DETECTION & ESTIMATION OF POTHOLES USING GEOSPATIAL & MACHINE INTELLIGENCE

Project Reference No.: *48S_BE_3183*

College : Alva's Institute Of Engineering And Technology, Moodbidri
Branch : Department Of Civil Engineering
Guide(S) : Mr. Shankargiri K. S
Dr Vinay
Student(S): Mr. Laishram Shekherchandra Khuman
Mr. Pruthvi M
Mr. Shree Doddamani

Keywords:

Potholes, Geo-tagging, QGIS.

Introduction:

Potholes are one of the most significant challenges faced by transportation networks worldwide, causing not only vehicle damage and safety concerns but also escalating maintenance costs for road authorities. In recent years, detecting and estimating the condition of roads, including potholes, has become crucial for efficient road management and maintenance. Traditional methods for pothole detection, such as manual inspections and visual surveys, are labor-intensive, time-consuming, and often prone to human error.

The use of Geospatial Technologies—which include Geographic Information Systems (GIS), Remote Sensing, and Global Navigation Satellite Systems (GNSS)—has revolutionized the way we monitor and manage road infrastructure. These technologies enable the collection, analysis, and visualization of spatial data related to road networks, which can be used to detect potholes, estimate their size and severity, and plan for timely repairs. The integration of geospatial tools with advanced data processing algorithms allows for more accurate, cost-effective, and real-time detection of potholes. With the rapid advancement of Geospatial Technologies (such as satellite imagery, drones, and Geographic Information Systems) and Machine Intelligence there is a unique opportunity to revolutionize the way we detect, estimate, and maintain road surfaces.

Objectives:

- To identify road distress using image processing techniques.
- To integrate geospatial data using mobile lidar into a comprehensive GIS framework for road distress analysis
- To validate the accuracy and reliability of the proposed system through field surveys and comparison with traditional inspection methods.

Methodology:

1. **Selection of road stretch:** For our study, we have selected a 1.7 km stretch of road to focus on. In this road stretch we have identified 13 potholes.
2. **Epicollect5:** In our project we are using "**Epicollect5**", a mobile data collection app that allows users to create custom forms for gathering and managing data in the field. It supports various data type such as text, numbers, photos, GPS locations, and audio recordings, making it versatile for a wide range of applications like research, surveys and monitoring. Users can collect data offline and later upload it to the "**Epicollect5**" server for storage and analysis, with the option to export data in formats like CVS or Excel. It is widely used by organizations, researchers and individuals who need a flexible, cost-effective tool for structured data collection.
3. **Collection of potholes data:** Photo of each pothole are taken by using "**Epicollect5**" app on smartphones with Lidar Embedded System and GPS features to make sure we capture the exact location of each pothole. And the photos are taken at a height of 1m from the surface of the ground. The GPS will help us record the coordinates along with the photos so we can map their positions accurately. This information will be used to pinpoint which areas need the most attention or repairs. By doing this we can better understand the condition of the road and plan necessary fixes.

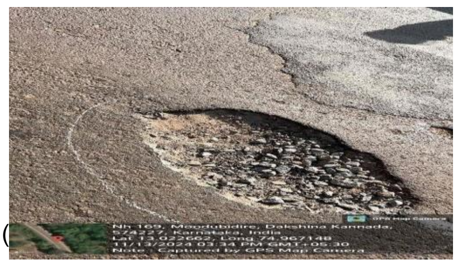


Fig 1: Collection of potholes data using Epicollect5 with GPS features

4. **Processing of Data using GIMP:** GIMP (GNU Image Manipulation Program) is a free and open-source raster graphics editor that is widely used for tasks like photo retouching, image composition, and graphic design. GIMP supports a wide range of image formats, has advanced editing tools (like layers, masks, and filters), and is customizable with plugins and scripts.

   In GIMP, we first select the “**File**” menu at the top of the screen and select the “**Open**” option. And it will allow us to browse our computer and select the image which we want to import into the software.

   Once selected, the image will appear in the GIMP workspace, and it will be ready for editing.Next, we need to access the “**Selection Tools**”, which we found under the “**Tools**” menu. In this menu, there is an option called “**Selection Tools**”, and within this submenu, one of the choices is “**Free Select**”.

The **Free Select** tool allows us to manually outline a specific area of the image by drawing a series of straight lines or curves, effectively creating a polygonal selection around the part of the image we want to work with. Once we have completed the selection, the area will be highlighted, indicating the boundaries of our choice.

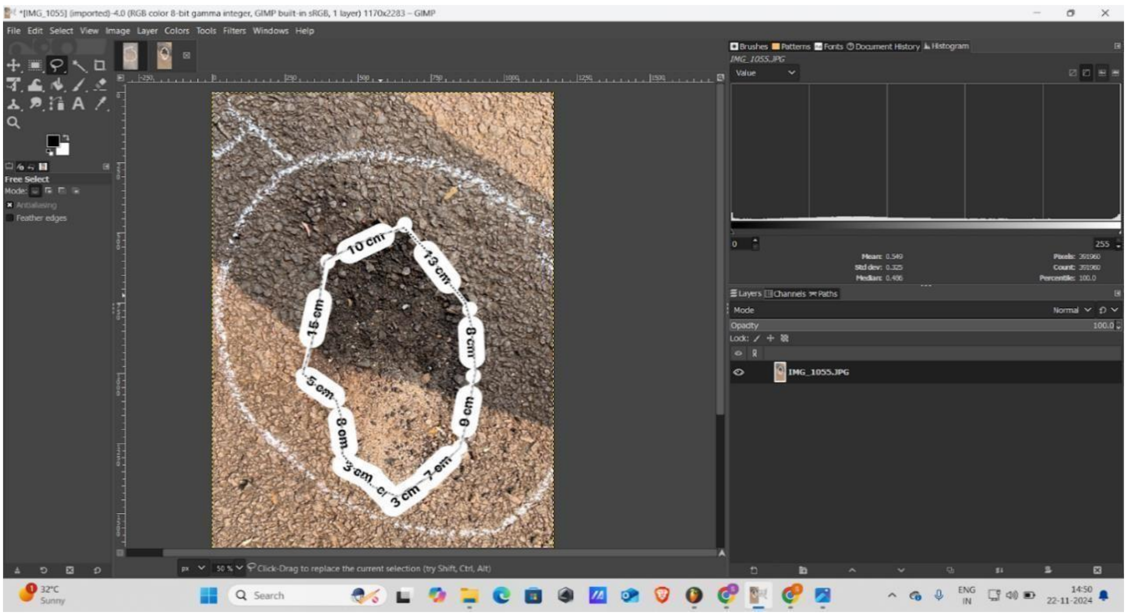
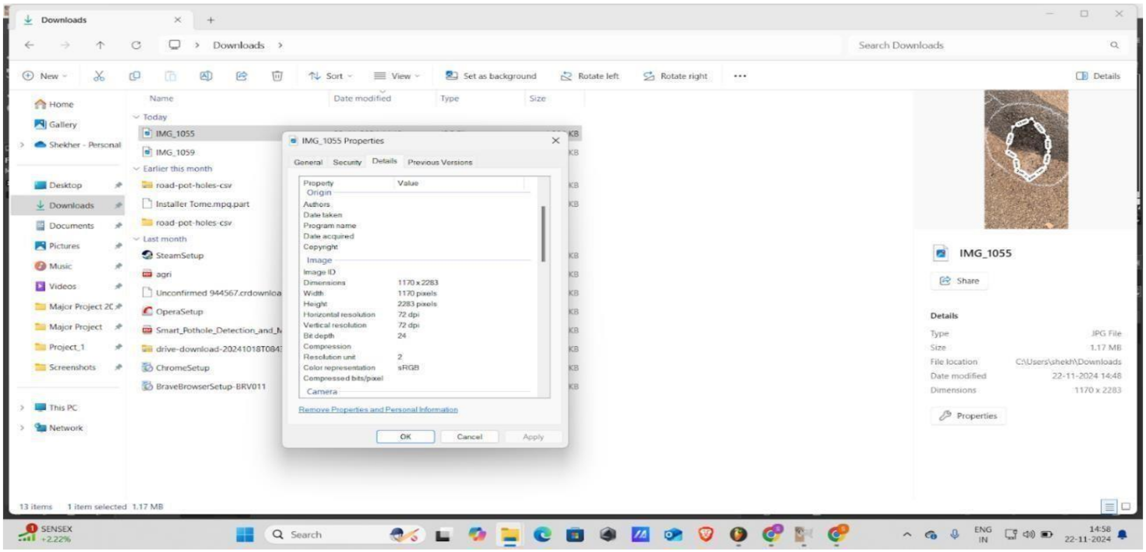


Fig 2: Pixels Figure counts using GIMP (GNU Image Manipulation)

After we made the selection, we can use GIMP's features to measure the size of the selected area. We can see the pixel dimensions of the area which we selected, which is useful for tasks like resizing, cropping, or analyzing specific parts of the image in greater detail.

This selection process, with the ability to measure in pixels, offers a precise way to work with images and ensures accuracy when editing or manipulating the selected regions.



Sl. no	Date	Time	Latitude	Longitude	Accuracy (m)	Distress Type	Potholes Area (cm^2)
1	11-11-2024	14:44	13.02191	74.969095	0	Pothole	167.64
2	11-11-2024	14:49	13.021879	74.968833	4	Pothole	159.21
3	11-11-2024	15:02	13.021878	74.968825	3	Pothole	6.56
4	11-11-2024	15:07	13.021848	74.968838	5	Pothole	254.0
5	11-11-2024	15:13	13.021210	74.968350	7	Pothole	434.40
6	11-11-2024	15:18	13.021544	74.968102	6	Pothole	462.95
7	11-11-2024	15:27	13.031137	74.965956	3	Pothole	63.34
8	11-11-2024	15:52	13.030884	74.965877	5	Pothole	271.43
9	12-11-2024	15:05	13.030909	74.965887	3	Pothole	143.66
10	12-11-2024	15:12	13.030790	74.965850	4	Pothole	326.655
11	12-11-2024	15:23	13.030506	74.965764	3	Pothole	38.99
12	12-11-2024	15:31	13.030291	74.965741	7	Pothole	119818

Fig 3: Dimensions of the image

Result and Conclusion:

Table 1: Potholes area calculation

Based on the study the following results are obtained with G.I.M.P. and AutoCAD method.

1. In this method, a fixed scale of 1:14.5 for 1 meter height is applied, and the area of one pixel is calculated as 4.4×10^{-6}cm² on the photo and 0.000927 cm² on the ground. Using the pixel count of 391,960, the final ground area is determined to be 363.34 cm², which is larger and more accurate due to precise ground scaling. While both methods are useful, Method 2 provides a more reliable estimate for real-world applications.

2. In this method, AutoCAD is used to determine the area as 16,780 m², which is scaled by 14.5 and converted into pixels. Each pixel corresponds to 0.000927 cm², resulting in a calculated area of
225.54 cm².

CONCLUSION:

1. This study aims to develop a method for detecting potholes and assessing the amount of material needed for repairs.

2. And it is focus on using easily available tools like smartphones and free software to make pothole detection simple and affordable for everyone, including local governments and smaller organizations.

3. GPS-enabled smartphones make it easy to pinpoint the exact locations of potholes, helping to map them and decide which ones need fixing first.

By adopting this approach, pothole detection and road maintenance can be simplified, ultimately reducing the risk of accidents caused by potholes and enhancing overall road quality.

Future Scope:

The following are the future scope and work can be done on this project

1. In our project we have identified potholes in flexible pavement but it can also be used to identify potholes in concrete pavement.
2. This method can be used not only in identifying the potholes but also other road distress.
3. Cost and savings can be expected in this method to estimate quantity of distress.