Project factsheet information

Project title	Driver Distraction Management Using Sensor Data Cloud
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Dates covered by this report	15.02.2013 - 25.04.2014
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Country where project was implemented	Bangladesh
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Partner organizations	NA
Total budget approved	30,100.00 AUD
Project summary	Driver distraction can be defined as any type of events or causes that take away drivers visual (eyes off the road), manual (hands off the steering wheel) and cognitive (mind off the road) attention from the driving task. To reduce the number of road accidents due to driver distraction, we designed and implemented a system for monitoring and controlling driver distraction, which is cost-effective and highly accurate. This system was implemented using sensor based data collection and transmission scheme. To manage the collected data, a cloud data management infrastructure and a user-friendly interface have been developed. We analysed, designed and implemented innovative system services such as real-time information collection and reporting on driver's healthcare, providing alert messages immediately in emergency cases, determination of the distraction levels, etc. During the entire implementation period, purchase of all the sensors, data collection from those sensors, training on cloud infrastructure and services, database creation and management, seminars and workshops, extensive verification procedures and writing research paper for dissemination of knowledge have been performed.

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Project Summary

Driver distraction can be defined as any type of events or causes that take away drivers visual (eyes off the road), manual (hands off the steering wheel) and cognitive (mind off the road) attention from the driving task. To reduce the number of road accidents due to driver distraction, we designed and implemented a system for monitoring and controlling driver distraction, which is cost-effective and highly accurate. This system was implemented using sensor based data collection and transmission scheme. To manage the collected data, a cloud data management infrastructure and a user-friendly interface have been developed. We analyzed, designed and implemented innovative system services such as real-time information collection and reporting on driver's healthcare, providing alert messages immediately in emergency cases, determination of the distraction levels, etc.During the entire implementation period, purchase of all the sensors, data collection from those sensors, training on cloud infrastructure and services, database creation and management, seminars and workshops, extensive verification procedures and writing research paper for dissemination of knowledge have been performed.

Background and Justification

Driver distraction is the main cause of road accidents and highway crashes. Events and objects that attract attention of the driver while driving are distractions. More specifically, distraction is any types of events or causes that take away visual, manual and cognitive resources from the driving task. Estimation by the US National Highway Traffic Safety Administration (NHTSA) finds out that driver distraction causes nearly 25% of police reported crashes[i]. Approximately, 80% of crashes and 65% of near-crashes involve some form of driver distraction and the distraction occurs within three seconds of vehicle crash[ii]. By comparison, Bangladesh has one of the worst records of road safety in the world. Road traffic accident can also be considered as a major health hazard in Bangladesh. Road accidents in Bangladesh claim, on an average, about 4000 lives and injure another 5000every year. The national loss due to road accidents is estimated around 600 million USD every year[iii].

The reasons behind the driver distraction are not easy to be identified. Even a single event at the time of driving vehicle may cause more than one type of distractions. Different forms of internal distractions include eating, drinking, smoking, music controlling, use of portable electronic devices (such as tablets and phones to make calls, sent messages, watch videos, etc.), distraction from passengers like having conversation with driver or holding drivers attention by their activities, reading, grooming; or external distractions like watching buildings, billboards, tourist attractions, people, or previous accidents etc.

Driver's health condition is also an important factor for driver distraction. Long-time driving, increase in blood pressure or hypertension, irregular heartbeat, increased body temperature, fatigue, drowsiness, as well as emotional states such as sadness, disappointment, anger or other forms of brain storming can affect significantly while driving and is also a vital cause of driver distraction.

Such distractions, even for just a few seconds, might take away visual, cognitive and manual control of the driver, leading to road accidents.

The driving performance of a distracted driver might degrade drastically. Other than accidents or crashes, he may start ignoring traffic signals, breaking speed limit, wrong overtaking, not signaling while turning, etc. Therefore a distracted driver is more likely to make errors while driving and these errors may lead to road accidents.

To reduce the number of road accidents due to driver distraction our project focuses on monitor drivers' health condition, different forms of internal and external distractions and his or her driving performance. Eventually, it will be possible to alert drivers, provide driver's performance information to vehicle owners, driver recruiters, road transport management and law enforcement organizations to keep the roads safe.

In this project, we have investigated the problem of designing and implementing a driver's distraction and driving performance monitoring and controlling system that includes the materialization of a set of services – real-time

information collection and reporting on driver's healthcare, their driving performance, providing alert messages immediately in emergency cases, determination of the distraction levels, etc. These services have been developed through the use of the latest sensor-based data collection systems, low cost wireless data communication systems, Internet and cloud computing technologies. Such an integrated system ensures the effective and efficient use of information collected for measuring the driver distractions as well as driving performance. We have analyzed, designed and implemented innovative system services to help drivers, owners of vehicles, driver recruiters, road transport authority, and traffic and law enforcement organizations with real-time and accurate information so that road accidents and casualties can be minimized.

Project objectives

The objectives of this project were to develop novel mechanisms, tools, and techniques in the area of driver distraction monitoring and controlling through sensor data cloud. The finished system provides a cost-effective, highly accurate and scalable driving management system for Bangladesh, with the potential for use in the rest of the Asia Pacific region. Consequently, we have outlined the following goals achieved through this project: along with relevant pictures.

Figure 1 Web interface of the project

(1) A sensor data collection and transmission scheme: this involved data collection from different sensors deployed in the vehicle and on the driver's body in the form of a text message, sending the collected data to the cloud through a 3G enabled smart phone. The smart phone serves as a sink for all the sensors. Data is collected in the local co-ordinator for a limited time period and then transmitted automatically to the cloud data center using 3Gnetworks. This is crucial for closely monitoring driver health condition (physical and mental), driver's driving performance and bad habits. It is also mandatory for giving driver alert message and recommendation whether it is safe for him or her to drive or not. Here, quality of service (QoS) has been assured in times of sending data to the cloud by considering the priority of the collected data from the sensors which has been verified in cloud simulators and the QoS as well as energy aware cloud computation technique has been approved by HPCC-2013 (High Performance Computing and Communications

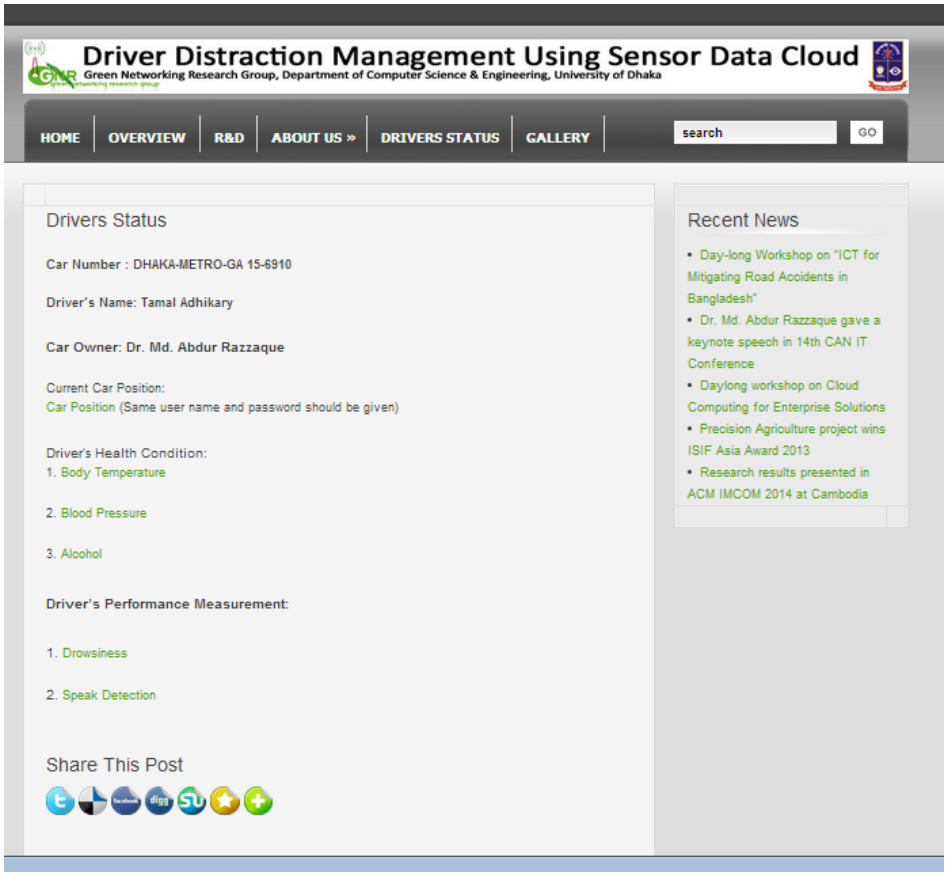

Figure 2 Web interface navigation

(2) Audio data buffering and transmission scheme: this involves designing and developing an audio data collection tool for determining driver's talking behavior We are collecting continuous images of the drivers face and processing the images in the controlling device to determine whether he is continuously speaking or not. We are taking the average value of the talking behavior for a minute if the value becomes greater than predefined threshold (0.6) we conclude the behavior is inappropriate. This is of vital importance for determining driver's performance and bad habits while driving. Driver's concentration on the road is monitored and controlled which helps to reduce traffic accidents. Data is received from audio sensors in real time, stored temporarily in the smart phone memory and analyzed for possible threshold crossing and if deemed necessary, spontaneously transmitted to the remote cloud datacenters.

(3) A video data monitoring and transmission tool: In this case, a High Definition camera for video data monitoring monitors driver's external distractions and traffic violations. This greatly assists vehicle owners and law enforcement authorities without direct manual/physical monitoring. Here, data is collected in the same way as audio data collection and transmission where a temporary buffer stores real time data, analyze them and incase of threshold crossing, sends data spontaneously to the remote cloud data centers.

(4) Cloud data management infrastructure: this includes deployment of cloud environment where distributed data computation, storage, data mining, knowledge discovery and performance analysis are performed. The importance of such distributed computation environment is that when deployed, a huge amount of data from

different sensors will be collected from hundreds of thousands of vehicles. This also reduces computation time, generates real time control and alert messages, and optimizes installation cost of simulation environment.

(5) User friendly cloud data access interface: this includes development of an interface for providing driver's distraction and driving performance related services. This interface evaluates collected information from the sensors through data mining, analyzing and knowledge discovering with a view to provide driver's performance charts, timeline performance, parametric performance, etc. in the form of a graph, table and other form of data display mechanisms. The interface is indeed simple and user friendly for easy accessibility of the respective users. The services are planned to be offered in a pay-as-you-go manner, which involves metering usage and charging independently of the time period over which the usage occurs.

Users and uses

Driver distraction is the leading factor in most accidents scenario. Therefore, the integrated platform that the project is expected to provide in the area of sensor-cloud computing for monitoring and managing driver distraction and performance will be very beneficial for the country as a whole. It is important to mention that in Bangladesh there are a lot of old and outdated cars which do not have the modern navigation system installed in it so our developed system will be very beneficial and cost effective to facilitate modern navigation monitoring and security. It will be more feasible for the individual car owners rather than the manufactures. Our system does not impose the manufacturers to upgrade their vehicles according to this unit. It will be applicable to all kinds of vehicles so that one does not need to buy a luxury car to afford all these facilities.

The infrastructure, algorithms, services and pervasive monitoring environment that have been developed under the proposed framework will contribute in managing the driver's physical and mental condition, and also the performance of the driver. Under the driver distraction monitoring and controlling system, whenever the physical or mental condition of the driver deteriorates beyond a threshold or the driver is somehow distracted, an alert message will be sent to the driver. This mechanism will decrease the probability of road accident due to driver distraction and thus it will be directly useful to **vehicle drivers** and **vehicle owners** and they will be the primary user of this driver distraction monitoring and controlling system.

The driver distraction monitoring and controlling system also contain an online database with an user friendly data access interface which stores the data collected from sensors and evaluates collected information from the sensors through data mining, analyzing and knowledge discovering to provide driver performance charts, timeline performance, parametric performance and other statistics based on data collected by the sensors in a long term basis. This information will be very useful for the **vehicle owners**, **transportation department of different organization** and **law enforcement agencies**. Also judges and advocates in the courts can get accident related information from the online database and provide more accurate verdicts in road accident cases.

The outcomes of this project are also very useful for the **health agencies** that provide road safety guidance for public well-being. Real-time information collection and reporting on driver's healthcare, their driving performances, determination of the distraction levels, etc. will be readily available to the **health agency** for developing new methods on road safety.

Overall, this research project will contribute to fulfilling the AP region's vision of health initiatives and provide opportunities to use latest pervasive technologies in this area of strategic importance. Key government organizations such as Ministry of Health and traffic and law enforcement organization will be further aided by the outcomes of this research. For example, the effective and efficient use of information collected for measuring the driver distractions as well as driving performances will help to reduce road accidents and death tolls during heavy traffic seasons. We have conducted a day long workshop which included a training session for the drivers, vehicle owners and recruiters. There was a brief presentation about the product unit and a demonstration involving volunteers from the audience. Present audience acknowledged the importance of such device and the assistance it will provide them while they are driving. Our system is fully capable of interfacing with user level web services and applications on different platforms. We have already developed a web based user interface to monitor the

total system. Our prototype is elastic to improve further easily and flexibly. Meanwhile the demonstration, we presented the live data collected from the modules to the participants. Some of the participants expressed their eagerness to deploy the device in their vehicles.

Indicators

Baseline	Indicators	Progress	Assessment	Course of action
No effective and implemented solution on driver distraction was present earlier. Some solutions simply stated about Workload Manager[iv], but did not prescribe specifically how to implement such manager.	Design and development of a cloud computing based effective driver distraction monitoring and notification system	Purchase of equipment such as GPS (Global Positioning System) tracker, coordinator device, temperature sensor, alcohol level detection sensor, blood pressure monitoring device, smart phone, HD (High Definition)camera and other essential accessories have beencompleted. A highly scalable and robust Google compute engine VM (Virtual Machine)instance has been hired to serve our cloud computing purposes. Data transmission to the server has been performed using Raspberry PI[1].	Equipment has been purchased after conducting thorough requirement analysis. Training on cloud infrastructure management system has also been performed.	ECG (electrocardiography)sensors have been bought and development of data collection and transmission from ECG sensors is ongoing. Some technical difficulties were identified and have been addressed.
To monitor the vehicle and the driver's physical condition, sensors and GPS tracker need to be deployed in vehicles.	Deployment of sensors and data collection	Deployment of GPS tracker, temperature sensor, and alcohol detection sensor have been tested and evaluated. Camera and BP(Blood Pressure)monitoring device have also been deployed and tested. A Smartphone is used as hotspot inside the vehicle to transmit data. Collected data from these sensors have been transmitted to the cloud server.	Before the sensors are deployed, the interface circuitry is developed for data collection purpose that works satisfactory.	Completed
There were no existence of mechanism for data uploading from vehicle to central server	Data uploading from vehicles to central server	We have implemented the client side circuitry and necessary coding. A database server in the cloud has been installed and data from sensors is sent to the database server.	Data collection to the control coordinator and transmission to the database server is going on continuously.	Completed
The project team had sound theoretical knowledge of cloud computing, but practical cloud computing knowledge was needed to be increased	Training programs	Two trainings and one workshop were conducted. One of the training was on "Cloud infrastructure and services" and the other on "Amazon web services-architecture and essentials". The workshop was on components of cloud computing and cloud usability.	The first training was a basic training and held in Dhaka, Bangladesh. The second training was an extensive and advanced training and it was held in Bangalore, India. The workshop was held in Dhaka also.	Completed
For storage and analysis of data collected from sensors, a storage system was needed	Hiring of Google Compute Engine storage, computation and analysing system	The task of developing the storage, computation and analysing system has been performed in Google cloud.	The storage, computation and analysing system is distributive, secured and managed automatically.	Completed
To access the cloud based storage, computation and analysing system, and user friendly data access interface is needed which can be effectively used by the mass people	Creation of a user friendly data access interface	A well designed user-friendly data access and presentation website has been developed. The website supports user login action for a particular user. Data for a user is shown in the form of graphs and tables. The website has been hosted and managed in the cloud data servers.	This web interface evaluates collected information from the sensors through data mining, analysing and knowledge discovery and provides drivers performance charts, timeline performance etc.	Completed

[1]http://www.raspberrypi.org/

Dissemination activities for circulation of project finding were needed	Research paper publication, spreading project results and findings through website	Two research papers were submitted to ACM[2] and IEEE[3]conferences and they got published. Report on project actions and findings have been shown in the website hosted in cloud (http://driverdistraction.gnrbd.net)	The research paper is titled "Energy-efficient Scheduling Algorithm for Data Centre Resources in Cloud Computing" and it was accepted in IEEE HPCC 2013[4]. Another research paper titled "A QoS and Profit Aware Cloud Confederation Model for IaaS Service Providers" has also got accepted in ACM IMCOM 2014[5].	Completed

[2]Association for Computing Machinery;
Web-site: http://www.acm.org/
[3]Institute of Electrical and Electronics Engineers;
Web-site: http://www.ieee.org/index.html
[4]Institute of Electrical and Electronics Engineers;
Web-site: http://www.ieee.org/index.html
[5] http://dl.acm.org/citation.cfm?id=2558064

Project implementation: understanding the chain that leads to results

Narrative - project implementation

The main task of our project wasto design and implement the driver's distraction and driving performance monitoring and controlling system which includes real time information collection and reporting on driver's healthcare and their driving performances, providing alert messages in emergency case and determination of the distractionlevels, creation of a database that stores data collected by the sensors and also performs data mining, analyzing and knowledge discovery to provide statistics on driver performance.In fulfillment of the task, the first step wasto develop an implementation plan which covers every aspect of the project. During the development of the plan, literature relevant to our project was reviewed and the lesson learned from them were taken into account.

Then in the equipment purchase phase,a GPS tracker, coordinator device, alcohol level testingsensor, temperature sensor, blood pressure detection sensor, ECG sensor where purchased, as well as other accessories.Duringthe sensor deployment and data collection phase, a GPS tracker has been deployed on a car. Using the GPS tracker, information about the vehicle such as coordinate, speed, location were successfully collected.GPRS/GSM (Global Positioning System/ Global System for Mobile communication) communication system was used to transmit the data to a local server. The GPS tracker was also proven to be useful in remote controlling such as turning the engine of the vehicle on and off.We also tested that a good level of accuracy in location detection can be achieved through the collected coordinate information from the GPS tracker. Deployment of sensors such as temparature sensor, alcohol detection sensor and data collection from the sensors are performed.

The work for creating a database for storing the data collected from the sensors and providing statistics on driver's performance using data mining, analyzing and knowledge discovery has been performed. As stated earlier, the whole project has been implemented using sensor based data collection system, low cost wireless data communication system, the internet and cloud computing technologies. Though the project team had sound theoretical knowledge in the cloud computing technologies, the practical knowledge of cloud computing technologies needed to be enhanced. That is why training on cloud computing technologies were arranged for the project team.Two trainings and a wrokshop were conducted. The first training was on "Cloud Infrastructure & Services" and held in Dhaka, Bangladesh. It was attended by the whole project team.For the advancedsecond training, two members of the project team were send to Bangalore, India for a training on "Amazon web services-architecture and essentials". Mr. Tamal Adhikary and Mr. Amit Kumar Das attened the training program on behalf of the team. It was held from 25/7/210213 to 2/8/210213 at Sancentre, Bangalore.[6] The training was conducted by Mr. Nadim Khan, IBM certified trainer. Sancentre is based in Bangalore and having strong networks to provide services in the wide range of IT enabled services Sancentre’s mature project management methodology, proven offshore delivery model and customer-centric business philosophy help enterprises guaranteed project success irrespective of size, industry vertical and technology domain. We have also developed a Smartphone application to go with our product unit. It is developed on famous android platform. It has all the state of the art features. User can install the application and sign in with their account credentials. At first they will be taken to the welcome window where they will be able to explore the latest information on the driver’s performance and health conditions. It also supports historical information for the convenience of the driver. Finaly, a workshop on cloud components and usability has been organised in Department of Computer Science, University of Dhaka, Bangladesh on the 27th of April. The workshop was hosted by Dr. Md. Abdur Razzaque and the research assistants of the project. The chief guest was Mr. Nazrul Islam Khan, secretary, Ministry of Posts, Telecommunication and Information Technology. Prof. Dr. Lutfur Rahman vice chancellor of Daffodil Internation University[7] and Mr. Ilias Kanchan Chairman of Nirapod Sharak Chai (we demand safe road)[8] was present as special guests. Other important persons from the Government of Bangladesh and owners of many private organizations were present in the workshop. A detailed list of participants is attached.

[6] http://sancentre.com/
[7] http://www.daffodilvarsity.edu.bd/
[8] http://wedemandsaferoadbd.org/

Lab Activities Gallery:

Figure 3 Lab Activities 1

Our Devices:

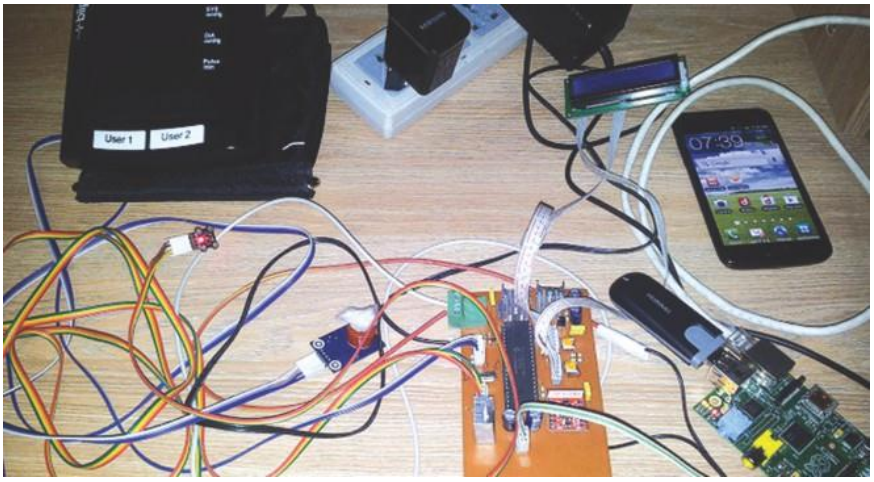

Figure 4: Devices

Test Run:

Figure 5: Test Run For Data Collection

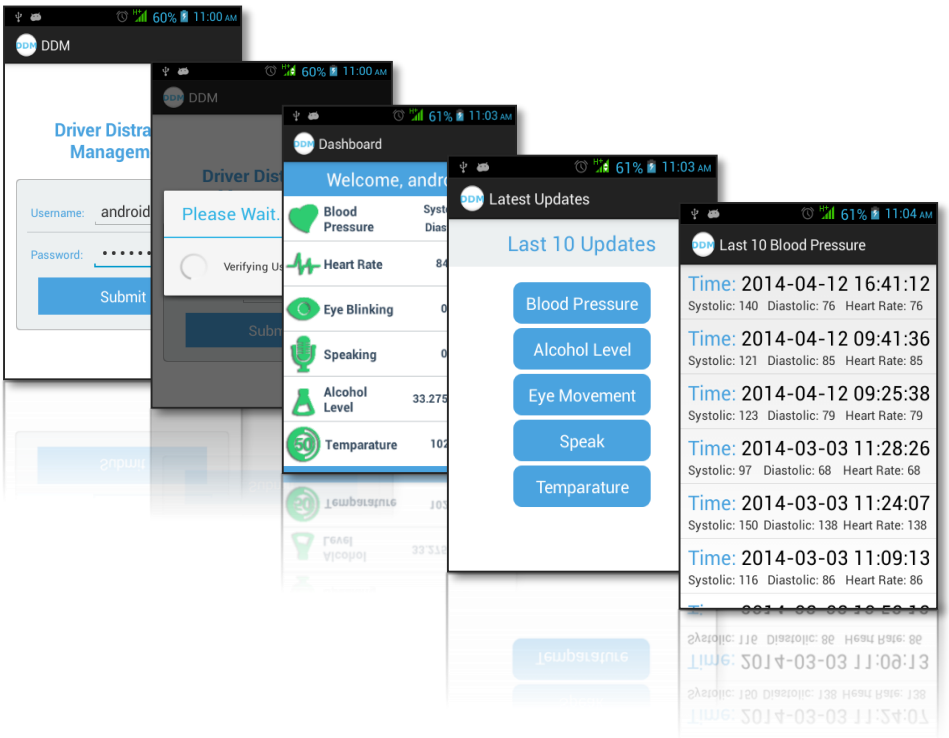

Figure: Mobile Application Screenshots

Cloud Training Gallery:

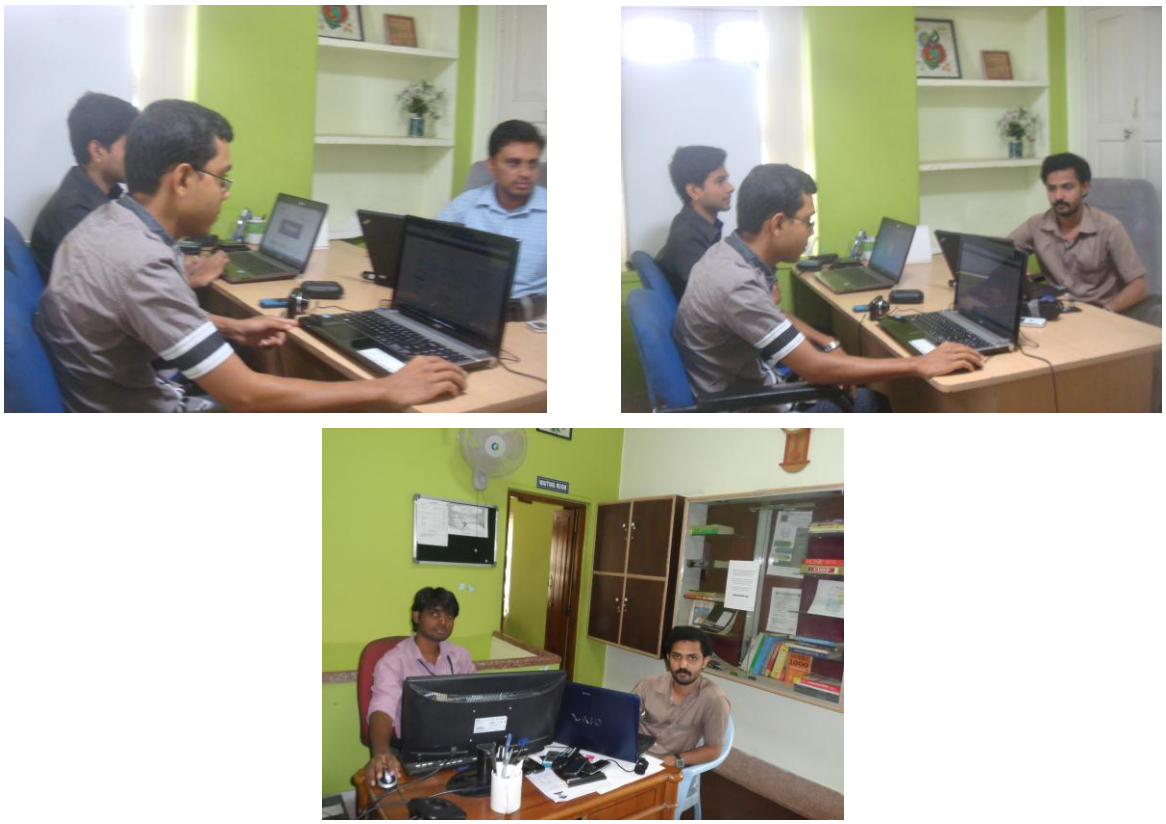

Figure 4: Cloud Computing and Management Trainers

Training Program on Cloud Computing (Bangladesh)

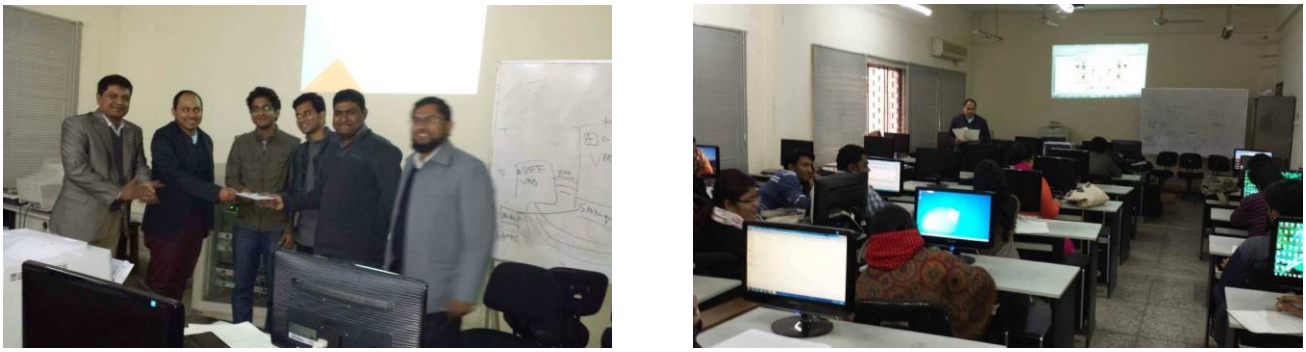

Figure 6: Cloud Computing Training

Conference in Cambodia

Figure 7: Presenting the Published Paper

Figure 8: A group picture of the Authors

Workshop Gallery:

Figure 9 Workshop

Figure 10: Keynote Presentation by Md. Abdur Razzaque

Figure 11: Audience Enjoying the Presentation

Figure 12: Chief Guest delivering his speech

Figure 13: audience enjoying chief guest's speech

Figure 14: Chief Guest, special guests and principal investigator

Figure 15: Discussion by the participants

Figure 16: Discussion by the participants

Figure 17: Industry Representative appreciating the product

Photo Gallery of Training Program for the Drivers:

Figure 18: Road Safety Awareness Session

Figure 19: Road Safety Awareness Session

Figure 20: Drivers enjoying the training

Figure 21: Learning the disadvantages of competing while driving

Figure 22: Road Signal Awareness Section

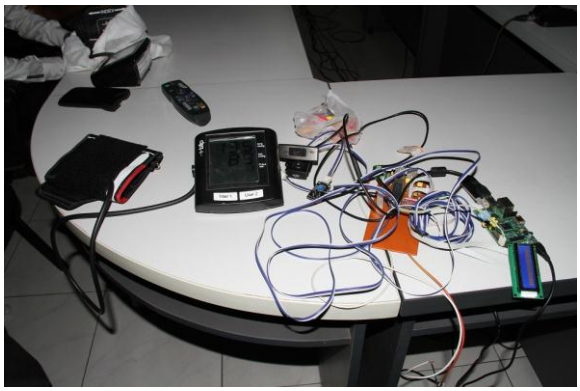

Figure 23: Device Display

Figure 24: Demonstration for the Drivers

Figure 25: Demonstration for the Drivers

Figure 26: Presentation for the Drivers

For dissemination of the project findings, a research paper is written titled "Energy-efficient Scheduling Algorithm for Data Center Resources in Cloud Computing"and it was accepted in the conference IEEE HPCC 2013[9]. Another paper titled “A QoS and Profit Aware Cloud Confederation Model for IaaS Service Providers” has also got accepted in the conference ACM IMCOM 2014[10]. Detailed project implementation steps and achievements has been shown on the website hosted on Google cloud. Also, a workshop will be arranged at the end of the year for propagation of the project activities - its implementation and impact on the society. Shohag Paribahan Ltd, a giant bus company in Bangladesh has agreed on financing this workshop as they have also agreed to run testbed implementation of the product unit on their buses. Shohag’s managing director also agreed on providing any financial assistance needed for the testbed study. The Secretary of Ministry of Posts Telecommunication and Information Technology (MOICT) has also agreed on supporting the large scale implementation of the product unit in the long run. We are also preparing a project proposal according to the MOICT’s specifications.

[9] Institute of Electrical and Electronics Engineers;
Web-site: http://www.ieee.org/index.html
[10] http://dl.acm.org/citation.cfm?id=2558064

Input	Project activities	Outputs	Outcomes	Timeline	Status	Assessment
Consultant hired	Performed requirement analysis and interface circuitry development of sensors	Sensors were purchased based on the requirement analysis and interface circuitry was used in sensor deployment.	Various data collected using the sensors deployed	May 2013–Feb 2014	Completed	Requirement analysis has been done using web services and case study of related projects. Circuitry has been developed using software tools and performance of circuitry was checked using simulators.
GPS tracker purchased	Deployed on a vehicle for experiment purpose	Collection of data such as coordinate, speed, location and capability toremotely control the vehicle (i.e., to turn off or on the ignition remotely)	Various data about the physical location of the vehicle can be known, Google map returns the actual location from the GPS coordinates	Jul 2013 – Feb 2014	Completed	Data collected in this way is stored in the cloud data center for further analysis
Temperature and Alcohol Detection Sensors are purchased	Deployed on a vehicle for experiment purpose	Collection of data such as temperature and alcohol level	Information about the physical condition of the driver can be collected and reported	Jul 2013 – Aug 2013	Completed	Data collected in this way is stored in the database for further analysis
Cloud technology expert hired. Projector for presentation available.	Conduction of training on "Cloud Infrastructure & Services"	Attainment of knowledge on cloud infrastructure and services	The project team is using the gained knowledge in creation and maintenance of the online database	June 2013	Completed	By this training, the project team gained the basic practical knowledge of cloud computing
Two members of project team	Sent to India for attendance of advanced training on "Amazon web service-architecture and essentials"	Attainment of knowledge on Amazon web services hiring and maintenance	The project team is using the gained knowledge in creation and maintenance of the database	25th July-2nd August	Completed	By this training, the project team has gained advanced practical knowledge of cloud computing
Cloud Computing Platform, Expert project members on cloud	Usage of cloud platform for computation and analysis through the knowledge gained from training	Creation and configuration of new VM instances in Google Compute Engine.	Created VM instance has been used to run database server, collected data analysis, data processing and mining and running user interface	1st August 2013 – 10th September 2013	Completed	Using the created VM instance online database server and web interface can be run on Google cloud servers
Hired Members of project team for interface development.	Creation of online database with user friendly access interface	Enable storage of data collected from the sensors and evaluation of information through data mining, analyzing etc.	Provision of driver's performance charts, timeline performance, parametric performance and other statistics	September 2013 - December 2013	Completed	An easy, highly user-friendly interface is developed to show user respective data
Members of project team, Software tools for verifying the findings available	Written aresearch paper based on the project findings titled "Energy-efficient Scheduling Algorithm for Data Center	Paper submitted and got accepted for publication in IEEE HPCC 2013	Dissemination of project findings	February 2013 – July 2013	Completed	Knowledge about the working field has been acquired by studying about cloud platform. Results have been checked using

	Resources in Cloud Computing"					CloudSim, a distributed cloud simulator
Members of project team. Software tools for verifying the findings available	Written aresearch paper based on the project findings titled "A QoS and Profit Aware Cloud Confederation Model for IaaS Service Providers"	Paper submitted and got accepted for publication in ACM IMCOM 2014	Dissemination of project findings	Oct 2013 - Jan 2014	Completed	Knowledge about the working field has been acquired by studying about cloud platform. Results have been checked using CloudSim, a distributed cloud simulator

Project outputs, communication and dissemination activities

Project outputs	Status	Assessment	Dissemination efforts
Sensors were purchased based on the requirement analysis and interface circuitry was used in sensor deployment.	Completed	Minimum set of sensors was bought and deployed efficiently through interface circuitry.	For dissemination of project findings[11], two research papers have been written and got approved. Project outputs are unofficially disseminated to government agencies and other beneficiaries. For official dissemination of project outputs, a seminar was arranged at University of Asia Pacific, Dhaka to let students, faculty members, industry representatives specially the beneficiaries learn about the project and its outcomes. Also a workshop will be conducted in April 2014 for circulation of project activities, its implementation and impact.
Blood pressure monitoring devices were purchased and used to measure blood pressure and heart rate	Completed	Only three devices were purchased for cost efficiency and testability of the system	
Collection of data such as coordinate, speed, location and capability toremotely control the vehicle (i.e., to turn off or on the ignition remotely)	Completed	Data collected in this way is stored in the database for further analysis.	
Collection of data such as temparature and alcohol level	Completed	Data collected in this way is stored in the database for further analysis.	
Enable storage of data collected from the sensors and evaluation of information through data mining, analyzing etc.	Completed	Data has been collected using a java program and inserted into the database through JDBC.Evaluation of data has been presented in the website.	
Attainment of knowledge on cloud infrastructure and services	Completed	The project team gained the practical knowledge of cloud computing	
Paper submitted and published in IEEE HPCC 2013	Completed	The procedure of energy aware VM allocation has been verified.	
Paper submitted and published in ACM IMCOM 2014	Completed	The procedure of VM confederation has been verified.	
Mobile application development	Completed	A state of the art and user friendly mobile application on android platform has been developed	
Workshop for researchers, government representatives and industry representatives	Completed	An informative and interactive workshop on the product activities and novelty of the product unit has been conducted	

[11] www.driverdistraction.gnrbd.net

Project management and sustainability

The project is led by Dr. Md. Abdur Razzaque, Associate Professor, Department of Computer Science and Engineering, University of Dhaka. Consultation service for this project is provided by Mr. Mohammad Enamul Hoque Chowdhury, Lecturer, Department of Applied Physics, Electronics and Communication Engineering, University of Dhaka. Team members for this project include Mr.Tamal Adhikary, Mr. Amit Kumar Das, Mr. Nazmus Sakib Miazi, Ms. Nusrat Mehajabin students of Department of Computer Science and Engineering, University of Dhaka.

The project team has strengthened its capacity and work towards sustainability with the support provided by ISIF Asia by providing project related training for the project team members. The project team did regular discussions on the project definition and progress. We have also arranged weekly seminars on the research topics in our department.

During the workshop titled “ICT for Mitigating Road Accidents” representative of Bangladesh Government the Secretary of MOICT assured us that he will help us gain government funds to develop the product further more. The managing director of Shohag Paribahan Ltd. a leading bus company also gave his word on running testbed studies of the product on their buses. So the future prospects of this project is quite bright and realistic.

During the project implementation period, the team members shared views and opinions with each other and worked together to achieve the goal. In this way, the ISIF Asia has helped to consolidate the research team. As mentioned earlier many private and government organizations has shown their interests in this product so that will nurture and further expand the interaction and growth of the team as a whole..

Impact

For the development of the project, the project team is still working together and helping each other. As a result, environment of friendship and co-operation have been established. In every phase of the project, all the challenges were addressed through the collaboration among the project members. As a result, a confidence of implementing the project in Bangladesh has been grown. Development of a few working unit of sensors will guide in fulfilling the target of deploying sensors in all the vehicles in Bangladesh. For developing the sensor units, we have identified several physical variables and accuracy of configuring the value of those variables has been obtained through several phases of R&D. All the components of the project have been designed using modular architecture. The cost of the integrated sensor device can be obtained through cost of each of low cost modules and expected to be affordable for common people. To design and implement the cloud computation platform, a group of faculties and members from Dept. of Computer Science and Engineering, University of Dhaka have worked hard and gained proficient knowledge in cloud resource management. For studying driver behaviours completely, 10-20 units of sensor circuits should have been deployed. And in this regard an appeal was made during the workshop and we received substantial response from the audience. More and more people in the society are recognizing the importance of this kind of device. It was also able to create mass awareness among the drivers. In the driver training session arranged by the research team where representative of Nirapad Sharak Chai (We demand safe road) gave a speech about some common distraction and ways to avoid them; he also praised the product and encouraged the drivers to accept technology based solutions for a safer driving experience. However, successful development of few sensor circuit units has made it possible to deploy as many as possible without hampering the service quality and system failure. Two of our published research papers can also be considered as the wide spread impact of this project. Furthermore, most of the research based organizations and groups are now well acquainted with ISIF Asia. Through the workshop and its media coverage they know about the funding opportunities ISIF creates and are eager to learn more about ISIF Asia’s works. Four national newspapers and two news websites covered our workshop and published bright reviews.

Overall Assessment

The driver distraction monitoring and controlling project leads to a number of innovations like new cloud infrastructure management, VM allocation model and cloud confederation model designing. Cloud infrastructure management system orders and assigns cloud resources for computing purpose. VM allocation process provides operating system to the users. Cloud confederation model helps to co-ordinate among multiple cloud providers to extend the limit of cloud resources and help each other in times of higher traffic load occurrence or massive processing capacity needed. The strength of the project includes a real time sensor based data collection system. The weakness of the project includes the discomfort the car driver might experience when sensor devices are placed on his body and around the driver's seat. Detection of driver's behaviour such as whether the driver is using phone or taking his eyes off the road is also a matter of struggle.

After completion of the research and development of the project, we justify our foresight about the fruitful completion with all the objectives fulfilled. The most important finding of the project is the innovative cloud infrastructure management and VM allocation model, which is both energy and cost efficient. The outputs of the project include

- Driver's health status data collection. Such as body temperature, drowsiness etc.
- Design and implementation regarding car location, speed, navigation history etc.
- A distributed secure cloud data storage and manipulation system.
- A user friendly web interface
- Knowledge enhancement of the project team members
- Two international conference papers in IEEE HPCC 2013 and ACM IMCOM 2014
- Flourished team work capabilities of the team members
    - Coordination among the members
    - Verbal, impersonal and formal communication progress
    - Collaboration and peer review

Among the team members and external personnel.

Figure 27: Team Members

Prime contribution of the project is a driver distraction monitoring and controlling system that collects real time information and report on drivers' health status, their driving performance, and provide alert messages immediately in emergency cases, determine distraction levels, etc. It will be beneficial for driver, owners of vehicles, driver recruiters and road transport authority. A major part of our project is detection of driver's drowsiness and driving behaviour; design, management and implementation of this are particularly important to the degree of success of the project. Eight faculty members and research students directly or indirectly worked hand in hand to implement the project. The project helped to build up the research capacity of the project team largely. During the implementation of project, some important lessons were learnt. For example,

- Before purchasing a sensor-device, we have to analyse more in detail about its applicability, its interface with the existing platform, its uses at the car, its flexibility etc.
- Practical knowledge on integrating embedded systems
- Got familiar with common and efficient coding practises on embedded systems
- Acquired extraneous knowledge on sensor level data communication
- Achieved hands on experience on cloud computing
- Gathered extensive knowledge on web service deployment and distributed user service implementation
- Enhanced group working capabilities and project management skills

Recommendations

Collaboration and coordination among the project grant recipients might help a lot to get mutual technical benefits from each other. The close monitoring and midterm presentation of ongoing projects might also help to accelerate the project activities so that the project objectives can be achieved as planned.

Other researchers interested in the issues of our project might address the following issues:

- There are wires connecting the sensors to the controller, which could be replaced by wireless and physical contactless alternatives.
- Fine-tuning the accuracy of the deployed sensors can be improved.
- Other researcher might study into the matter of determining the stopping distance regarding inter vehicular networks.
- Any warning regarding the turns and bumps in the road.
- Develop a more comfortable blood pressure measuring device.

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