INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
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MAARG: Monitoring and Assessment of Roads by Geo-citizens

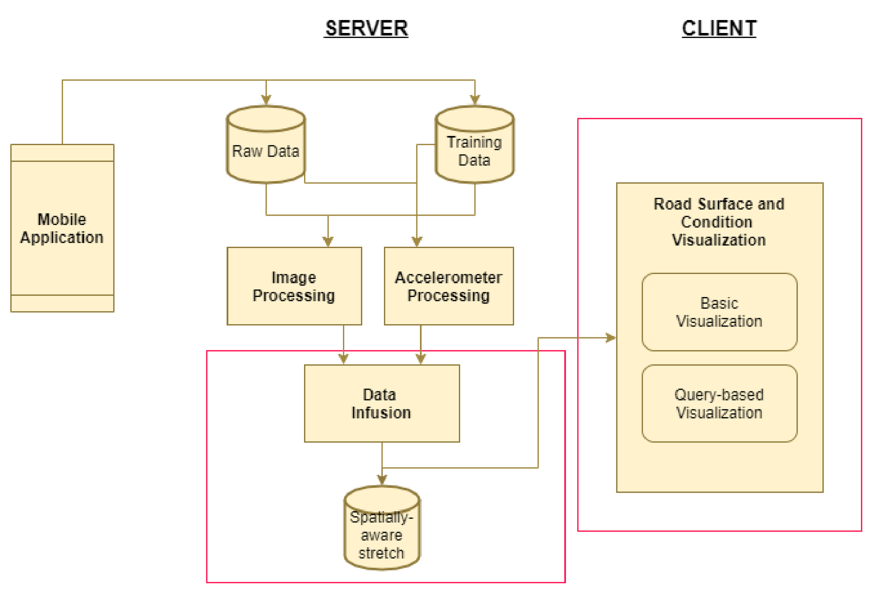
ABSTRACT

The following poster deals with a proposed system for monitoring the condition and surface of roads in developing countries like India. This system will be used by government agencies to monitor municipal activities like road laying and planning. The system utilizes a database created by geo-citizens or government workers as an input. The heavy machinery in existing systems is not an optimized solution to this problem. Some existing systems use GPS and accelerometer data for determining such artifacts. So, it is evident that there is a need for a system that generates robust, frequent and accountable geo-tagged data.

OBJECTIVE

We propose a new collaborative model for such a purpose by fusion of data from multiple sensors hosted on smart-phones of several active geo-citizens. The system focuses mainly on volunteered geographic information, in which users can use their respective smart-phones to collect the data required and upload it for further analysis. The server side of the system infuses this data into a PostGIS database and displays the road condition on a near real-time basis over a WebGIS. The strength of a good visualization in imparting insight to decision-makers is widely recognized. We advance the paper by assessing procured road data and displaying it in an easy to understand format. In addition to visualization, the WebGIS component also provides for timeline analysis of changes in road conditions, which may help in the improved management of road infrastructure.

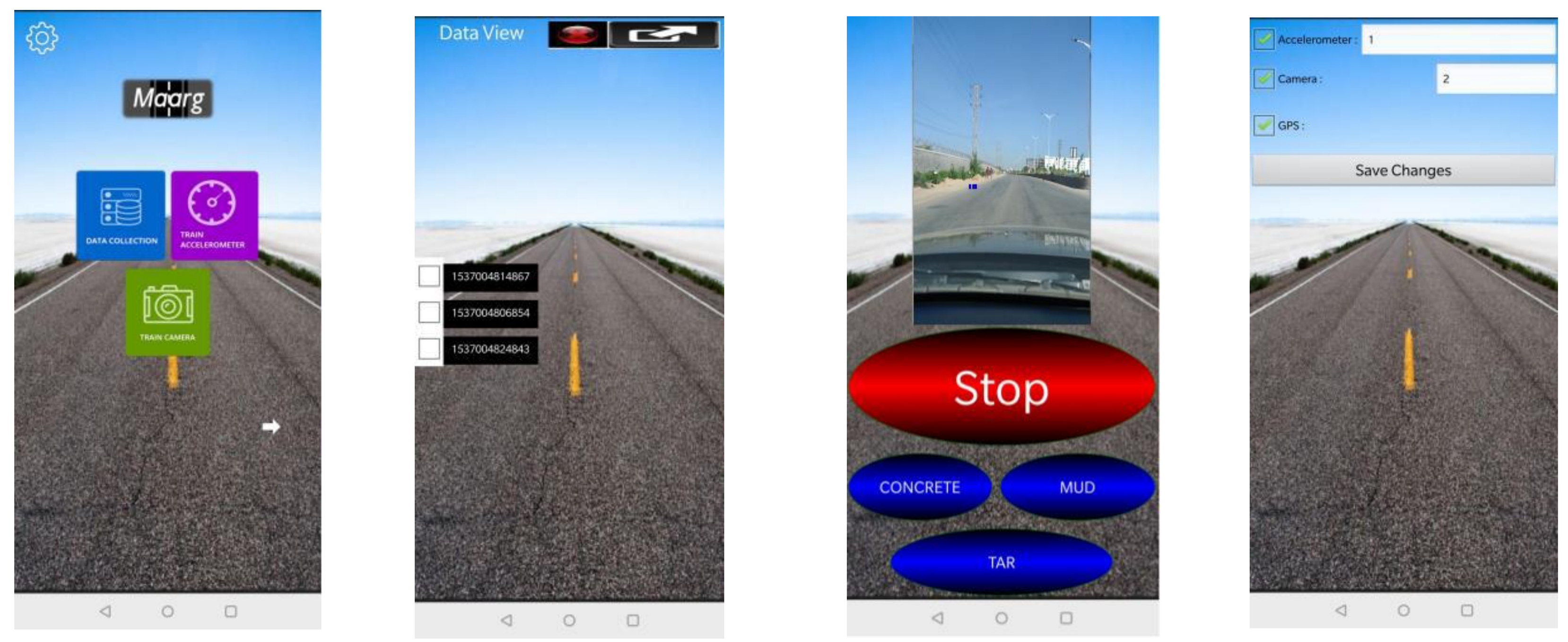
SYSTEM DESIGN



The system architecture is a distributed client-server software structure. The mobile application is used to acquire and train data. The data collected is then uploaded to a server that runs an ML-based classifier on this data. The classified data is then fused and stored as different segments. This is the input to the visualization dashboard. This poster focuses mainly on the highlighted components.

Mobile Application

The mobile application is built on the popularly used Android platform and is compatible with smartphones integrated with an accelerometer and a camera with at least 5 MP resolution. The application primarily has two modes; Data collection mode and Training mode. The data collection mode is used for the collection of necessary multi-sensor data that includes road images, accelerometer readings in all three axes, GPS coordinates, and GPS speed. The user shall securely mount the smartphone on the car's dashboard such that the target road is within the camera's view. A help screen assists the user to use the app in data collection mode conveniently.



Processing Server

The classification of the data is performed using the algorithm reported in (Rajamohan et al., 2015). To summarize the process, tar roads vs. mud/concrete roads based on the intensity distribution of the scene and the mud roads are differentiated from concrete roads depending on the colorfulness of the image. Accelerometer readings across x,y,z are classified using k-NN algorithm. The road condition classification is based on the International Roughness Index (IRI) classes, viz., Good, Satisfactory, Unsatisfactory, and Poor. The final road surface types are Bitumen (tar), Concrete, and Mud

Visualization Dashboard

In this paper, we present a WebGIS dashboard comprising a back-end server that analyses and aggregates information from multiple inputs. For systems such as traffic monitoring systems, only tracking, and positional information is used. The proposed system not only using the tracking information but also the image information to give the optimized result. Hence, our system processes positional information and attaches on the fly analysis of the data collected from different sensors. This is achieved by collating multiple users' data efficiently.

Data Fusion Model

Data fusion involves achieving three objectives which are demarcated as a. compactness of data that deals with how any particular data is uniquely and concisely represented, b. extensiveness of the data that measures the number of attributes associated and c. factuality of the data that shows how true the data is to the real world. The proposed system intends to conform toa novel model that adheres to the aforementioned principles.

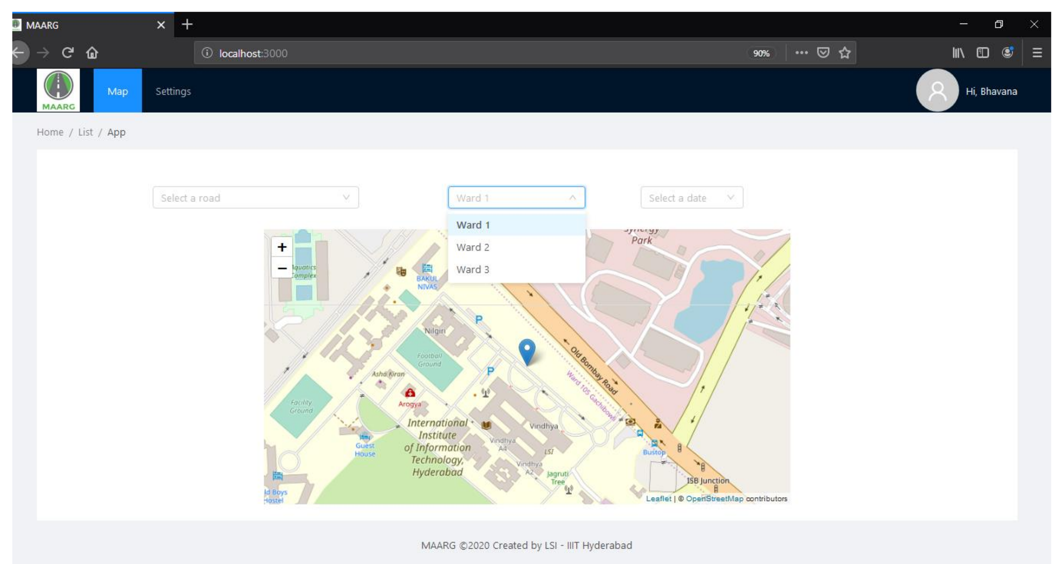
Challenge in data fusion: As the current system deals with a diverse stream of data, there arises a problem of standardizing this data to conclude some meaningful information. We segregate the problems into two categories a. accuracy which means that using low-cost devices we should get the accuracy close to high-end systems and b. result conflict which arises due to the multiplicity of the data, in which case there are multiple conclusions made for the same attribute of the data.

Case Study

The purpose of this case study was to thoroughly analyze the system which could reveal factors or information otherwise ignored or unknown. The proof of concept of the system has been deployed and data was collected on a stretch of 15 km in Gachibowli and Tarnaka areas of Hyderabad, India on a nearly monthly basis for 5 unique users for validating the concepts and verifying the proposed models. The analysis in the next section is the outcome of this study area.

Query Engine

An assumption has been made that even-though commuters travel through different lanes on a multi-lane road, we do not distinguish the lanes to provide the outcome. Let us take an example of the Old Mumbai highway in Hyderabad, which is a3-lane road on both sides. In our experiments we have observed that commuters prefer to take the lane that is free from potholes. Hence, a majority vote of all user data collected for the stretch of road is taken for each segment and final verdict is allocated. BASIC VISUALIZATION: The basic visualization shows the most current classification ac-cording to the 12 classes. QUERY-BASED VISUALIZATION: The system supports two types of queries as given: Spatial Queries: Analysis of the road based on municipality ward can be opted. Temporal Queries: Queries based on different time periods can also be performed for different roads.



CONCLUSION

A low cost sensor based visualization framework is a solid match for cities since it removes the requirement for specific high-end monitoring infrastructure. This system can be utilized to produce geo-tagged insights on road infrastructure. For instance, faster deterioration of some roads over others can be easily determined. The framework presently gathers and shows the information which gives different organizations a prepared reference about surface and condition qualities. This frame-work proposes an intuitive citizen supported model to screen road surface and condition. Crowd-sourced model for such ap-plications can be actualized by 1) Geo-citizens; 2) Office staff of districts or city enterprises; 3) Campaign or strategic activities which are onetime occasions; 4) Cabs and commercial vehicle operations units. The present model is a convenient methodology that can be utilized in any of these methods. Most of the existing systems only provide information regarding the condition of the road, but this system also covers the surface in-formation. By making such a system available, we show a true example of utilizing GIS in governance.

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