

A Complete Road Health Monitoring System for Bangladesh: Crowdsourced Data Collection through User Application and Smart Analyzer with Real-time Feedback System for Driving Assistance

Abstract

Bangladesh has been fighting with the issue of ensuring a safer road management system since its inception. Yet Bangladesh is suffering from incapable infrastructural road-routes and unattended maintenance of the system. Building good-quality roads with sustainable materials covers only a part of the maintenance and preservation of a safe road system. But maintaining real-time observation and constant data collection about the routes is a must to ensure safe roads for safe commutation. Both high-ways and local-roads need to kept under effective surveillance system. Besides human errors on roads, we can automate the real-time data collection about the road condition and provide analyzed feedbacks to government and people. In this project, we present a smart system for road health monitoring. The two main branches of this project is Large-scale crowd-sourced data collection of road-surface condition through user application and Real-time feedback based on image segmentation to detect road-cracks and anomalies. The proposed system consists of implemented version of each of the subsystems with the collected data by the research team. We believe that such crowd-sourcing based platform will be highly effective to ensure safer commutation experience of citizens of Bangladesh and help the government to maintain roads effectively.

System Diagram

The project consists of the following features:

1. *A Web Application:* The system is a web-based application based on crowd-sourced and dedicated data collection, where any user can update images from any area's road and can log data from smartphone-sensor based application.
2. *Route Suggestion:* The system marks best routes keeping in consideration of road condition and vehicle movement data collected from mobile-sensor application.

The proposed approach is implemented using customized ML model of Image-segmentation to detect road cracks and anomalies[Figure 1] . The ML model is inspired from our related work on PSPNet[1] and KittiSeg[2].

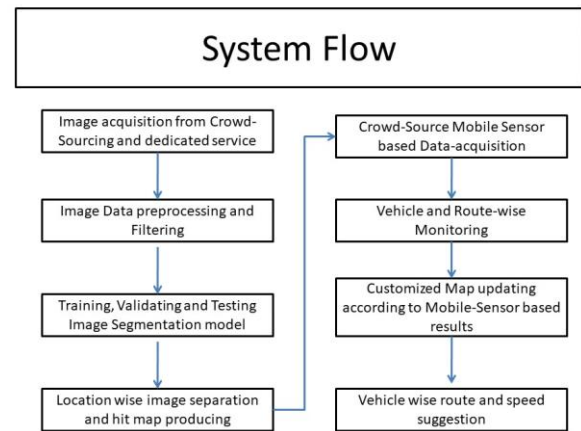


Figure 1: System Diagram of Image Segmentation, Mobile-sensor Data processing and Route Suggestion

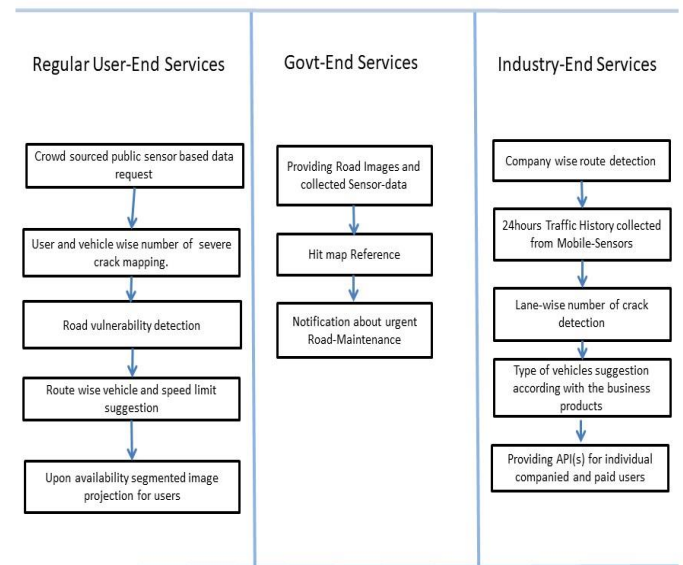


Figure 2: Services End of the Proposed System

The model is built on 7-layers of FCN, preceded by VGG16 pre-trained model on ImageNet used in encoder and FCN

layers replaced by 1-by-1 convolutions, followed by a transposed convolutions of decoder. From each image, "Road" and "Crack" are segmented only. The model is trained on 500 epochs, with a loss value of 8%. The dataset consists of 8000 images collected by the research team and 1200 images obtained from LGED department of Bangladesh government. Figure-2 represents the segmented user-end features of the system.

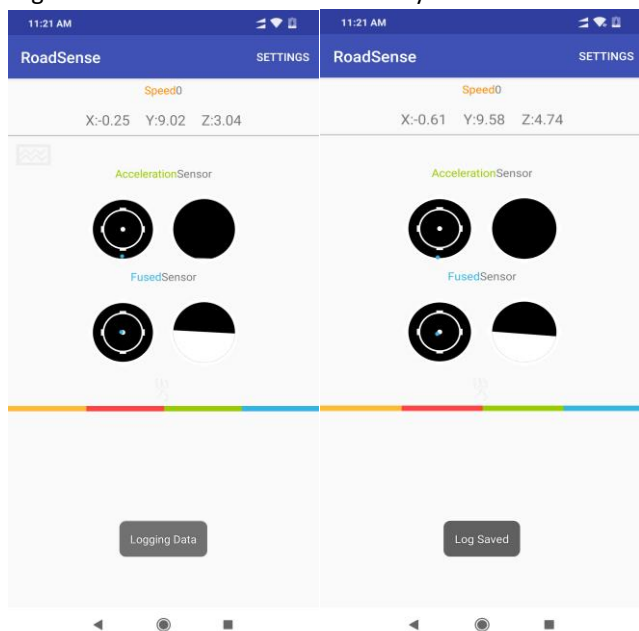


Figure 3: Smartphone-sensor Data-Logger App

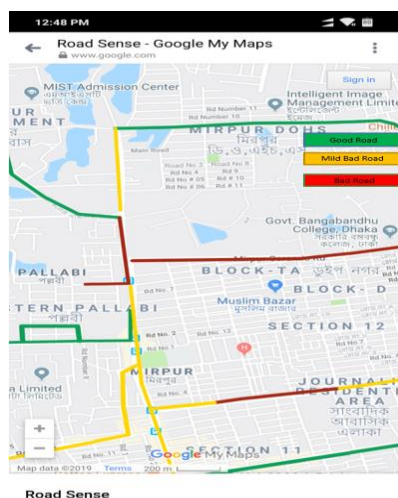


Figure 4: Proposed Customized Map for projecting Road Condition

For road-health monitoring from the perspective of user experience while riding a vehicle on routes, the research team built a data-logger app based on smartphone-

sensors[Figure 3]. LSTM[5] and CNN[6] is applied on the mined dataset from the app to predict the condition of roads and number of cracks. Based on the image segmentation analysis and feature extraction from sensor-mined data, the proposed customized map for user-end is built[Figure 4].

Novelty of Project and Significance

Maintenance of road-routes and related infrastructures are still known to be the concern of civil engineering departments in most countries. The concept of "Smart-City" [4] is new in the computer-science research field. The idea of automated road-health monitoring system comes under the provision of futuristic smart-city idea. While there has been works on building smart vehicles with sensors and intelligent systems, smart road-routes are still in concept phase in research field of Smart Transport Infrastructure, collectively known as Intelligent Transport System (ITS) [3]. In case of Bangladesh, there has been no such significant work until now to include technology in road maintenance. Hence, this project aims to realize a very novel and significant idea to implement a low-cost yet effective system for a non-tech viable environment in Bangladesh with lowest deployment of sensors and related maintenance.

The significance lies on building a common platform for citizens and government. Such a platform is viable for people to provide information about bad road conditions and authority can take action immediately. Our proposed system addresses the safety concern of common people on the roads before they have to experience at their own.

Impact on Society

In developing countries, lack of structural health monitoring makes roads and highways vulnerable over the time. Rough road condition at one-side causes acute traffic congestion and on the other side causes severe health damages to the passengers who travel in light vehicles through ragged roads. Even the heavy vehicles to face terrible road accidents in rough roads. The existing road-maintenance system focuses on providing post-accident related concerns like ambulance and emergency contact calling etc. The road decay conditions are found both in developed and developing countries due to environmental effects and natural decay of road-constructing materials. For all of the above reasons, common people need to foresee the road condition before they travel and choose their vehicles accordingly. Avoiding rough roads and choosing alternative

routes can reduce traffic jam largely. Google-Map can show only heavy constructional sites in the map but does not project local road updates. Whereas the customized app of the proposed system can demonstrate the local route update based on road condition and people can choose alternative routes to avoid traffic jam accordingly. The crowd-sourced data will be helpful to know earlier about a locality in dire need to fix their roads.

Business Model:

The road maintenance sector is still under-treated in terms of intervention of technology, and the persistent rough road conditions are causing irrecoverable damages in human lives as well as economic loss of industries. The proposed road health monitoring system aims to provide an informed platform for the users to know about road conditions prior to their commutation, as well as to provide information to the concerned authority to maintain roads properly. The target market of this system includes industries dependent on imported valuable materials, hospital services, travel companies and common people.

We plan to implement a freemium business model, versioning the system in two categories: Industry-Level (Paid version on Monthly basis) and User-Level (Free for certain features). The free version will follow marked routes on customized app with legends based on road conditions, while the paid version will allow users to view images with detected cracks and anomalies. The exclusive services including hit map projection of user request, dataset of images and sensors and road-maintenance notification will be offered for Govt. and its related organizations based on monetary exchange. This way the proposed system will be highly effective and beneficial for the Govt. to monitor the road management system.

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