Antibiotic resistance pattern between biofilm producing organisms and the biofilm non producers were then compared using several antibiotics. Further reference strain of biofilm former *Staphylococcus aureus* ATCC 25923 was established on a substrate system – chitin flakes and it was confirmed using SEM and FT-IR analysis.

The second year study showed the sensitivity pattern of the selected medical/ herbal plants viz. *Curcuma longa* (Haldi), *Azadirachta indica* (Neem), *Ocimum sanctum* (Tulsi), *Aloe vera*, *Allium sativum* (Garlic) against the 53 strong biofilm formers. Three strong biofilm formers viz. *Staphylococcus aureus* UC9/1, *Acinetobacter baumannii* QA7, *Pseudomonas aeruginosa* P2 were selected for further study. Out of the selected medicinal plants *Curcuma longa* (Haldi), *Azadirachta indica* (Neem) showed effectiveness when biofilm biomass formation were assessed by studying the metabolic activities of selected strains, thus, these two plants were considered further. Both planktonic and sessile form of bacteria were studied for all the 3 strains in a simple *in vitro* system with Chitin flakes as the substrate for biofilm adhesion. Viable count of both the phase were determined after plant extracts challenge to combat biofilm infection.

Antimicrobial penetration ability of the plant extract through the biofilm of *Staphylococcus aureus* UC9/1 formed on polycarbonate membrane filters as a substrate was also studied in the second year.

Objective of the project for the third year

1. Antimicrobial penetration study of *Curcuma longa* (Haldi), *Azadirachta indica* (Neem) against *Acinetobacter baumannii* QA7, *Pseudomonas aeruginosa* P2 biofilms in polycarbonate membrane filters.
2. Formation of biofilm *in vivo* on rat model and study of antibiofilm activity of *Curcuma longa* (Haldi) on open wound infection by *Staphylococcus aureus* UC9/1.

MATERIAL AND METHODS

Out of the total 107 bacterial isolates collected over a period of 10 months from Department of Microbiology, The Institute of Post-Graduate Medical Education and Research and Seth Sukhlal Karnani Memorial Hospital (IPGMER and SSKM Hospital), Kolkata from different

patients with specific sources viz. blood, infected devices, skin surface, urine and pus where there is a chance of biofilm formation, 53 were biofilm formers.

- **Plant decoction preparation**

For the present part of work herbal plants *Curcuma longa* (Haldi), *Azadirachta indica* (Neem) were chosen. The matured twig with proper inflorescence of *Azadirachta indica* (Neem) was collected from local garden, Heritage Institution of Institution, Kolkata. Other was bought from local markets. The leaves and tubers were dried at room temperature. The dried leaves and tubers were powdered by using grinder to coarse powder, packed into Soxhlet column and then extracted with 70 % ethanol for 24 hours (h). The extract was evaporated to dryness. The obtained crude extract was stored in airtight container in refrigerator at -4°C for further studies.

- **Antimicrobial penetration study of bacterial biofilms in polycarbonate membrane filters.**

The biofilms of *Acinetobacter baumannii* QA7, *Pseudomonas aeruginosa* P2 were grown on white polycarbonate membranes according to the method of Anderlet *al*, 2000 [7] with modifications. A drop of the diluted culture was used to seed the polycarbonate membranes (diameter, 13 mm; pore size, 0.4 µm) placed on tryptic soy agar plates. The plates were inverted and incubated at 37°C for 48 h, with the membrane-supported biofilms transferred to fresh culture medium every 24 h.

The membrane-supported biofilms were transferred to Mueller–Hinton agar (MHA) plates inoculated with bacterial strains set to McFarland standard 0.5, so as to give a confluent lawn of growth after incubation. Antibiotic discs of Gentamicin and Vancomycin pre-moistened with sterile water placed on top of it. Similarly, plant extracts were added to sterile filter discs and placed on top of the membrane supported biofilms. Wetting the discs prevented antibiotic movement via capillary action through the biofilm. Control assemblies consisting of sterile membranes and antibiotic discs, without biofilm, were set up in parallel. The plates were incubated for 24 h at 37°C and the zones of growth inhibition on MHA plates with test and control assemblies were measured. The biofilms were then washed with normal saline by vortexing for 1 min to remove non-adherent cells and viable counts were determined. Experiments were performed in triplicate.

- **Toxicity study**

The toxicity study of the ethanolic and the fresh plant extract was performed as per the standard protocol²². Adult male rats, weighing between 200-250 grams were taken for the study. Five rats

were taken in Group I for study of ethanolic ointment and another five rats were taken in Group II for study of fresh plant extract. They were kept 7 days in the animal house at 22°C to 25°C. Common rat diet of the animal house and unlimited supply of water was provided for the animals. For testing of possible toxic effect of the ethanolic extract, 10% ointment of ethanolic extract was used. The fresh plant extract was used undiluted.

The fur of the rats was removed by VEETR [Rackitt Benckiser (India) Limited] ointment application before the experiment. The body parts were washed by distilled water thoroughly after removal of hairs. More than 10% of the body part of the test animals was made hair free. The animals of Group I were treated with 10% ointment of the ethanolic extract and animals of Group II were treated with fresh plant extracts of *Curcuma longa* on the skin surface and the ointment as well as the fresh extract was kept in close contact with the skin with a porous gauze dressing and non-irritating tape for 24 hours. The ointment/fresh extract was changed daily. The experiment was repeated for 14 days.

- **Study of efficacy on wound healing in rats**

For this study, 10% ointment of ethanolic extract of *C. longa* was made¹⁹. The fresh extract was used as such.

The rats were divided into two groups (three animals each), Group I- Control, Group II- biofilm infected wound treated with *C. longa* ointment Group III- wound treated with Povidone Iodine. The rats were anesthetized by intramuscular injection of Xylazine (10 mg/kg body weight) and Ketamin (40 mg/ kg body weight). The hair of the animals was removed carefully with hair removable cream VEET. Punch wounds were prepared by an 8 mm. diameter skin biopsy punch and was infected with *Staphylococcus aureus* UC9/1 for biofilm formation. The animals were placed in the cage with restricted movement to protect the wound area from licking or causing damage by paw or teeth. The ointments were applied thrice daily.

Study of wound healing activities

Physical studies

(a) Contraction of wound size

The wounds were measured by tracing the wound margin on a butter paper and then measured by a thread and the thread was measured by a scale. Then the length of the thread was considered as a boundary of a circle from there the area was measured. The healing of wound was considered on the day when encrustation was automatically removed and no measurable gap was found in the wound area. This was measured on different days (0, 3, 6, 9, 12 and 15 days post treatment wound), in mm.

(b) Wound healing index

Calculation of Wound Index was an arbitrary method of numerical expression of condition of the wound calculated⁶.

Collection and staining of samples for histopathological study

Samples were harvested by punch biopsy from the wound site at regular intervals as per the protocol. After collection, the samples were preserved in 10% Neutral Buffer Formalin solution for routine histopathological study. The sections of five micron thickness were obtained from each sample and the slides were stained with routine Haematoxilin and Eosine method²⁹.

RESULT

- **Antimicrobial penetration study of bacterial biofilms in polycarbonate membrane filters.**

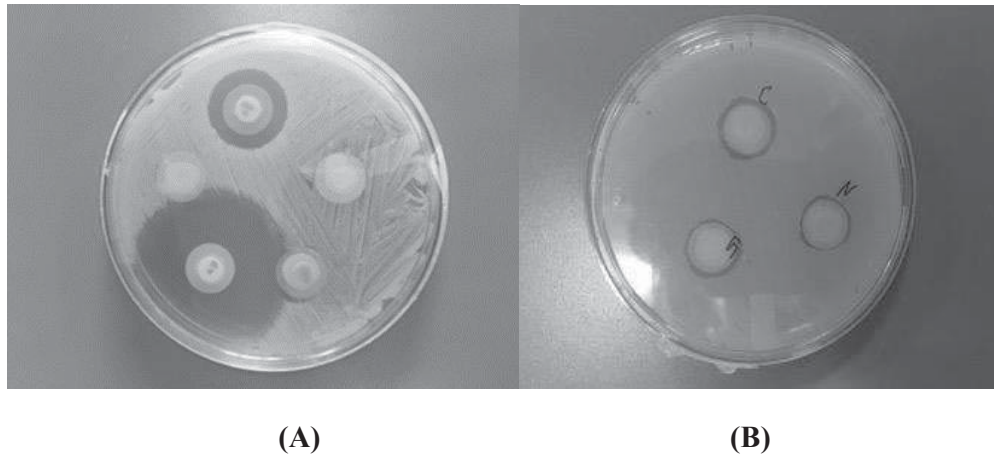


Fig 1. Zone of inhibitions of antimicrobials (A)Gentamycin (10 μ g), Vancomycin(10 μ g) with control(B) showing zones for Haldi (20mg) and Neem extract(20mg) on *Acenitobacterbaumani*QA7 biofilm.

PUBLICATION

RimashreeBaishya, Ankita Singh, Bhoomika Basu Mallik, AsmitaDewanjee, Prasanta Kumar Maiti, Kumkum Bhattacharya, Soma Banerjee
Antibacterial Activity Of *Mikania Scandens* (L.) Willd. Against MultidrugResistant Bacterial Pathogens Isolated From Clinical Samples. *International Journal of Applied Biology and Pharmaceutical Technology*.2017: 8(4): 1-4.

AWARDS

RimashreeBaishya, Arisha Arora, P.K.Maiti, Anjan Adhikari, Soma Banerjee. Anti Biofilm And Antibacterial Activity Of Plant Extracts Against Bacterial Specimens. National Seminar On “Biotechnology In Human Health And Environment” .Seth AnandramJaipuria College, Kolkata (23rd March , 2018). **BEST POSTER PRESENTATION AWARD.**

Progress Report

ON

Design and Fabrication of Pt- free/low level Pt Nano catalysts for Oxygen Reduction Reaction (ORR) in low temperature Fuel cell

Sanctioned Letter No. : 01(2847)/16/EMR-II dated: 12.05.2016

Period : 1st August, 2016 to 31st January, 2020

Date of Commencement: 01.08.2016

Submitted to

**Council of Scientific and Industrial Research
Extramural Research Division
CSIR Complex, Pusa
New Delhi-110012**

By

Prof. Jayati Datta



DEPARTMENT OF CHEMISTRY

Heritage Institute of Technology, Kolkata

Chowbaga Road, P.O East Kolkata Township, Anandapur, Kolkata,

West Bengal 700107

Progress Report of the Project 01(2847)/16/EMR-II

Broad objective: Studies in this scheme are devoted toward the electro-catalysis in low temperature fuel cell: Ethanol Oxidation Reaction (EOR) and Oxygen Reduction Reaction (ORR). The primary objective is to develop new and novel materials for faster electrode kinetics in anodic and cathodic reactions with newer approaches. Excerpts from the entire work activities under the above project are furnished below (publication enclosed).

I. Focus on low Pt electrocatalysts: Use of additional co-metal with Pt in the anode & cathode matrices (Pt-Pd/C, Pt-Ni/C and Pt-Co/C in both EOR & ORR).

Experimental outline of synthesis and fabrication of Pt-Pd (1:1)/C & Pt-Ni (1:1)/C nano materials:

Required amount of mesoporous Vulcan Xc-72 was taken in deionised water and dispersed thoroughly by alternative stirring and sonication. Then requisite amount of metal precursor solution (H_2PtCl_6 , PdCl_2 and $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$) was added and reduced by subsequent addition of NaBH_4 . The product was centrifuged, washed and dried in oven to get the desired metal catalysts.

Result and discussion

Morphology and materials characterization

The TEM images shows that the metal nanoparticles (NPs) grow with a spherical geometry having particle size 3-4, 4-5, 3 and 7-9 nm for Pt/C, $\text{Pt}_{45}\text{Pd}_{55}/\text{C}$, $\text{Pt}_{59}\text{Ni}_{41}/\text{C}$ and $\text{Pt}_{44}\text{Co}_{56}/\text{C}$ respectively.

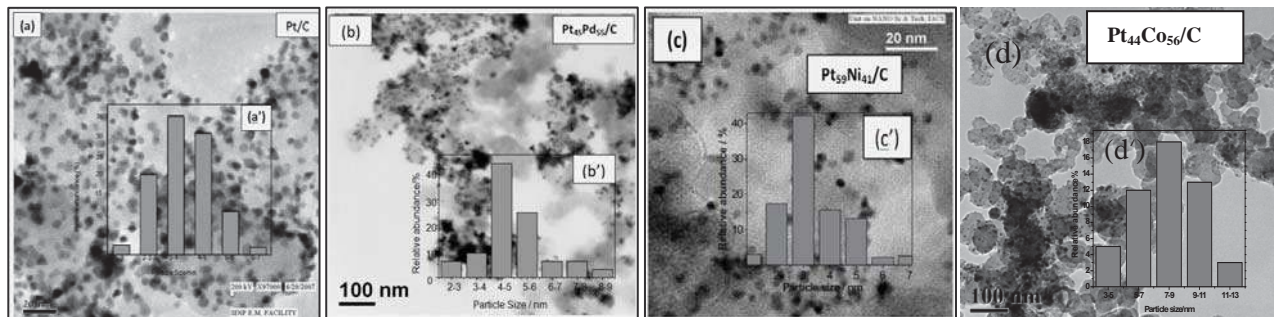


Fig.1 TEM image (a) Pt/C; (b) Pt-Pd/C; (c) Pt-Ni/C and (d) Pt-Co/C electrocatalyst.

Electrochemical Characterization:

Electrochemical measurements were conducted using a computer controlled potentiostat / galvanostat with PG STAT 12 and FRA modules (Metrohm, A.G., Switzerland). Experiments were carried out in a glass cell using a conventional three electrode set up incorporating Hg-HgO reference electrode (-0.14 V vs. SHE), a bright Pt-foil (10 mm x 10 mm) counter electrode and our fabricated catalyst as working electrode at room temperature. For EOR synthesized catalyst was fabricated on graphitic block with exposed area of 0.65 cm^2 . For EOR, the electrolyte contained 0.5 M NaOH and 1.0 M ethanol purged with nitrogen (99.9%) for 20 min before starting each of the experiments.

EOR catalysis:

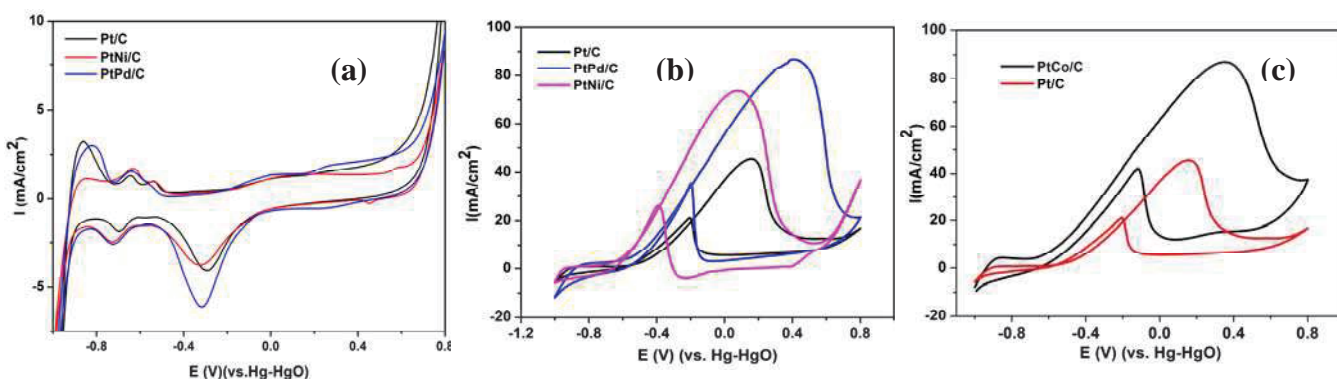


Fig.2. Cyclic voltammograms of Pt/C, Pt-Pd/C, Pt-Ni/C catalysts in (a) 0.5 (M) NaOH at 50mVs^{-1} scan rate (b) 0.5 (M) NaOH and 1.0 (M) ethanol solution at 50mVs^{-1} scan rate (c) Cyclic voltammograms of Pt/C and Pt-Co/C in 0.5 (M) NaOH and 1.0 (M) EtOH.

Fig.2(a) describes the cyclic voltammogram of the catalysts with characteristic feature of hydrogen adsorption-desorption (HAD), double layer charging region, oxide formation and adsorbed oxide reduction (AOR). EOR peak current density output of ~ 86 mA/cm^2 and ~ 74 mA/cm^2 and ~ 87 mA/cm^2 is obtained for Pt-Pd/C, Pt-Ni/C and Pt-Co/C respectively which is better than Pt/C (~ 45 mA/cm^2) and serve the purpose of economic viability as well as better performance.

Relevant Publications: A. Dutta, R. Adhikary, P. Broekmann, J. Datta*, Intelligent catalytic support by Ni / NiO /Ni(OH)₂ in low level of Pd/Pt boosting the performance of alkaline DEFC, **Applied Catalysis B: Environmental**, Vol. 257, 2019, 117847.

A. Mondal, A. De, and J. Datta*, Selective methodology for developing PtCo NPs

ORR catalysis:

In ORR the working electrodes were fabricated by loading of synthesized nano-catalysts as ink on the glassy carbon (GC) rotating disc electrode (RDE) (area = 0.07071 cm²) and allowed to dry properly. For ORR, the electrolyte contained 0.5 M NaOH saturated with oxygen by purging oxygen gas (XL grade, BOC India Ltd.) for 30 min before starting each of the experiments. All the test solutions were prepared using Milli-Q water and experiments were done at room temperature.

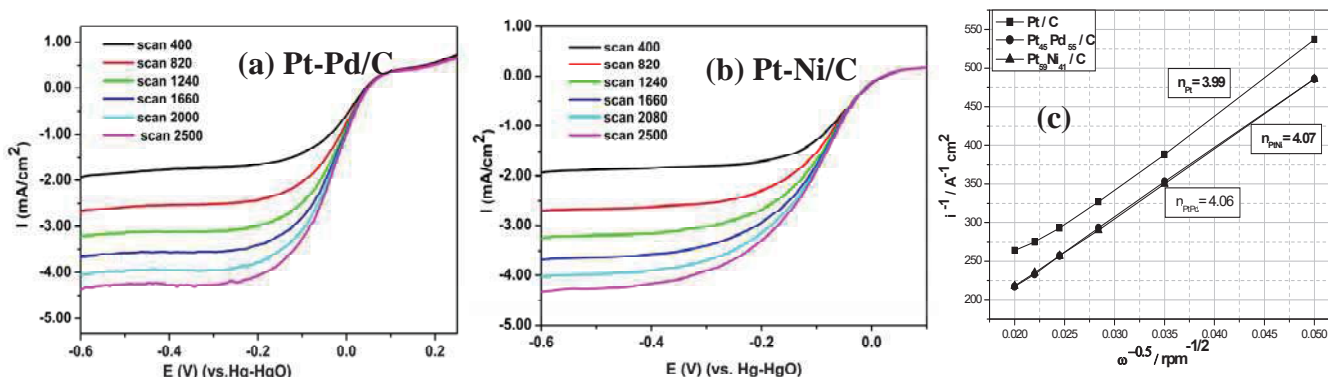


Fig.3. Linear sweep voltammograms of (a) Pt-Pd/C, (b) Pt-Ni/C catalysts in 0.5(M) NaOH saturated with oxygen at 10mVs⁻¹ scan rate at different rotation speed (400-2400rpm). (c) Levich – Koutecky plot of Pt/C, Pt-Pd/C and Pt-Ni/C catalysts.

Fig.3(a) and Fig.3(b) represent the characteristic LSV plot for Pt-Pd/C and Pt-Ni/C and gives a limiting current density value of 4.4 mA/cm² and 4.35 mA/cm² respectively. Fig.3(c) represents the Levich – Koutecky plot of Pt/C, Pt-Pd/C and Pt-Ni/C catalysts. The number of electron exchanged (n) calculated from L-K plot gives a value ~ 4, which indicates complete conversion of O₂ to OH⁻.

Above work to be communicated.

II. Focus on Pt-free electrocatalysts: Use of transition co-metals with Pd in anode & cathode matrices.

Synthesis and Fabrication: Carbon supported Pd-Co [Pd-Co/C] and Pd-Ni [Pd-Ni/C] catalysts were synthesized by ethylene glycol reduction method. Commercially available carbon powder

ANNUAL PROGRESS REPORT

Formulation and Fabrication of composite Titania Matrix with Surface Plasmon and Quantum dots for use in Dye Sensitized Solar Cell and Sensor systems

Sanction Letter: SR/NM/NS-1385/2014 (G)&(C) dated 20.11.2015

Date of Commencement: 1st January, 2016

Period: 1st January, 2016 – 30th April, 2018

**Principal Investigator: Professor (Dr.) Jayati Datta,
Department of Chemistry, Heritage Institute of Technology Kolkata,
Kolkata 700107
(Previously, Department of Chemistry Indian Institute of Engineering
Science and Technology, Shibpur)**

**Co- Investigator: Dr. Partha Bhattacharyya,
Department of Electronics and Telecommunication
Engineering, Indian Institute of Engineering Science and
Technology, Shibpur.**

**Financial support by
DEPARTMENT OF SCIENCE AND TECHNOLOGY-NANO MISSION
GOVT. OF INDIA, NEW DELHI**

PROGRESS REPORT

1. Project Title: Formulation and Fabrication of composite Titania Matrix with Surface Plasmon and Quantum dots for use in Dye Sensitized Solar Cell and Sensor systems	DST No: SR/NM/NS-1385/2014 (G) dated: 20.11.2015
PI (Name & Address): Dr. Jayati Datta, Department of Chemistry, Indian Institute of Engineering Science and Technology, Shibpur (Formerly Bengal Engineering and Science University, Shibpur), P.O. Botanic Garden, Howrah – 711 103, West Bengal	Date of Birth 21.11.1953
Co-PI (Name & Address): Dr. Partha Bhattacharyya, Department of Electronics and telecommunication Engineering, Indian Institute of Engineering Science and Technology, Shibpur (Formerly Bengal Engineering and Science University, Shibpur), P.O. Botanic Garden, Howrah – 711 103, West Bengal	Date of Birth 22.02.1978
<p>1. Broad area of Research</p> <p>1.1 Sub Area: NANO SCIENCE/NANO TECHNOLOGY</p> <p>2. Approved Objectives of the Proposal :</p> <p>The major objective of the scheme involves introduction of a Ru based dye onto a selected range of tailor made TiO₂/ZnO matrices modified with plasmonic metal and/or semiconductor NPs to improve the photon absorption capacity of the dye by localized surface plasmon resonance phenomenon on one hand and to promote conjugate photo-sensitization effect on the other, in a in-house fabricated DSSC. Attempt are to be taken to introduce graphene oxide in the anode matrix as well as to fabricate Quantum dot sensitized Hybrid Solar Cell in the final phase.</p> <p>Application of functionalized TiO₂ nano structures toward fabricating sensor device for quality control of fast, low ppm and low/room temperature volatile organic compounds related to fruits and vegetables degradation were also under investigation. Modest theoretical approach on first principles DFT simulation of the electronic and structural properties of wide band-gap semiconductors and correlation of HOMO and LUMO energies of the dye were also proposed in the original scheme.</p> <p>Based on the equipment sanctioned (only for DSSC studies), the objective is oriented toward comprehensive work on in-house fabricated DSSC and QDSC systems.</p>	
Date of Start: 01.01.2016 (Manpower Recruitment: RA dt. 05.04.2016 & JRF dt. 21.06.2016)	Total cost of Project: Rs. 1,76,43,200/-
Date of completion: 31.12.2018	Expenditure as on 20.11.2017: Rs. 1,44,87,310/-

3. Methodology :

(i) Synthesis of TiO₂ matrix and substrate modification:

- (1) Nano structured TiO₂ matrix developed and optimized using chemical route on FTO substrate.
- (2) Surface plasmon modified Titania: Ag and Au NPs embedded on TiO₂ developed under various methodologies like UV assisted technique, sol method and others. In the second phase decoration of titania with bi-layer deposition of Ag/Au has been undertaken.
- (3) Epitaxial growth of Cd chalcogenide on TiO₂ layer: Modification by intermixing of low and high energy material include CdX over layer (CdS, CdSe, CdTe) onto TiO₂ adopting chemical (CBD) and electrochemical deposition techniques.
- (4) Increasing the functional behavior of TiO₂ by application of multi-elemental thin film technology: fabrication of hybrid material for DSSC anode.
- (5) Viability studies on using graphene/reduced graphene oxide (rGO-TiO₂/ZnO) to modify DSSC matrix.
- (6) Feasibility studies on fabrication of quantum dots (QD) and application to solar cells for developing QDSC.

(ii) Physical Characterization:

Surface morphology and compositional analysis of the matrices were studied through Scanning electron microscope, TEM, XRD, and EDS. Spectrophotometric measurements (UV-Vis, FTIR, Raman) to determine the structural composition and physicochemical changes of the matrix.

(iii) Sensitization of modified DSSC anode with commercial and indigenous dyes.

The as prepared TiO₂ anode matrices were immersed in ethanolic (1mM) solution of the respective commercial N3 dye and laboratory prepared indigenous dyes.

(iv) Fabrication of DSSC:

The dye absorbed FTO-modified TiO₂ electrode and Pt coated FTO counter electrode assemble together to form 'sandwich' type cell.

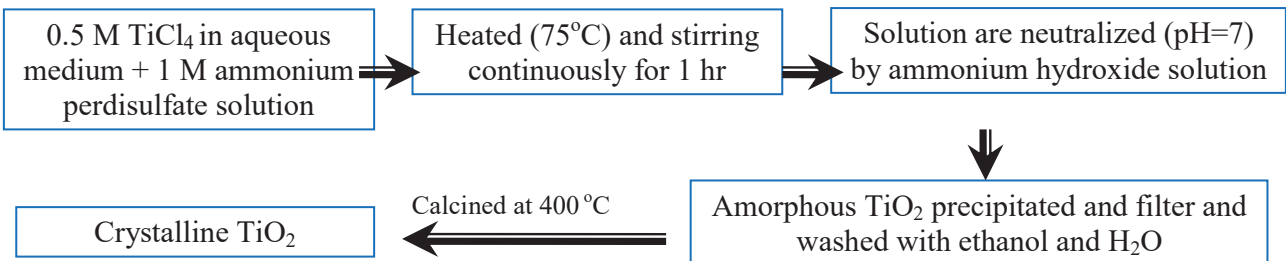
(v) DSSC characterization:

Spectro-electrochemical techniques like Voltammetry, Current-Voltage, %IPCE and Electrochemical Impedance Spectroscopy, Potentiodynamic Polarization, Chronoamperometry etc. were used to ascertain the performance characteristics of the proposed cell. Optimal level of surface plasmon and low band gap semiconductor material on the base titania matrix being validated in the modified DSSC.

4. Salient Research Achievements:

4.1 Summary of Progress

1. (a) Synthesis of TiO₂ NPs:



The laboratory prepared (LP) anatase TiO₂ were mixed with commercially available Degussa P25 (TiO₂) (Sigma Aldrich) in 2:3 proportion in ethanolic solution containing acetic acid, ethyl cellulose and terpeneol as the binding agents.

(b) SPR effect of metal nano particles like Ag and Au NPs on TiO₂ in DSSC

Introduction of surface plasmon (SP) onto photosensitizer electrodes has been one of trends in fabricating dye sensitized solar cells (DSSC) with improved functional properties. Metal nanoparticles, like Ag or Au, would induce the surface plasmons, which are used to couple light into the underlying optical modes of the active layer. The enhanced photo-conversion efficiency is attributed to the localized surface plasmon resonance of metal NPs that enhances the light harvesting of the solar cells.

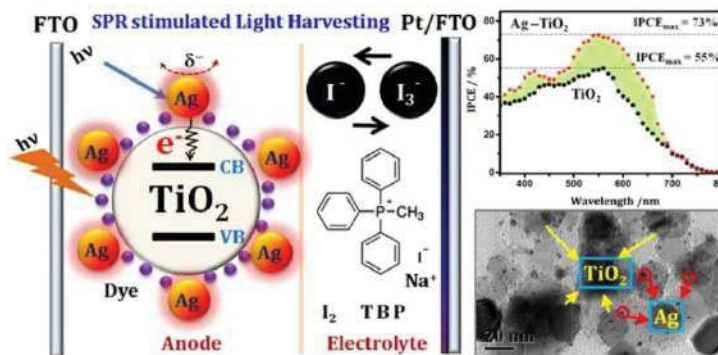


Fig.1. SPR effect of AgNPs decorated TiO₂ in DSSC using TPMPi in the electrolyte.

1. Electrode preparation:

Fabrication of AgNPs doped TiO₂ matrix

The laboratory prepared (LP) anatase TiO₂ were mixed with commercially available Degussa P25 (TiO₂) in 2:3 proportion. In course of fabrication of the DSSC anode, TiO₂ paste was uniformly coated on FTO glass substrate (Dyesol, Australia) by the help of doctor's blade technique and sintered at 500 °C. Finally, the AgNPs were synthesized directly onto the TiO₂ matrix by photoreduction of AgNO₃ solution at different concentrations by using UV radiation with the help of UWave-100, Sineo (China).

Fabrication of AuNPs doped TiO₂ matrix

The AuNPs were also synthesized on TiO₂ matrix by photo-reduction of 0.005 mM HAuCl₄ solution using same UV radiation technique.

UV assisted deposition of Au-Ag bilayer over TiO₂ matrix

The Au-TiO₂ photo anode followed by deposition of Ag, from 0.005 mM aqueous solution of silver nitrate. The UV assisted photo-reduction was carried out in UWave 1000 Sineo microwave synthesizer. The TiO₂ photo anodes were dipped in the respective precursor solution bath for simultaneous reduction and deposition of Au or Ag over the TiO₂ surface. Throughout the process of deposition, the time of photo-reduction in the microwave synthesizer was varied like TiO₂-Au(30)Ag(10), TiO₂-Au(30)Ag(20), TiO₂-Au(30)Ag(30), TiO₂-Au(30)Ag(40) and optimized by electrochemical characterization.

2. Physical Characterization

SEM-EDS, TEM and XRD study

Fig. 2 represents the XRD plots for TiO₂ and Ag doped titania matrix. Considering the intense peak indexed [JCPDS file] with $d = 3.5 \text{ \AA}$ (101) and 2.0 \AA (110) corresponding to the respective TiO₂ and AgNPs, the dimensions of the crystallites were found to be 25–40 nm for TiO₂NPs and 2–3 nm AgNPs. Au have been deposited effectively as shown by the XRD peaks at 44.42°, 64.41° and 77.39° (**Fig.2**) as confirmed from the JCPDS file and found to be around 14-16 nm AuNPs. **Fig. 3** represents the XRD pattern of AuTiO₂ and Au-Ag-TiO₂ matrix.

A representative SEM image of Ag-TiO₂ NPs is shown in **Fig. 4a**. It is seen that the highly dispersed spherically shaped Ag NPs are found to reside on the top of TiO₂NPs. A typical TEM image of pure TiO₂, AgTiO₂, AuTiO₂ and bilayer of Au-Ag-TiO₂ are shown in **Fig. 4b&d**. **Fig.4.e** shows the typical fringe pattern of CdSe-TiO₂ matrix. It is ensured that TiO₂ matrix (25-30 nm) is embedded with AgNPs of 2–3 nm size while AuNPs is 10-15 nm in size which matches with XRD data.

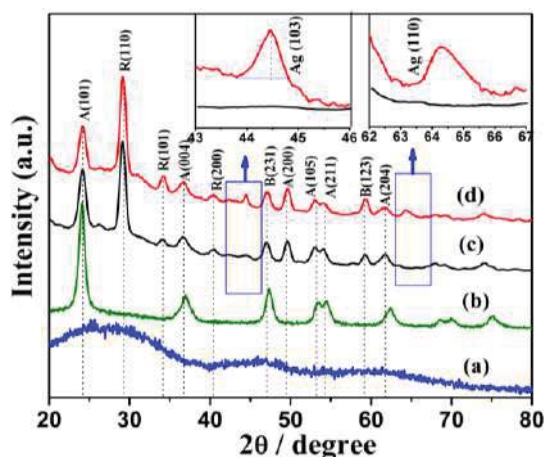


Fig. 2. XRD of (a) LP TiO₂, (b) LP TiO₂ calcined at 500°C, (c) working mixture (LP TiO₂ + P25) calcined at 500°C (d) Ag doped matrix. [A, B and R represent anatase, brookite & rutile phases of TiO₂ respectively].

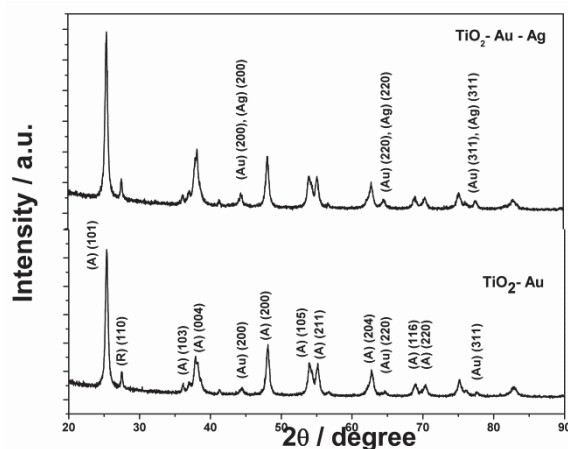


Fig. 3. XRD pattern of AuTiO₂ and Au-Ag-TiO₂ matrix. [A, B and R represent the anatase, brookite and rutile phases of TiO₂ respectively].

4.5 Any other

Project Personal (02): Research Associate: Dr. Atanu Jana joined the project on **5th April, 2016**.

Junior Research Fellow: Mr. Gourab Ghosh joined the project on **21st June, 2016**.

5. Research work which remains to be done under the project (for on-going projects)

- Synthesis of ZnO matrix and substrate modification.
- Preparation of TiO₂-GO intercalated composite by both hydrothermal method or by autoclave treatment and details study in DSSC system.
- Preparation of rGO-TiO₂-ZnO nano rods and application in DSSC.
- Novel QD sensitized / TiO₂ hybrid films will also be fabricated either in-situ (hydrothermal route) or ex-situ (dipping of the composite film into QDs sol) techniques
- Different SP composite will be fabricated by UV radiation, microwave assisted or sol preparation technique and details study in DSSC.
- Physical characterization of the matrices developed under different techniques.
- Electrochemical characterization like Voltammetry, I-V Characteristics, % IPCE and APCE, IMPS & IMVS, EIS, Potentiodynamic Polarization etc.
- Optimizing device fabrication and performance screening.
- Durability studies of the proposed cell will be extended using Resin Polymer Gel Electrolyte, Co²⁺/Co³⁺ system, Na₂S/S dissolved in water as electrolyte.

Ph.Ds Produced no:

PhD Registered: 02

Technical Personnel trained:

PG: 04

Research Publications arising out of the present project:

12 papers Peer Review Journals.

List of Publications from this Project (including title, author(s), journals & year(s))

(A) Papers published only in cited Journals (SCI)

1. A. Pal, A. Jana, S. Bhattacharya, **J. Datta***, *SPR effect of AgNPs decorated TiO₂ in DSSC using TPMPPI in the electrolyte: Approach towards low light trapping*, **Electrochimica Acta**, 243 (2017) 33–43.
2. S. Bhattacharya, **J. Datta*** *CdTe coupled TiO₂ anode matrix for dye sensitized solar cell: A novel co-sensitizer approach towards highly efficient energy conversion*, **New Journal of Chemistry**, **41** (2017) **8663-8672**.
3. D. Acharyya, Partha Bhattacharyya, *Highly Efficient Room Temperature Gas Sensor based on TiO₂ Nanotubes-Reduced Graphene Oxide Hybrid Device*, **IEEE Electron Device Letters**, 37 (2016) 656-6593, 2016.
4. D. Acharyya, K.Y. Huang, P.P. Chattopadhyay, M. S. Ho, H-J. Fecht, P. Bhattacharyya, *Hybrid 3D Structures of ZnO Nanoflowers and PdO Nanoparticles as a Highly Selective Methanol Sensor*, **Analyst (RSC)**, 141 (2016) 2977-2989.
5. A. Jana, M. Hazra, **J. Datta***, *Periodic voltammetry as a successful technique for synthesizing CdSe semiconductor films for photo-electrochemical application*, **J. Solid State Electrochemistry**, 21 (2017) 3083–3091.
6. M. Hazra, A. Jana, **J. Datta***, *Improved stability toward photo-electrochemical behavior of multi-chalcogenide CdSeS thin films*, **Applied surface science**, In Press, 2018; **DOI: 10.1016/j.apsusc.2018.05.141**
7. M. Hazra, S. Chatterjee, **J. Datta***, *Multi-elemental chalcogenide n-BiCdSe films grown under controlled depth voltammetry: Improved photo-electrochemical behaviour toward energy conversion*, **New Journal of Chemistry-Accepted 2018, DOI: 10.1039/C8NJ01304G**
8. P. Hazra, M. Hazra, **J. Datta***, *Electrosynthesized Nano-structured CdZnSe Films for Application in Photo-electrochemical Cell*, **Journal of Solid State Electrochemistry-Under Review-2018**

9. A. Jana, M. Hazra, **J. Datta***, *Fe doped CdSe films with improved photosensitivity and stability for use in liquid junction solar cell*, **ACS-Applied Material and Interfaces** (communicated 2018).
10. B.N. Mongal, S. Bhattacharya, T.K. Mandal, **J. Datta***, S. Naskar*, *Synthesis, Characterization, Optical, Electrochemical, Photovoltaic and Theoretical Studies of 4'-substituted Terpyridine based Ruthenium Dyes*, **Polyhedron**-communicated 2018.
11. S. Bhattacharaya, **J Datta***, *CdSe coated TiO₂ electrode as an efficient photoanode in a typical N3 based dye sensitized solar cell*, **ACS sustainable Chemistry and Engineering** (Communicated 2018)
12. G. Ghosh, S. Bhattacharaya, **J. Datta***, *Sequential deposition of Ag-Au on titania matrix by photo reduction: Improved functional behaviour of DSSC-Solar Energy* -2018 (communicated)

(B) Papers published in Conference Proceedings, Popular Journals etc.

1. **J. Datta**, *Combinatorial Approach in Designing TiO₂-Cd Chalcogenide Hybrid Nano Structures for Panchromatic Light Harvesting in N3 based Dye Sensitized Solar Cell*, **3rd Global Nanotechnology Congress and Expo" August 21-23, 2017 at Dallas, USA.**
2. A. Jana, **J. Datta***, *Nanostructured CdFeSe composite films fabrication through periodic voltammetry: Improvement in functional properties for application in photo-electrochemical cell*, **53rd Annual Convention of Chemists 2016, Dec 27-29, 2016, Gitam University, Visakhapatnam.**
3. S. Bhattacharya, **J. Datta***, *Attractive functional behaviour of Ag doped titania in Dye Sensitized Solar Cell*, **53rd Annual Convention of Chemists 2016, Dec 27-29, 2016, Gitam University, Visakhapatnam.**
4. G. Ghosh, S. Bhattacharya, **J. Datta***,
5. A. Jana, M. Hazra, **J. Datta***, *Development of CdSe films under potential scan and application in PEC solar cell*, UGC Sponsored National Seminar On "Recent Trends In Chemical Research" **29 th Sept & 1 st Oct 2016, Sarojini Naidu College for Women, Kolkata, India.**
6. S. Bhattacharya, **J. Datta***, *Cd-chalcogenide-N3 dye bisensitizer in titania based dye sensitized solar cell*, National Conference On Recent Trends In Functional Materials In Relation To Nanomaterials and Nanotechnology, **February 4-5, 2016, St Paul's Cathedral Mission College and Indian Chemical Society, Kolkata.**

Patents filed/ to be filed: NA

Major Equipment (Model and Make)

S No	Sanctioned List	Procured (Yes/ No) Model & make	Cost (Rs in lakhs)	Working (Yes/ No)	Utilization Rate (%)
01.	DSSC Characterization Unit & I-V Unit	Yes IPCE: Model: PEC-S20DC; Make: Japan Spectral measurement units: Model: FTIR-7600, Make: Australia and Model: Enspectr R532, Make: USA Multiparameter: Model: VSTAR92; Make: USA; I-V: Model: PECK2400-N2, Japan (Online UPS, Unitron)	Rs. 62,04,558/-	Yes	90%
02.	Solar Simulator	Yes Solar simulator with LED light soaker: Model: PEC-L01, Make: Japan and Australia	Rs. 19,23,434/-	Yes	90%

03.	Screen Printer	Yes Screen Printer: Model: Screen Printer 25, Make: Australia	Rs. 10,59,092/-	Yes	65%
04.	Cell Construction Unit	Yes (i) Hole Drilling machine: Pdt No: E002-1151; Make: Australia (ii) Programmable hot plate Pdt No: E002-1151; Make: Australia (iii) Test cell assembly machine: Pdt No: E002-1233 Make: Australia (iv) Freeze Dryer: Model COOLSAFE CS-110-4 SYSTEM, Denmark (Online UPS, Unitron)	Rs. 27,01,285/-	Yes	70%
05	High Temperature Oven	Yes Make: The Aerials, Kolkata	Rs. 3,10,000/-	Yes	90%
06	---	Some routine Instruments and accessories to the Item No: 1, 2 & 4.	---	To be procured	---

Jayati Datta.

Jayati Datta

**Principal Investigator
Professor & Head
Department of Chemistry
Heritage Institute of Technology
Kolkata-700107**

FORMAT FOR COMPLETION REPORT

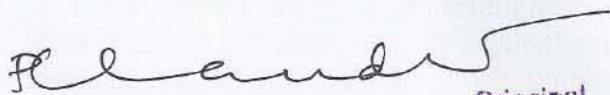
PART - 1

1. Title of the project : Post-Disaster Situation Analysis and Resource Management Using Delay-Tolerant Peer-to-Peer Wireless Networks (DiSARM)
2. Implementing Organisation : Heritage Institute of Technology, Kolkata
3. Sanction No. and Date : ITRA/15(58)/Mobile/DISARM/01
Sep 19, 2013

ITRA/15(58)/Mobile/DISARM/01/Rev/2015,
Dated: July 23, 2015
4. (a) Total Budget Outlay : Original: Rs. 30.46 Lakhs
Revised, if any: Rs. 43.55 Lakhs

(b) Duration of project : 60 Months

(c) Date of completion : 31.12.2018
and reasons for delay, if any
5. Total funds spent under various approved Budgetary Heads/actual expenditure. Reasons for deviation, if any (as per enclosed Table 1) :
6. Details of equipment/assets acquired out of MIT funds with the name of equipment, sources of supply, total cost/whether Indian or imported (as per enclosed Table 2.1, 2.2 and 2.3) :
7. Details of manpower associated with the project: (as per enclosed Table 3)
8. Details of year wise audited statement of accounts and utilization certificates submitted to MIT (as per G.F.R.19 & 19A) :



Principal Investigator **Heritage Institute of Technology**
Principal

PART - II

1. Project work and achievements :

a) Executive Summary:

In this project DiSARM, several tools like DTN Connect, DTN Sync, etc. have been developed for communication between the DTN enabled devices on a peer-to-peer basis. A couple of routing protocols suitable for our application domain have been proposed. Potentials of different social media, like – WhatsApp and Twitter have exploited for situational analysis through distributed snapshot integration. As disaster management services, we have designed strategies for effective resource planning that includes – forecasting resource demands, enumerating resource utilities, validating the resource needs transmitted over fragile network and utility driven resource planning. Other disaster management services include empirical relationship among the network connectivity and situational information dissemination metric that would help may help disaster management authorities to chalk out a volunteer deployment plan. We have also developed a simple multiplatform (web and app-based) Disaster Management System that provides decision support to disaster management authorities through active involvement of the “crowd”. All the proposed solutions are validated through simulation and smart-phone based test-bed implementation.

b)

Activity 1	Target 2	Achievement 3	Reasons of variation 4
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Activity: Research

Target 1: Developing routing algorithms

Achievement:

- Proposed a human movement model that characterizes the movement pattern of different stakeholders in a post-disaster scenario in smart city.
- Developed a multilayer encryption and hashing based scheme is proposed to protect the transmitted resource needs against privacy attacks like - authenticity, eavesdropping and modification attacks.
- A security aided and group encounter based PRoPHET routing protocol is suggested, where security features are incorporated into PRoPHET to provide security against eavesdropping, blackhole, identity spoofing and bundle store overflow attacks.
- A trust based Watchdog technique is proposed seamlessly integrated with PRoPHET to provide security against communication attack like – packet drop and trust/reputation attacks like – badmouthing and ballotstuffing.
- Suggested a reputation auditing scheme to refine reputation estimation techniques so that the actual intention behind the non-forwarding and dropping can be judged and the nodes having genuine reasons behind such misbehavior are not penalized irrationally
- Proposed Priority-enhanced PRoPHET to ensure best-effort delivery of emergency messages using a two-step approach, (i) segregation of high priority messages

through natural language processing based filtering and (ii) dissemination of filtered messages over DTN

- Devised a compromise-tolerant DTN, where time-varying pseudonyms are used to obscure the actual identity and safeguard the privacy of genuine nodes.
- Suggested a Blockchain based incentive scheme for DTN based post disaster communication network that uses Bitcoin to incentivize nodes for cooperation.

Target 2: Distributed snapshot integration from unreliable sources

Achievement:

- An opportunistic knowledge sharing scheme is proposed for transmitting the assessed resource needs to the control station in absence of normal communication facilities
- Proposed Post-Disaster Map Builder, a crowdsensed digital pedestrian map construction system over smartphone based DTN that generates digital pedestrian maps of the disaster affected areas using battery powered mobile handheld devices.

Target 3: Developing resource allocation and distribution strategies using online algorithms

Achievement:

- A principal component regression (PCR) model is derived for forecasting the exact demand for different emergency resources in a shelter, based on the dynamic influencing situational parameters
- A utility function is proposed that dynamically and quantitatively enumerates the utility of each emergency resource at different shelters
- A case-based reasoning (CBR) driven resource need validation technique to be executed at the control station is proposed
- A utility based integer programming model for optimal resource allocation is formulated that minimizes the overall resource deficit and the total resource deployment time
- Mapped post disaster resource management as a content sharing problem with strict time constraint and proposed an automated, energy efficient and decentralized resource management scheme over DTN. The proposed scheme allows periodic group based sharing of resource inventories and supports search and retrieval of queries within a restricted time period.

Target 4: Aggregation , filtering and distributed query processing at the control station

Achievement:

- Developed an online algorithm for generation of a coherent aggregated view of resource needs over a smartphone based DTN

Target 5: Develop a suite of software and system solutions

Achievement:

- Developed an Interactive SMS Based Mobile App for Post Disaster Data Collection

- An Interactive Community-driven Crowdsourced Information System (CROWNS), web and app based, has been developed to collect and analyze post-disaster situational information and customized report generation for different Govt. and non-Govt. disaster management agencies
- Developed an Information System for Next Generation Collaborative and Responsive Community (NCoRe) to empower next-generation collaborative and responsive rural community

Activity: Outreach and Societal Sensitivity Development

Target 1: Feasibility study of proposed system architecture

Achievement:

- Studied World Disaster Report 2013 (by International Red Cross Society), Sphere standards and different smartphone and web based applications used in disaster management around the globe and working on assessing the scope of using ICT in managing disasters in India.
- Done feasibility study on existing DTN system architectures to propose an energy efficient DTN framework for Post Disaster Relief Operation.
- Proposed an innovative usage of social technology to build resilient community, a mandatory prerequisite to enhance disaster preparedness and coping up mechanisms among collectives inhabited in vulnerable areas.

Target 2: Field visit for meeting victims of recent calamities, Government organizations, NGOs and other stakeholders

Achievement:

- Project team visited Nepal after the April 2015 earthquake for post disaster situational analysis and need assessment
- Conducted a field trial at Chandanpiri village at Namkhana Block, West Bengal on 5th and 6th March 2016 to test functionalities of the Crowdsourced Information System for Disaster Management (CROWNS)
- As a part of outreach program, a survey has been conducted in January, 2016 based on the condition of the disaster affected population before and after the disaster AILA in different villages of Sundarban of West Bengal. This survey helps us in developing a Crowdsourced Information System for Disaster Management and also in our research work.
- Several meetings were organized with Govt. and NGOs like RKM, Bharat Sevashram Sangha, CASA and DFY. Subsequently study reports were prepared on:
 1. How ICT can fill the gaps in Disaster Management System in Developing Economies
 2. Disaster Management Framework: In Indian Context
 3. Business Continuity Management Lessons in a Post Disaster Scenario
 4. Disaster Management and Technology: Challenges and Scopes
 5. Impact Analysis of Cyclone Disaster Management Practices in Coastal Region of West Bengal: A Qualitative Assessment
 6. Strategic decision making using Social media analytics: A perspective from Crisis management During Uttarakhand Disaster

- Visited Multipurpose Cyclone Shelters of Odisha to evaluate the prospects of establishing information kiosks therein, for community based disaster preparedness and resilience
- Meetings held with Odisha State Disaster Management Authority regarding possibility of establishment of information kiosks at the Multipurpose Cyclone Shelters

Target 3: Video Lecture series

Achievement:

- Lectures of Short Term Course on Next Generation Networking organized in June 2015 has been uploaded to Youtube https://www.youtube.com/channel/UCIQus0jQFfi0_dtzHfdTlyA
- Proceedings, tutorials, invited talks and keynote addresses of IEEE International Workshop on Distributed Systems for Coordinated Disaster Management, CORDIM, organized in January 2016, has been uploaded to http://disarmproject.net/cdm_proceedings.html

- | | | |
|------|---|---------------|
| i) | No. of Systems/Sub-systems with specifications or feasibility report on futuristic studies: | 3 |
| ii) | No. of Research papers/Technical Reports: Conferences: 19,
Journals: 08 ,
Book: 01 | |
| iii) | No. of trained manpower: SRFs – 05, Student Interns - 21 | |
| iv) | Anticipated know-how transfer to industry: | 2 |
| v) | Technology/Know-how developed (Hardware, software & other details, if any);
know-how document available or not: | 2 |
| | • Developed an Interactive Community-driven Crowdsourced Information System (CROWNS), web and app based, to collect and analyze post-disaster situational information and customized report generation for different Govt. and non-Govt. disaster management agencies. (along with IIMC) | |
| | • Developed an interactive community-driven information system (NCoRe) to harness the potential of community participation in governance that exploits the potential of community knowledge, making them available to the community and empowering the communities to interact, collaborate and participate in the development of society and transforming the way they live, learn and work. (along with IIMC) | |
| vi) | No. of industries shown interest for know-how utilization/commercialization: | 1 |
| vii) | No. of users/interested for taking prototype/ finished product:
(The prototype has been field-tested and lot of users have shown interest) | 150 (approx.) |

viii) No. of industries/users interested in applying the know-how developed for enhanced productivity: Nil

c) Additional information

i) Details of patents registered, if any : NIL

ii) Technological spin offs, seeding of : Developed an Interactive Crowdsourcing Platform (CROWNS) (web and mobile app) for ICT based Disaster Management
a major activity and how the project has

Developed an Information System for Next Generation Collaborative and Responsive Community (NCoRe) to empower next-generation collaborative and responsive rural community.

iii) Future areas for work : • Planning to implement a decentralized scheme for Post-Disaster Resource Management



Principal Investigator

Principal
Heritage Institute of Technology

**TABLE 1: HEADWISE BREAK-UP OF EXEPENDITURE
(Rs. In Lakhs)**

S.No.	Head	Approved Budget Outlay	Expenditure Incurred Upto 31.12.2018 RE FE Total *	Expenditure From 12.11.2013 To 31.12.2018 RE FE Total*	Anticipated Expenditure From - 31.12.2018 till project closure- FE BE Total	BE	Remarks
1.	Capital Eqpt. (FE Comp)*	2.50000	1.95	Not Relevant	Not Relevant		
2.	Consumable items/ components (FE comp)	N.A.	N.A.				
3.	Duty on Imports	N.A.	N.A.				
4.	Staff Salaries	25.80000	25.45				
5.	Travel	9.50000	8.41				
6.	Contingencies	0.75	0.74				
7.	Overheads/, if any	N.A.	N.A.				
8.	Other expenditure debitible to this project ("Training & Development" and "Workshop/ Conference/ Seminar")	5.00000	5.00				

• FE utilised, over and above sanction made by DOE, through OGL facilities may be indicated separately. Please indicate if there is any
 • Deviation from originally approved budget and whether necessary approval has been taken.

* Figures (un-audited) are till November 2018. Figures till December 31 can be provided in January 2019.

[Signature]
Principal Investigator
 Principal
 HERITAGE INSTITUTE OF TECHNOLOGY

Chief Finance Officer
[Signature]
 Chief Financial Officer
 HERITAGE INSTITUTE OF TECHNOLOGY

TABLE 2.1: EQUIPMENT (IMPORTED) PROCURED FOR THE PROJECT

(Rs. In Lakhs)

NIL

S. No.	Description	Manufacturer/Supplier	Brief specifications	Purchase Order No. & date	Date of Receipt	Total Cost	Duty * Paid	Conditions G- Good B - Bad

Please indicate duty amount paid for each equipment

Mention conditions of equipment purchased. If bad, describe the fault/defect and what action has been taken to repair it?

R. R. R.

Principal Investigator

Principal
Heritage Institute of Technology

Chief Finance Officer

M. S. S.

Chief Financial Officer
HERITAGE INSTITUTE OF TECHNOLOGY

**TABLE 2.2: CAPITAL EQUIPMENT (INDIGENOUS) PROCURED FOR THE PROJECT
(Rs. In Lakhs)**

S.No.	Description	Manufacturer/ Supplier	Brief Specifications	Purchase Order No. & date		Date of Receipt	Total Cost	Duty * Paid	Conditions G- Good B - Bad
1	Smartphone	Ayush Communication	Samsung Galaxy Grand 2 SM G7102	732	18.03.14	21.03.14	21320	NIL	G
2	Smartphone	Ayush Communication	Samsung Galaxy Grand 2 SM G7102	732	18.03.14	21.03.14	21320	NIL	G
3	Smartphone	Ayush Communication	Samsung Galaxy & Duos	732	18.03.14	21.03.14	9470	NIL	G
4	Smartphone	Ayush Communication	Samsung Galaxy & Duos	732	18.03.14	21.03.14	9470	NIL	G
5	Laptop with carry case	Vision Comtech	Dell Inspiron 300 series, intel core i5, 4 th generation	412	12.09.14	18.09.14	42000	NIL	G
6	Laptop with carry case	Vision Comtech	Dell Inspiron 300 series, intel core i5, 4 th generation	412	12.09.14	18.09.14	42000	NIL	G
7	Mouse	Vision Comtech	Logitech B175	412	12.09.14	18.09.14	735	NIL	G
8	Mouse	Vision Comtech	Logitech B175	412	12.09.14	18.09.14	735	NIL	G
9	Bluetooth Speaker	Vision Comtech	Creative	412	12.09.14	18.09.14	1418	NIL	G
10	Keyboard	Flipkart	Logitech K480 Bluetooth Tablet Keyboard	OD206386117 786671000	27.06.16	27.06.16	1971	NIL	G
11	Tablet	Flipkart	Mi Pad	OD206386117 786671001	27.06.16	03.07.16	10999	NIL	G
12	Smartphone	WS Retail Services Pvt. Ltd	SAMSUNG Galaxy J7 - 6	OD206386117 786671002	27.06.16	27.06.16	15989	NIL	G
13	Smartphone	WS Retail Services Pvt. Ltd	SAMSUNG Galaxy J7 - 6	OD306386152 169487000	27.06.16	27.06.16	15989	NIL	G
14	WiFi Router	Reliance Retail Ltd.	Jio Router JMR540	38701010015 11012017	11.01.17	11.01.17	1999	NIL	G
Total							195415		

Mention condition of equipment purchased. If bad, describe the fault/defect and what action has been taken to repair it?


Principal Investigator

Principal
Heritage Institute of Technology

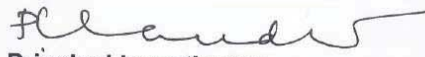
Chief Finance Officer


Chief Financial Officer
HERITAGE INSTITUTE OF TECHNOLOGY

TABLE 2.3: SALE/TRANSFER OF CAPITAL GOODS (WITH PRIOR PERMISSION OF MIT)

NIL

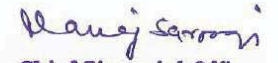
S.No.	Description	Sale/Transfer S/T	Orgn. To which sold/ Transferred	Sale Value Rs. In lakhs	Funds Refunded to MIT



Principal Investigator

Principal
Heritage Institute of Technology

Chief Finance Officer



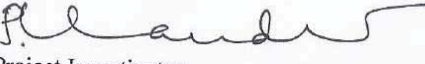
Chief Financial Officer
HERITAGE INSTITUTE OF TECHNOLOGY

DETAILS OF MANPOWER EMPLOYED DURING THE PROJECT PERIOD

Post-Disaster Situation Analysis and Resource Management Using Delay-Tolerant Peer-to-Peer Wireless Networks (DiSARM)

Heritage Institute of Technology, Kolkata

S.No.	Name	Designation	Qualification	% of time devoted to this project	Salary drawn Y/N	Date of Joining	Date of Leaving	Total Average Emoluments (monthly)
1	Suman Bhattacharjee	Senior Research Fellow	M. Tech.	100%	Y	26.12.2013	31.12.2014	25,000
						01.01.2015	31.10.2016	36,400
2	Priyanka Roy	Senior Research Fellow	MCA	100%	Y	01.06.2015	31.05.2016	25,000
3	Prasun Seal	Research Fellow	M. Tech.	100%	Y	01.06.2016	28.02.2017	25,000
4	Subhasis Chakraborty	Research Fellow	MCA	100%	Y	01.02.2017	31.07.2017	36,400
5	Tanujit Sarkar	Senior Research Fellow	B. Tech.	100%	Y	01.02.2018	30.04.2018	36,400
6	Jayanta Basak	Senior Research Fellow	M. Tech.	100%	Y	11.10.2017	31.12.2018	36,400
7	Tarun Kumar	Research Associate	MCA	100%	Y	01.08.2017	31.10.2017	15,000
8	Pragna Debnath	Intern (2 months)	B. Tech, CST	100%	Y	15.05.2015	14.07.2015	4000
9	Saniul Haque	Intern (2 months)	B. Tech, CST	100%	Y	15.05.2015	14.07.2015	4000
10	Ayanesh Biswas	Intern (3 months)	MCA	100%	Y	01.06.2015	31.08.2015	4000
11	Rahul Dubey	Intern (3 months)	MCA	100%	Y	01.09.2016	30.11.2016	4000
12	Tarun Kumar	Intern (2 months)	MCA	100%	Y	01.02.2017	31.03.2017	4000
13	Rohit Singh	Intern (1 month)	MCA	100%	Y	01.06.2018	30.06.2018	4000
14	Ishani Ray	Intern (1 month)	MCA	100%	Y	01.06.2018	30.06.2018	4000
15	Ankita Saha	Intern (1 month)	MCA	100%	Y	01.06.2018	30.06.2018	4000
16	Souvik Basu	Institute Faculty Member & Researcher	MCA, M. Tech. Ph.D.	30%	N	26.12.2013	31.12.2018	NIL


Project Investigator
Principal
Heritage Institute of Technology


CFO
Chief Financial Officer
HERITAGE INSTITUTE OF TECHNOLOGY

**(See Government of India's Decision 7 (b) under Rule 148 (3))
Assets Acquired Wholly or Substantially out of Government grants
Register maintained by grantee institution**

**Block Account maintained by Sanctioning Authorities
Name of Sanctioning Authority : ITRA-Media Lab Asia**

Name of Grantee Institution	No. & Date of sanction	Amount of the sanctioned grant	Brief purpose of the grant	Whether any condition regarding the right of ownership of Govt. in the property or other assets acquired out of the grant was incorporated in the grant-in-aid sanction	Particulars of assets actually credited or acquired	Value of the assets as on 31.07.2017	Purpose for which utilised at present	Encumbered or not	Reasons if encumbered	Disposed	Research & authority, if any, for disposal	Amount realised on
Heritage Institute of Technology, Kolkata	ITRA/15 (58)/Mobile/DIS ARM/01 (Sep 19, 2013)	Original: Rs. 30.46 Lakhs	Execution of the project Post-Disaster Situation Analysis and Resource Management Using Delay-Tolerant Peer-to-Peer Wireless Networks (DiSARM)		Smartphone [Samsung Galaxy Grand 2 SM G7102]	21320	Filed trial for testing information crowd sourcing apps developed for disaster management in rural areas	NO	NA	NO	NA	NIL
	ITRA/15 (58)/Mobile/DIS ARM/01 /Rev/2015 (July 23, 2015)	Revised, if any: Rs. 43.55 Lakhs			Smartphone [Samsung Galaxy Grand 2 SM G7102]	21320	Filed trial for testing information crowd sourcing apps developed for disaster management in rural areas	NO	NA	NO	NA	NIL
					Smartphone [Samsung Galaxy & Duos]	9470	Filed trial for testing information crowd sourcing apps developed for disaster management in	NO	NA	NO	NA	NIL

					rural areas							
					Smartphone [Samsung Galaxy & Duos]	9470	Filed trial for testing information crowd sourcing apps developed for disaster management in rural areas	NO	NA	NO	NA	NIL
					Laptop with carry case [Dell Inspiron 300 series, intel core i5, 4 th generation]	42000	Used as camp nodes for collection, aggregation and analysis of field trial data Hosting the CROWNS and NCoRe web portals	NO	NA	NO	NA	NIL
					Laptop with carry case [Dell Inspiron 300 series, intel core i5, 4 th generation]	42000	Used as camp nodes for collection, aggregation and analysis of field trial data Hosting the CROWNS and NCoRe web portals	NO	NA	NO	NA	NIL
					Mouse [Logitech B175]	735	Laptop Peripherals	NO	NA	NO	NA	NIL
					Mouse [Logitech B175]	735	Laptop Peripherals	NO	NA	NO	NA	NIL
					Bluetooth Speaker [Creative]	1418	Used for warning, de-warning, alerts during mock-drills	NO	NA	NO	NA	NIL

				Keyboard [Logitech K480 Bluetooth Tablet Keyboard]	1971	Tablet Peripheral	NO	NA	NO	NA	NIL
				Tablet [Mi Pad]	10999	Used as camp nodes for collection, aggregation and analysis of field trial data	NO	NA	NO	NA	NIL
				Smartphone [SAMSUNG Galaxy J7 - 6]	15989	Filed trial for testing the scalability of information crowd sourcing apps developed for disaster management in rural areas	NO	NA	NO	NA	NIL
				Smartphone [SAMSUNG Galaxy J7 - 6]	15989	Filed trial for testing the scalability of information crowd sourcing apps developed for disaster management in rural areas	NO	NA	NO	NA	NIL
				WiFi Router [Jio Router JMR540]	1999	Used as mobile internet connectivity during field trials to connect to the servers	NO	NA	NO	NA	NIL


Principal Investigator Principal
 Heritage Institute of Technology