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

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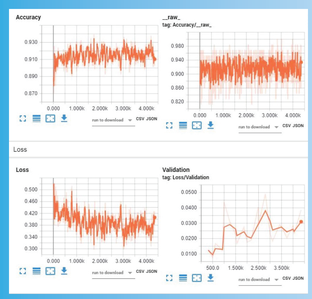
Abstract

Bangladesh has been fighting with the issue of ensuring a safer road management system since its inception. Yet Bangladesh is suffering from incapable and unattended road communication 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. Automation in real-time data collection about the road surface condition and providing analyzed feedbacks to government and people can be very effective to reduce road accidents across the country. 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. We believe that such crowd-sourcing based platform will be highly effective to ensure safer commutation experience of citizens of Bangladesh.

Image Segmentation

The proposed segmentatioon model consists of encoder (VGG16 model pretrained on ImageNet for Classification) and decoder (Transposed convolution to upsample the input image to original image)



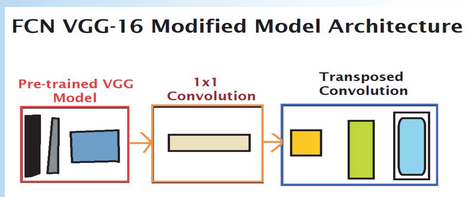


Fig. 1: Image Segmentation Model Architecture

Fig. 2: Accuracy, Loss and Validation Graph of the FCN Model

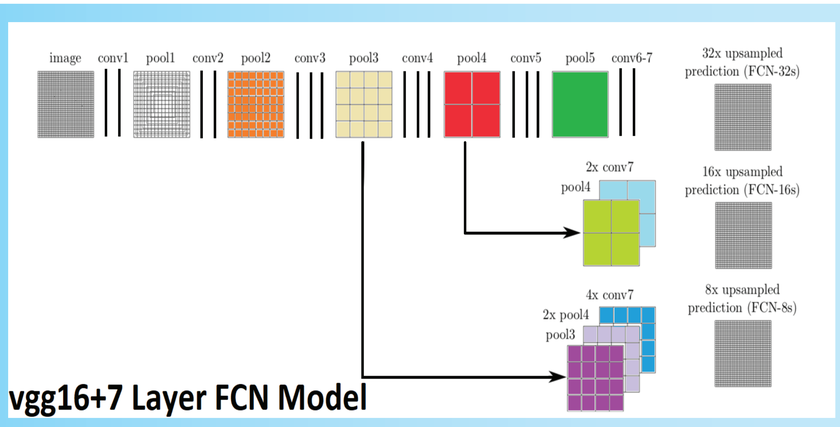


Fig. 3: Proposed Segmentation Model Architecture

System Flow

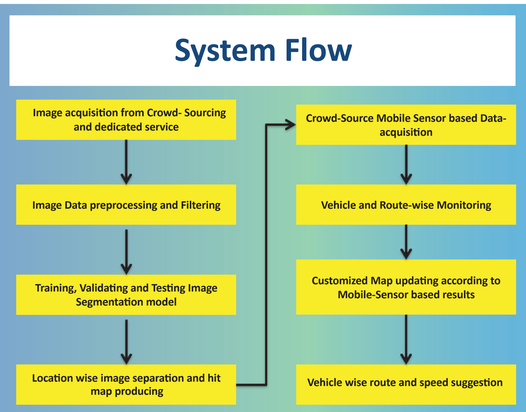


Fig. 4: System Architecture

Application Interface

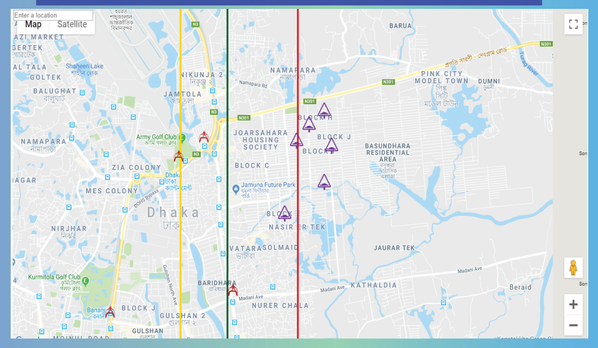


Fig. 5: Customized Marked Route Map Projecting Road Condtions, Foot Overbridges and Speed Breakers

Fig. 6 Test Output of Proposed Segmentation Model (a) Groud Truth Picture (b) Segmentation Image

Future Works

1. System Automation
2. Smart Driving Assistance System
3. Acquiring Large Volume Data from Web Platform.
4. Large Scale Collaboration with Govt.

Data Flow

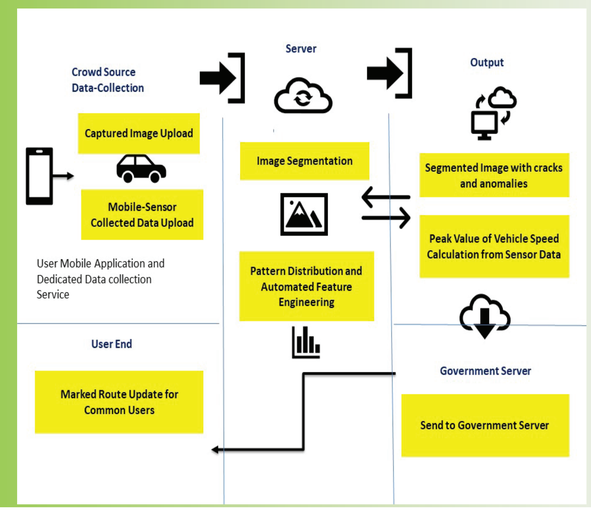


Fig. 7: Data Input Output Flow of the System

Smartphone Sensors Based Time Series Data: Pattern and Feature Engineering

We have collected time-series data of accelerometer sensors and speed value using smartphone sensors through mobile application. The dataset follows "Johnson Unbounded Distribution" pattern, that matches random skewness and kurtosis of the data.

PDF	$\frac{\delta}{\lambda\sqrt{2\pi}} \frac{1}{\sqrt{1+\left(\frac{x-\xi}{\lambda}\right)^2}} e^{-\frac{1}{2}\left(\gamma+\delta \sinh^{-1}\left(\frac{x-\xi}{\lambda}\right)\right)^2}$
CDF	$\Phi\left(\gamma+\delta \sinh^{-1}\left(\frac{x-\xi}{\lambda}\right)\right)$

Fig. 8: Equations of Johnson-U Distribution

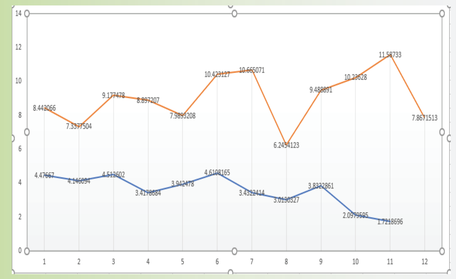


Fig. 9: Plotted Values of Acquired Smartphone Sensors' Data

Automated Feature Engineering Using CNN

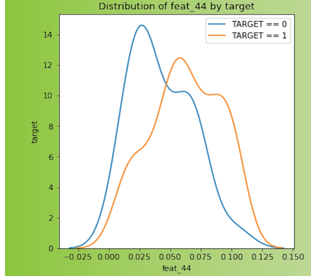


Fig. 10: Kernel Density Estimation plot of the highest correlated variables

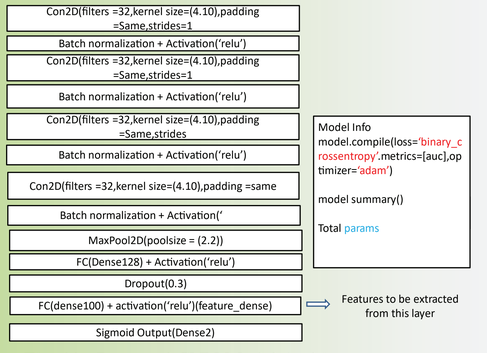


Fig. 11: Proposed CNN Model Architecture