Potholes+

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Abstract - *Our project's main purpose is to create pothole-free roads and improve governance by involving the public more. It also intends to provide low-cost, dependable automation of current systems. At every level of user-system interaction, the system will provide great data protection, as well as robust and reliable storage and backup options.*

***Key Words*: Detection, Reporting, Yolo Model, Virtual Assistant, Classification, Route optimization, Communication.**

1.INTRODUCTION

It's an inefficient and time-consuming approach that's leading to an increase in potholes and traffic. Every one of these documents is extremely difficult to keep track of, inefficient, and prone to errors. Keeping these documents on paper is very expensive. In this approach, with the manual structure as our project's core, we've created a computerized version of the manual framework as "Potholes+".

The approach is based on creating an effective easy-to-use system for all entities of the government and the general public. Our country is connected from one part to the other by excellent road network connectivity. These roads and highways often are damaged and contain potholes, these damages and potholes are reported to the government but the process is too tedious and manual. With the advent of technology computer systems and static databases have been used by the government to keep the pothole records. This is however not very interactive and often needs the aid of another person to be implemented.

The purpose of designing an application that circulates the idea of government officials and the general public's interaction is to make this process more efficient. This brings together the best professionals on the same page so they can focus their energies on providing the best possible repair services. This year's rains have wreaked havoc on India, and potholes are the government's primary concern. The difficulty now is that the various departments are unable to work together to tackle the problem. **ISSUES:**(a) There is a fundamental divide between civil agencies, citizens, and elected officials. (b) The goal is to create a mobile-based dynamic reporting system that will make it easier for all stakeholders to share information. (c) The goal is to improve governance by involving the people more.

1.1 DRAWBACKS OF EXISTING SYSTEM

There are several drawbacks of the existing work on the potholes detection and amendment system. The primary drawbacks of the existing system include the following points that Potholes+ aims to counter:

Loss of reporting and construction data - A lot of data is often lost and left unattended at the reporting stage. Even if reports are made they go unnoticed due to the lack of direct interaction with civil agency members.

Time-consuming and error-prone process - The process of reporting potholes and fixing them is a time-consuming one. Due to the manual work involved, there are higher chances of errors and miscommunications.

Costly- Hiring employees to track potholes, members to maintain and follow up with communication and maintain a streamlined flow of work proves to be much costlier.

Not economically and technically feasible to maintain records on paper - It is no wonder that paper records are pretty redundant for the current times. Both for effective follow-up and feasibility paper records are no longer economical.

Lack of communication - Lack of communication with all parties involved often proves to be ineffective.

Lack of security - The concerns for data security and confidentiality is also one that needs to be tackled.

1.2 MOTIVATION

Our motivation for Potholes+ includes the following aspects that we wish to achieve for fixing potholes effectively. **Paper-less -** We aim to make the process completely paperless and easy to manage. **Easily accessible to the citizens -** All citizens can have easy accessibility through a centralized app for effective communication. **Cost-effective-** A one-stop destination for all activities will make the process cost-effective. **Time effective-** Ready communication and actionable tasks make the mechanism time-effective as well. **Reduce power consumption-** A centrally managed system will reduce overall power consumption and wastage. **Automation of the existing system-** It not only allows the creation of a new system but the automation of the existing system as well. **Excellent security of data-** Data

can be maintained securely and confidentially with access control specifications. **Better storage facilities-** Data storage and management facilities can be greatly improved in a digital environment.

Communication between Stakeholders- One of the most important factors of the system is effective communication between all stakeholders which directly translates to better action taken on the pothole to be fixed and the situation at hand.

2. CONCEPTS AND METHODS

Data Acquisition

The stress caused by road irregularities could be captured by cellphones' built-in accelerometers. This shock can be labelled with position information using the inbuilt GPS chip, making road irregularities to be stored on a digital map. This is done using a smartphone with an accelerometer and a GPS chip that was connected to a mobile network.

Data Processing

For acquiring meaningful features for analysis, data processing is required. The data processing in this study was broken down into five steps: resampling, reorientation, filtering, labelling, and segmentation.

Filtering

The reoriented signal must be filtered along three axes to eliminate driving characteristics such as vehicle acceleration, deceleration, and turning that are unrelated to road quality.

Labelling

The filtered data is manually labelled, with the ground truth being the captured video footage. The majority of transversal abnormalities, such as speed bumps and road joints, do not need to be repaired. As a result, in this study, transverse and pothole are separated, providing three categories:

Three categories of road surface:

- flat manholes, tiny cracks, holes, and repairs, as well as a bunch of other minor defects
- long transverse depressions, speed breakers, road joint areas, etc. and
- Potholes include deep manholes, severe fissures, holes, and projecting, and thick patches.

i. Feature Extraction

After transformation, feature extraction creates important and meaningful features from raw data that have Raw data has a lower discriminating strength between classes. Feature extraction is a challenging and critical stage in traditional machine learning, as the user requires a deep understanding of the application in order to properly train a model.

ii. Machine-Learning Classification

Machine learning is a technique for automatically optimizing the performance of computer programs based on data or experience. One of the most critical jobs in machine learning is classification. It entails making predictions about the categories of objects in the testing set using a model built with a training dataset. The goal of this work was to apply machine learning to locate potholes using car vibration data obtained by the smartphone; this was a significant classification task.

Classic machine-learning methods, as opposed to Neural Networks, already offer adequate classification skills with relatively modest dataset needs. In this research, traditional classifiers such as

- **Logistic regression (LR),**
- **SVM and Random forest (RF)**

The performance of the characteristics extracted from various regions of vibration signals was tested after they were applied.

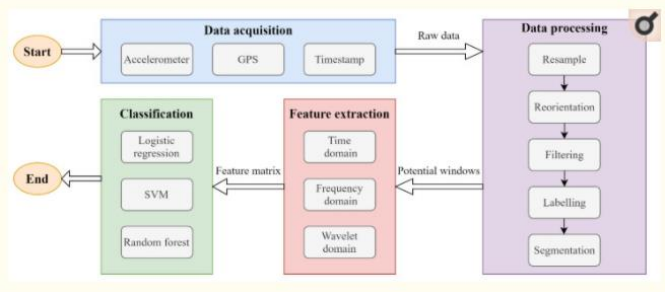

Fig – 1: Concepts and Methods

YOLO Object Detection Algorithm

Object detection is a classic computer vision problem in which you try to figure out what and where — specifically, what entities are present in a given image and where they are located. Furthermore, the classification does not work with photos that contain several objects. YOLO is popular due to its great accuracy and ability to run in real-time. The approach takes only one forward propagation to run through the neural network to make predictions, so it "only looks once" at the image. Following non-max suppression, It then produces recognized items along with

bounding boxes (which ensures that the object detection algorithm only identifies each object once).

Using YOLO, a single CNN predicts several bounding boxes and their class probabilities.

YOLO improves detection performance by training on entire photos. This approach provides a number of advantages as compared to other object detection methods.

- YOLO is very fast.
- YOLO perceives the entire picture during training and assessment, inferring contextual information about classes as well as their appearance.
- YOLO learns generalizable representations of objects, outperforming existing top detection approaches.

Fig – 2: Yolo Model

3. LITERATURE SURVEY

Table -1: Literature Survey

Module Titles	Description
Pothole Detection (Data Acquisition and Processing)	A pothole-detection method based on smartphones is suggested and validated through trials, which include a variety of data-processing techniques. The yaw angle of reorientation is calculated using a viable technique, and thresholds are utilized to choose probable pothole windows, which are not stated in most comparable papers.
Classification and suggestion	In terms of time and pothole detection accuracy, the performance of several feature domains is studied and compared. Several classifiers' strengths are presented, as well as potential scenarios for the classifiers.
Optimized routes and flagging.	The suggested method's performance is evaluated using datasets derived from a variety of road types in order to determine their universality and robustness. Our technology detects potholes more effectively than most other methods previously described.

4. FUNCTIONALITY

The applications will start with an animated screen for three stakeholders(**civil agency member, Local citizen, and an elected representative)**. They will be sent to a login page where they will be able to access their accounts. Sign in with your email and password, sign in with your phone number, or sign in with Google for a faster sign-in. Users who intend to use the program must first register with the system.

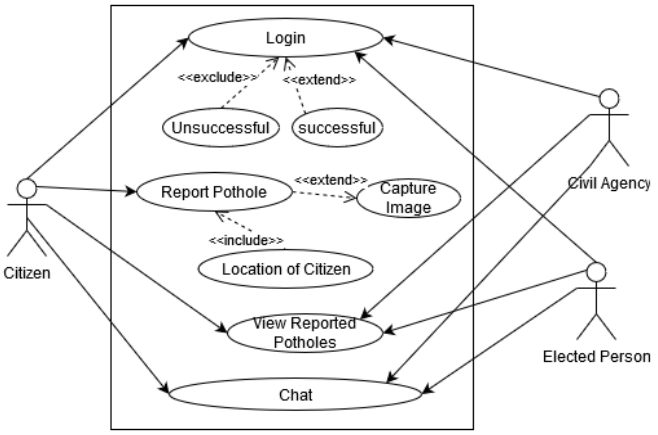

Fig – 3: Use case diagram

Several options will be given to the citizens which includes Report a pothole, View reported potholes on maps, Chats, Profile, etc. where citizens can report a pothole by clicking images of the pothole and nearby images, shooting a video if necessary, and filling in details of the potholes(Pothole

status, Address, Landmark, Dimensions(optional), comments/Notes, etc.).The application will **automatically capture the user's location** and it will also give citizens an option to view their reported potholes on Google maps. The application will also give citizens the to report a pothole while they are traveling where the application will **detect such potholes** with the help of machine learning algorithms.

Fig – 4: Pothole Detection

The citizens will receive a **smart reply message** if their reported pothole is filled and can also track the progress of the complaint.
The application will also **detect the number of potholes** from the images which are reported by the citizens.
Citizens need to **look up again** in some cases if they report an image with **no pothole present** on the road. Hence fake complaints will be identified.
Hidden potholes will be classified especially in the **monsoon season** because it's very hard to identify such potholes with the depth and drivers will be alerted for the same.
Civil agency members will receive **smart notifications** with a day's optimum route plan to drive their vehicle and repair these concerns from citizens reporting potholes.

Representation of roads in terms of good road, bad road or road with lesser number of potholes on maps.

Fig – 5: Representation of Roads

5. MODULES

5.1 Home page for Citizens

The home page for citizens gives an insight into reported potholes with their respective severities highlighted.

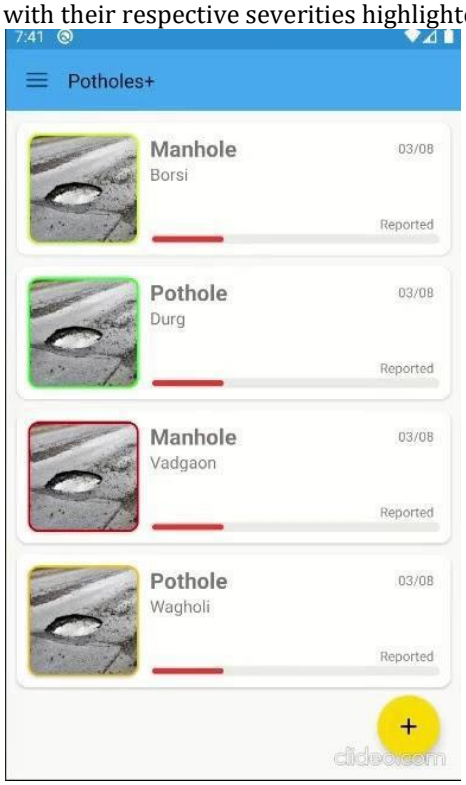

Fig – 6: Citizen's Home page

5.2 Adding a pothole page

Users can add a pothole, describe how severe it is, and add a location for identification on the map along with a landmark.

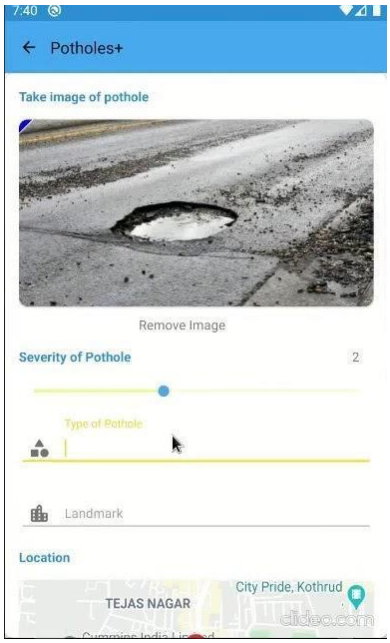

Fig – 7: Adding a Pothole

5.3 Navigation menu

The navigation menu for each user allows toggling between the map view, reporting a pothole using a trip, the chat interface and insider program as well as the help menu.

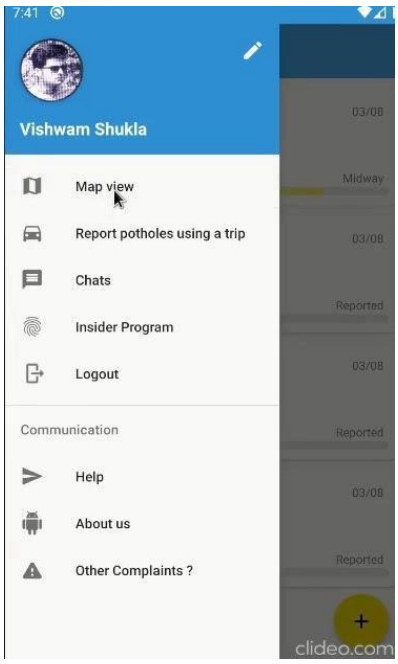

Fig –8: Navigation menu

5.4 Profile Page

On the profile page, the individual details are updated along with the number of reported and fixed potholes against the name of that user.

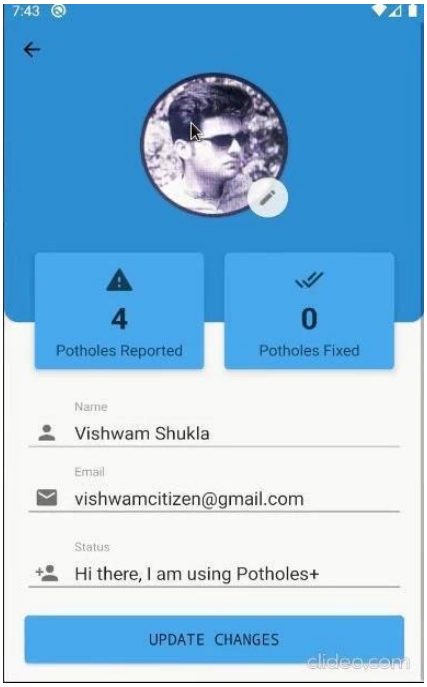

Fig – 9: Profile page

5.5 Map View

The map view shows a location spot for a reported pothole when focussed on areas within the map of that location.

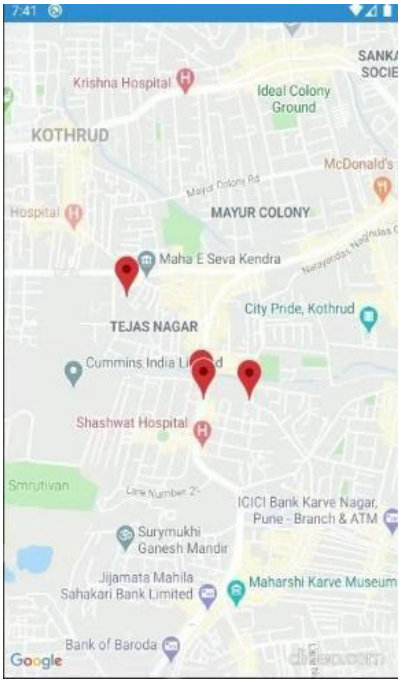

Fig – 10: Map view

5.6 Other Complaints

On clicking these locations, pictures of that pothole can be uploaded along with any other complaints such as accident-prone issues, water pipe bursts, etc that can be reported.

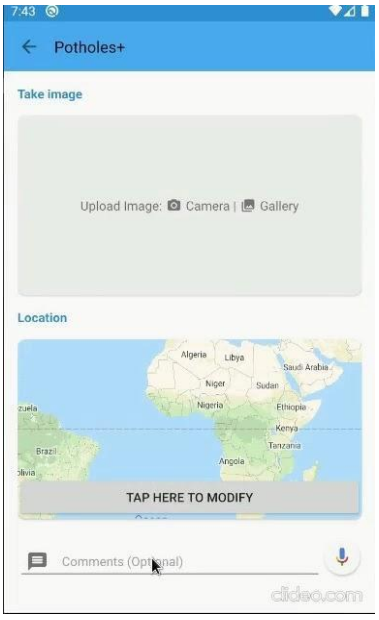

Fig – 11: Other complaints

5.7 Chats

Chats can be initiated with civil agency and concerned members by the user after a connection request is validated and accepted.

Fig – 12: Chats

5.8 Insider program

Insider programs are provided as rewards to incentivize users to come forth with pothole reports and get rewarded on valid and successfully fixed potholes.

Fig – 13: Insider program

5.9 Reporting Potholes using a trip

For users who can't bother to take a picture or can't view potholes during a trip, a feature to report potholes with a sensor-based feature from changes in the accelerometer and gyroscope readings is included.

Fig – 14: Reporting Potholes using trip

5.10 Results from reporting Potholes using a trip

The results from these reported potholes can be seen as locations marked on the map along the route of the trip,

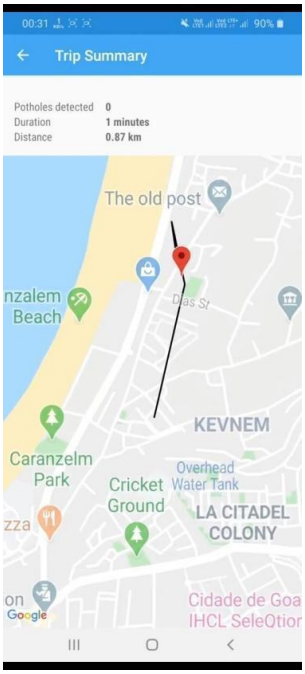

Fig – 15: Result of Reporting potholes using trip

5.11 Pothole Detection

The pothole detection works with the implementation of the YOLO algorithm for object detection, Here the number of red squares highlighted in the picture determines the number of potholes in the picture.

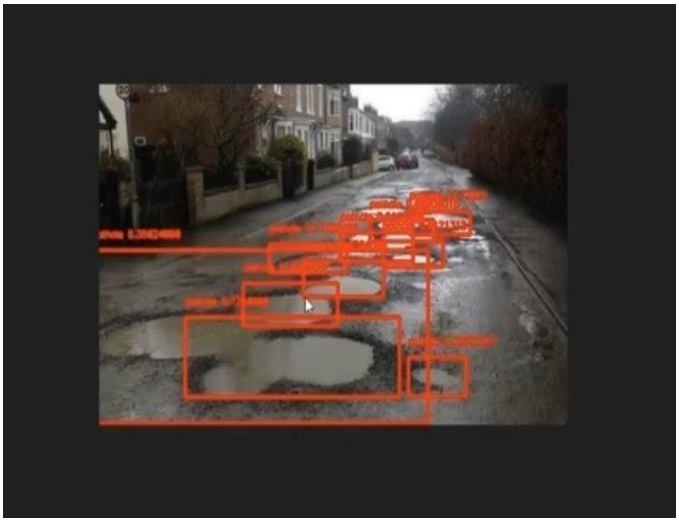

Fig – 16: Pothole Detection

5.12 Home page for Civil agency members

The home page for the civil agency members shows a dashboard for all reported potholes, the ones under processing, with midway progress, and those for which work has been completed.

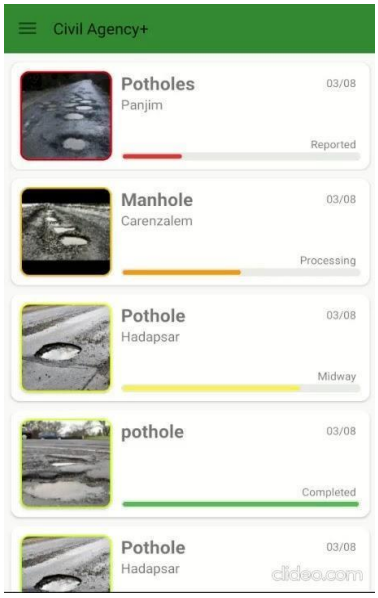

Fig – 17: Home Page for Civil agency members

5.13 Detailed information on Pothole

Civil Agency members can access detailed information about a certain pothole, and update its status from reported to processing, midway, and completed.

Fig – 18: Pothole details

5.14 Verification of completed work

They can then verify the work on a pothole by updating a picture of the fixed pothole along with additional comments on the status.

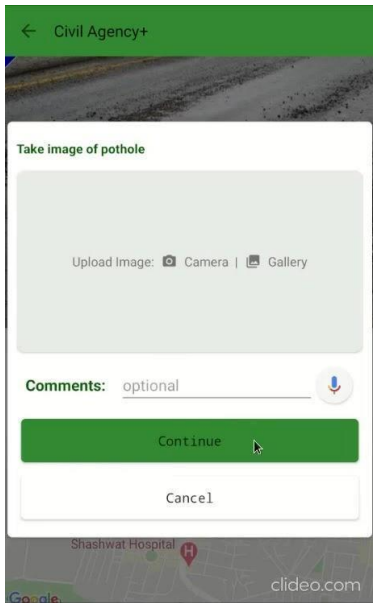

Fig – 19: Verification of completed work

5.15 Home page for elected members

The home page for elected representatives gives a brief overview of, the statistics of potholes reported, processed, and fixed in a certain time period for better actionable results.

Fig – 20: Home page for Elected members

5.16 AI-Powered Chatbot

It also features an AI-powered chatbot for active interactions and customer care.

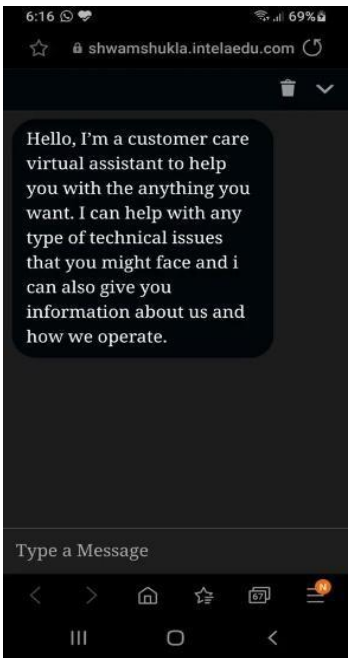

Fig – 21: AI-powered Chatbot

5.17 Multi-Language Support

Multi-language support is integrated for users from all over the country.

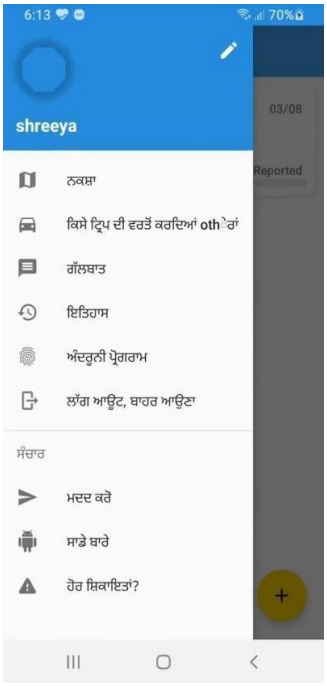

Fig – 22: Multi-Language support

6. FUTURE ENHANCEMENTS

There will be Two-way verification of potholes using cameras and sensors which can be deployed on the vehicles and can be automatically marked on the map or Mounting the smartphone on the dashboard. It will use computer vision and machine learning to read the surface of a road.

The Drivers will be alerted to opt for routes with lesser potholes or to slow down vehicles. There will be Predictive Road Maintenance in which Deep learning algorithms will assess cracks, fractures, and other road deterioration to determine whether a road requires minor repairs or extensive reconstruction overhaul also to assess the severity of the problem.

The system will also classify whether it's a pothole or not (Manhole, Bump, Cracks, etc.). There will also be Vehicle-to-vehicle communication devices that notify drivers of big potholes in their routes while also advising them to maintain a safe driving pace based on the size and dimensions of the pothole. This is particularly critical at night when visibility is reduced. If a car meets a pothole in the road at a slower pace, the vehicle may sustain less damage.

There will be Lane-wise Navigation in which If there is a pothole on any of the lanes of a multi-lane road, drivers will be alerted to change the lane and maintain the speed before the arrival of that pothole hence safety will be improved. Hidden potholes will be classified especially in the monsoon season because it's very hard to identify such potholes with the depth and drivers will be alerted for the same.

7. CONCLUSION

The system, along with these capabilities, will be used to extend roadways, airport runways for safe landings, and in the defense of rescue and disaster operations, where a drone instead of a user's mobile camera scans the surroundings for an image scan. Additional civic issues, such as garbage disposal, tree fall, mosquito threat, water pipe burst, and so on, can also be addressed using the same technology arrangement. Thus, through the application, we are making the process paperless and roads potholes-less.

REFERENCES

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