Report on Various Road Quality Predictor Projects

Approaches discussed

=>Sensor based detection using smartphone vibration data

=>Object detection using deep learning(YOLO)

=>Vision based detection using convolutional neural network

Sensor based Pothole Detection using CNN

Link :https://www.mdpi.com/1424-8220/23/22/9023#sensors-23-09023-f001

Objective : Detection of Road potholes by applying CNN method based on road vibration data.

Source : MDPI Paper

Date Published : 7November, 2023 => Even though it was published back in 2023 it used a revolutionary approach by using mobile sensors and using the readings as an input to CNN.

Achievements

1) The main differentiating factor of this approach was that it didn't rely on the dashcam of cars which is not common till this day in India.
2) Smartphones were used as the primary device which has much larger penetration in India.
3)Extra cost for the dashcam was eliminated.
4)Commendable accuracy of 93.24%. In field study generated an accuracy of 80% to 87%.

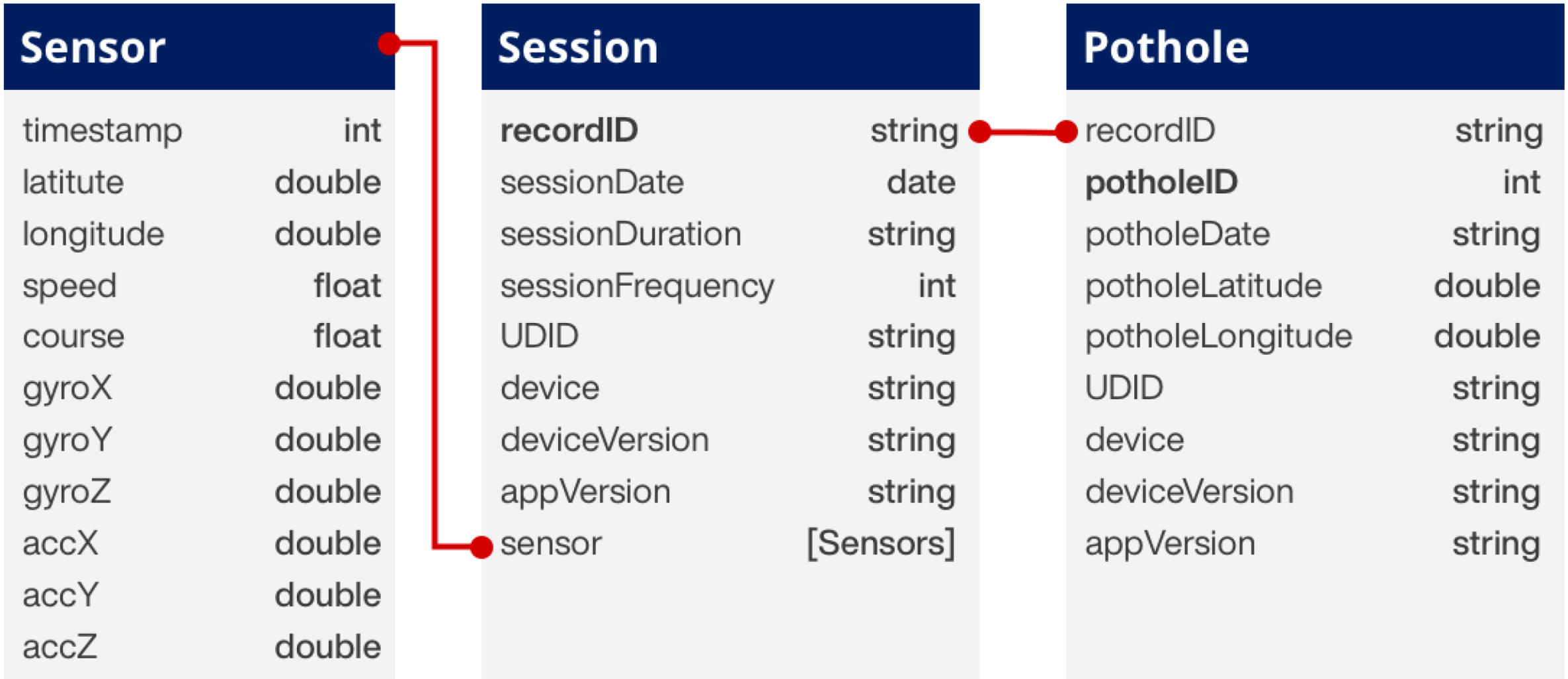
Dataset Preparation

1)For the dataset collection the motion sensors like accelerometer ,gyroscope and many others were used.

2)Detection is based on the road vibration data exceeding a predefined threshold value indicating surface irregularities(Dynamic threshold was used).

3)The vibration data from these sensors were continuously recorded ,all data were stored in a local database within the mobile device .For this purpose the "Realm database" (data directly on the phone and is fast for frequent writes) was used.

4)In the created database ,three tables of name sensor , pothole and session were designed to store road vibration data obtained from sensors.

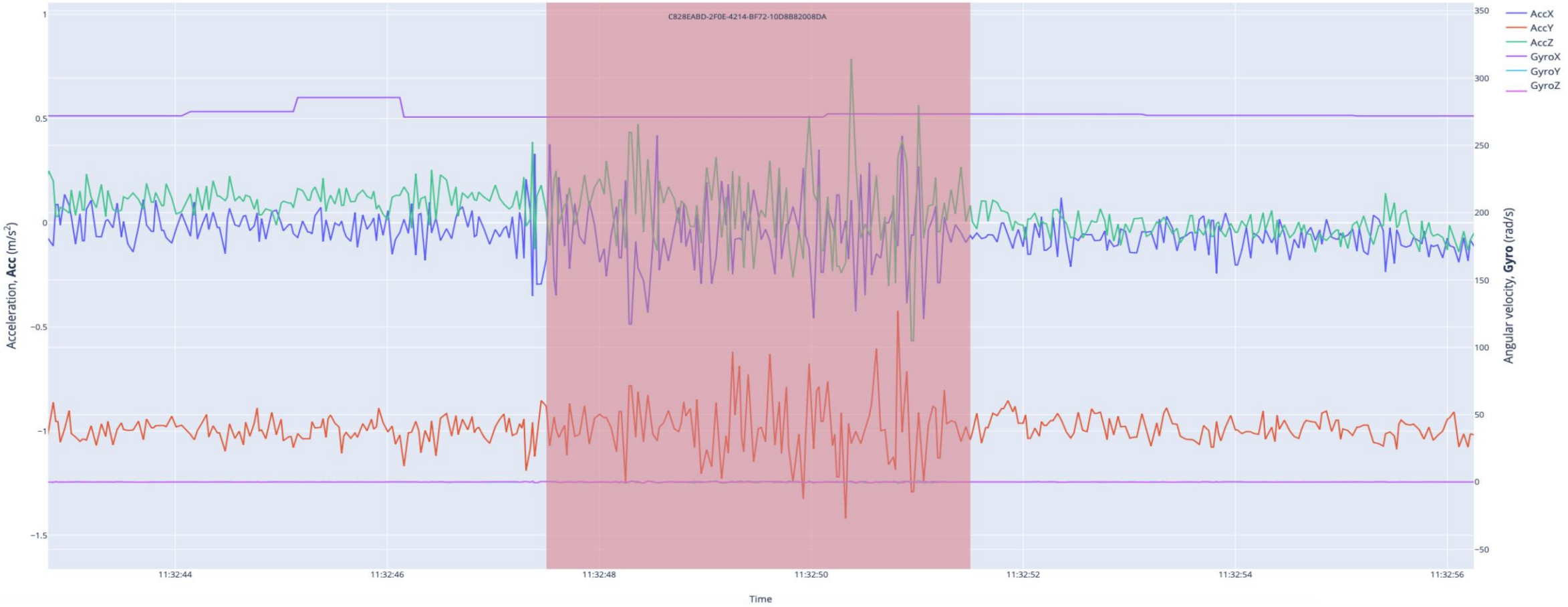

Sensor
timestamp int
latitute double
longitude double
speed float
course float
gyroX double
gyroY double
gyroZ double
accX double
accY double
accZ double
Session
recordID string
sessionDate date
sessionDuration string
sessionFrequency int
UDID string
device string
deviceVersion string
appVersion string
sensor [Sensors]
Pothole
recordID string
potholeID int
potholeDate string
potholeLatitude double
potholeLongitude double
UDID string
device string
deviceVersion string
appVersion string

5)During the data acquisition and model testing, the environmental conditions remained consistent: a dry day, on a dry asphalt road, and a maximum vehicle speed of 50 km/h, with the same driver. Both the training and testing of the CNN model were conducted under these environmental conditions.

Data Preparation

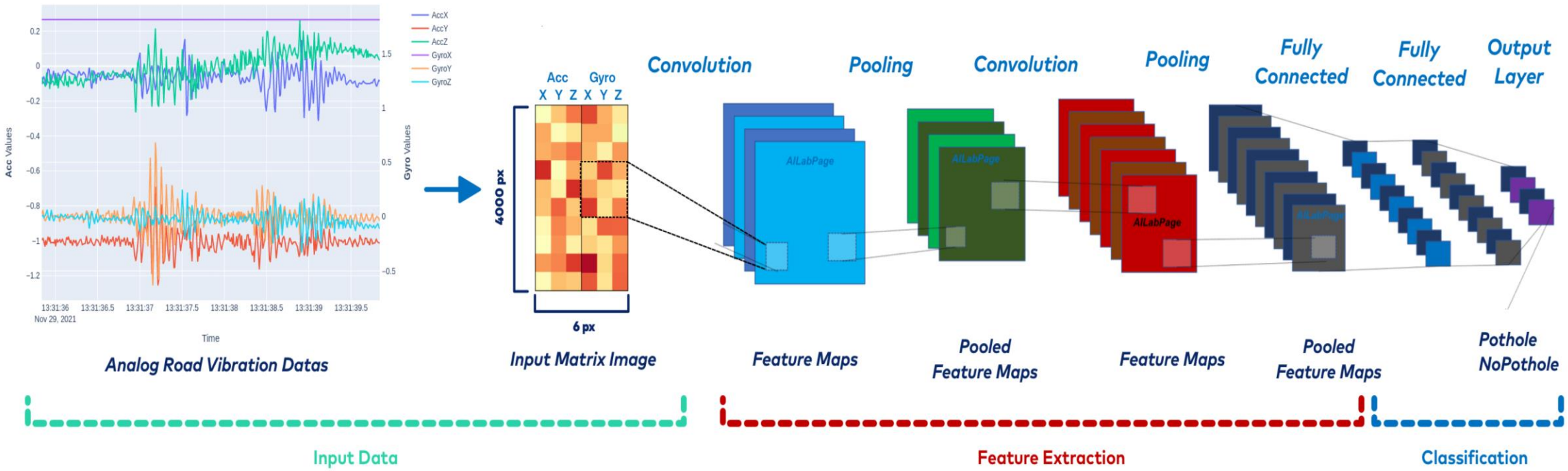
1)Google Colab was chosen due to its advantages in organizing and processing data in deep learning.

2)The road vibration data include attributes such as Timestamp, Latitude, Longitude, Acceleration (Acc(xyz)), and Angular Velocity (Gyro(xyz)), while the pothole data include attributes such as ‘PotholeID’, ‘PotholeLatitude’, and ‘PotholeLongitude’.



Road vibration data (acceleration Acc(xyz) and angular velocity Gyro(xyz) signals) and pothole region (red area).

Training and Validating of Convolutional Neural Network Model



Road vibration data were transformed into an input visual matrix for the CNN model

Different models with varying numbers of layers and parameter values were developed to detect road potholes using a CNN-based approach

2)iWatchRoadv2: Pothole Detection, Geospatial Mapping, and Intelligent Road Governance

Link : https://arxiv.org/html/2510.16375v1

Objective :

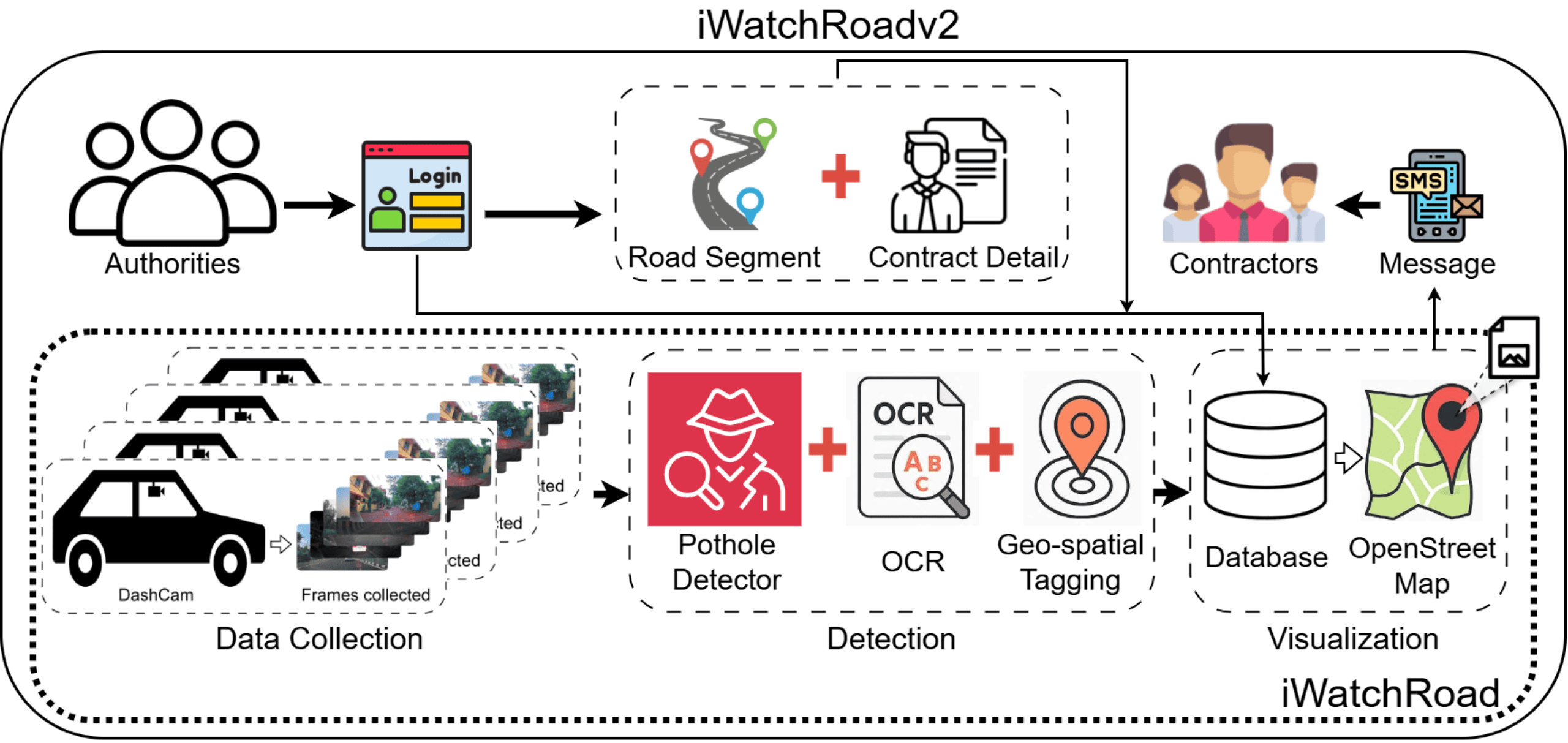
1)Real-time pothole detection by using YOLO
2) GPS-based geotagging
3)The system automatically sends alerts to contractors and officials when road health deteriorates, supporting automated accountability and warranty enforcement.

Date Published :18 Oct 2025

Achievements:

1)A fully automated end-to-end platform for real-time pothole detection, GPS-based geotagging and dynamic road health visualization using OpenStreetMap (OSM).

2)To overcome the lack of geotagging seen in previous research, the approach aligns timestamps extracted from video frames using Optical Character Recognition (OCR) (AI, 2020) with GPS data, guaranteeing precise location information for each detected pothole.


iWatchRoadv2
Authorities
Login
Road Segment
Contract Detail
Contractors
SMS
Message
DashCam
Frames collected
Data Collection
Pothole Detector
OCR
OCR
Geo-spatial Tagging
Detection
Database
OpenStreet Map
Visualization
iWatchRoad

Implementation:

BHARAT POTHOLE: We introduce an extensive, self-labeled dataset that features various infrastructure of Indian roads, encompassing varied road classifications, meteorological conditions, and illumination scenarios representative of authentic driving contexts.

Specialized Detection Architecture: We developed and publicly released a deep learning-based pothole identification model utilizing YOLO, optimized on the BHARAT POTHOLE dataset, showing strong performance in challenging operational environments.

OCR-driven GPS Alignment: We established synchronization between dashcam video sequences and external GPS trajectories through OCR-based timestamp extraction from frames, facilitating accurate geolocation.

Web based Mapping System: We constructed a web interface using OpenStreetMap that visualizes identified potholes along with frame imagery and contextual metadata, generating a real-time pothole cartographic system.

Vision-Based Pothole Detection Using CNN Model

Link : https://link.springer.com/article/10.1007/s42979-023-02153-w

Objective : Detection of Road potholes by applying CNN method based on road visual data.

Source : Springer Paper

Achievements:

1) Pothole detection using the texture and surface of pavements that are different at the location of the pothole from the other part of road.

2)Addressing various road conditions and different scale, shape, size and illumination effect of potholes.

Dataset

To achieve this objective, the image datasets with pothole and without pothole which obtained from the Kaggle was used.

Took different datasets from Kaggle and combined them to train the proposed model. A single dataset consists of both types of images (i.e., images with pothole and without pothole).

processed the collected images data after collecting images of non-potholes and potholes. Various procedures on the images were executed during pre-processing of a data.

Cropping an image means removing or adjusting the images outside borders to improve frame or design.

There are numerous augmentation technologies used to get the most out of small collected dataset . As augmentation increased the volume of dataset, the proposed model can be trained in a better way.

When a picture of a non-pothole and pothole is rotated, it still seems like a non-pothole and pothole, and represents the scenario as if it was obtained from a various angles.

Training using CNN

Multiclass classifier model and tensor flow approach were used to solve multiclass classification problem. CNN classifier was used to classify the images of data set.

Network is fed as input and output is generated according to neurons' activation functions in first part, i.e., feed-forward part.

Back-propagation is the second part of training in which comparison of output was carried out with desired or target output.

Results and Observations

The designed model was evaluated by drawing graph of loss and accuracy vs epochs. The graphs of loss and accuracy vs epoch indicate the learning performance of model over time. We run up to 65 epochs for training the proposed model, and found that, the accuracy of model remains less than 87.5% for 29 epochs but same was increasing continuously up to 99.91% at 30–65 epochs after that there is instability in accuracy on further increasing the epoch.