ISSN No:-2456-2165

Comparative study of Pothole Dimension Using Machine Learning, Manhattan and Euclidean Algorithm

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Abstract:- Pothole in roads constitutes a major problem for both citizen and government. The pothole can create serious damages to the vehicles such as vehicle flat tires, scratches, dents and leaks. Thus, to detect these potholes and provide maintenance is highly time consuming and required lot of man power. Therefore this paper purposes a pothole detection system which is used for detecting the pothole and to analyze the image to determine its dimension. For detecting the pothole captured road images are inserted in the system then feature extraction and classifier performs. Lastly the predictor is done with the detection of pothole based on machine learning. The pothole detection system is derived from that assumptions that any strong dark edges within the extracted surfaces estimated a pothole if it observes certain constraints. Such as size color. Any outlines that meet these conditions are estimated as pothole by the algorithm. On the other hand for analyzing the image of pothole starts by converting the road surface images to gray scale and calculate the SURF points using Manhattan and Euclidean algorithm for calculating the dimensions of the pothole in the MATLAB environment, further comparing the system result obtain by these algorithms with the result calculated manually in order to find the error percentage of the system.

Keywords:- *Pothole Detection System, Manhattan Algorithm, Euclidean Algorithm, Knearest Neighbor Algorithm, MATLAB.*

I. INTRODUCTION

India, the second largest population in the world and a fastest growing economy, is known to have a large network of roads; roads are meant to be dominant means of transportation in India today. The carry almost 90% of vehicular and passenger traffic. Most of the roads are congested and narrow with poor quality and low maintenance which increases the load on road and the rate of failure of road increases. Due to failure of road it has been found the number of distress on the pavements such as edge deformation, rutting, bleeding, cracks as one of the pavements distress is pothole, the term pothole is used to describe a deep rut in road Pothole are formed due to heavy rains and movements of vehicular traffic increases the mechanical stress which leads to the structure deformation. This is extremely dangerous for drivers on high speed road to drive upon and unexpected difficulties on roads causes more accidents and the fuel consumption of the vehicle also increases. It is necessary to provide maintenance and rehabilitation to such pavements distress. However detecting the pothole manually and existing methods are expensive and more time consuming therefore several efforts is made for developing a technology that can automatically detect and recognize pothole.

Fig 1:- Images of pothole surface

Exiting methods such as vibration based method, 3d laser- scanner methods are not much cost effective but sometimes this method fails to detect the pothole accurately due the distorted data and various noises in the video data. This the prime inspiration behind making a project that uses a simple 2D image to improves pothole detection system which accurately detect the pothole and further analyze the image of pothole for determining the measurements of dimensions i.e. min depth , max depth , mean depth, overall area and volume from that to calculate the cost for providing maintenance. Thus pothole detection system is based on image processing using machine learning to processes the image to detect the pothole and further to analyze the image of pothole using Manhattan algorithm and Euclidean algorithm in the MATLAB version R2015a (64 bit) to calculate the measurements of dimensions of the pothole. MATLAB version R2015a (64 bit) having image processing tool box and user friendly graphical user interface which provide interface such as edit text, list box.

ISSN No:-2456-2165

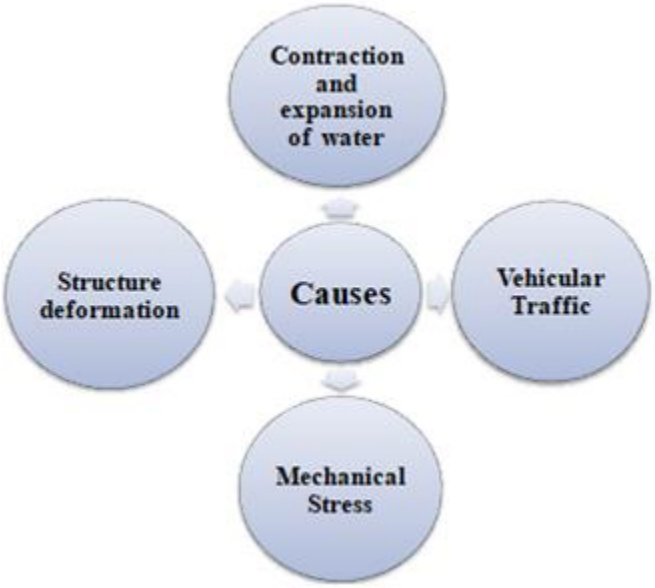

Fig 2:- Images of pothole surface

➢ *Objective*

- The main objective of the study is to develop an overall digital image processing algorithm in order to detect and classify pothole automatically. This overall algorithm will support highway maintenance automatically by determining pothole.
- After detecting the pothole calculate the dimensions (length, area, depth) of pothole using Manhattan Distance and Euclidean Distance algorithm.

After calculating the dimensions and further comparing result of system with the result calculated manually in order to find the error percentage of system.

II. RESEARCH METHODOLOGY

This section provides the general architecture for the pothole detection using image processing technique and analyzes the pothole to determine the dimension. The advantage of the image processing techniques is that it give more efficient result rather than any other conventional method. On the other hand the various steps involved in the image processing techniques firstly collect the image of pothole which will be subjected to pothole detection system by using digital camera. After capturing the images goes through the pre-processing where the process like feature extraction and classifier perform. Lastly the predictor is done with the detection of pothole. After detecting the pothole using image processing technique now to analyze the pothole to determine the dimension using Manhattan and Euclidean algorithm. Here both Manhattan and Euclidean algorithm are used to calculate the geographical information system (GIS) between the two points. Now taking the pothole image thus by browsing the image and selecting the methodology to analyze the image to determine the depth and volume and further comparing the result obtain by the system with the result calculated manually in order to find the error percentage of the system.

III. NEED TO STUDY

- Generally, estimation of dimension of pot hole is carried out manually which Requires more manpower, equipments, time and cost.
- This system is developed to carry out the estimation with, less time and cost.
- This made the estimation much more easier and efficient

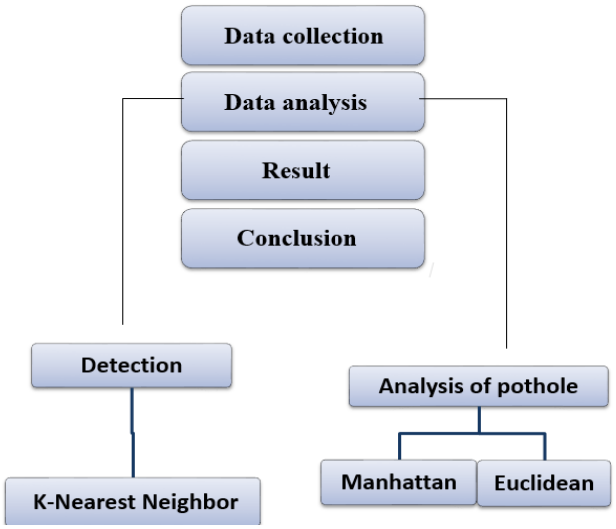

Fig 3:- Research Methodology

IV. DATA COLLECTION ANALYSIS AND IMPLEMENTATION

A. Collecting the pothole images

The image dataset contain more than 1000 images of pothole on the road surface,. its purpose is for training, testing, analyzing and validation. The image data of potholes is captured with the help of digital camera. The images are collected from both Internet and Agra-Bombay national highway (NH-3) between Indore and Dewas. The image data of potholes for test is taken from top view and side view which accurately detects the pothole in images the sample images in fig shows the pothole on the road surface the images are 800*600 in jpg format.

Fig 4:- Pothole Images

B. Data Analysis

After the collection of the images in order to achieve the proposed objective the process of analysis actually consists two main steps.

Step 1: The process of detecting the pothole.

Step 2: The process of analyzing the pothole.

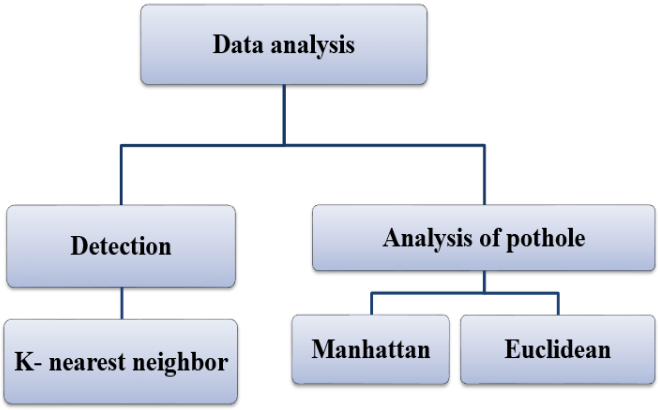

Fig 5:- Shows the Data Analysis

➢ *Detection*

In the first step: In the process of detecting the pothole the K- nearest neighbor algorithm is used to classify the pothole. For simplicity this classifier algorithm is also called KNN classifier. To be surprised k-nearest neighbor classifier is simple algorithm which stores the available cases and which classify ne cases which is bases on a similarity measure (e.g. Distance Function) KNN stores the entire training dataset which it uses as its representation .it makes prediction just in time by calculating the similarity between an input sample and training data set. The process of detection consists of the collection of images which are input in the system after which the feature extraction and Knn Classifier perform which allows the predictor to detect the pothole.

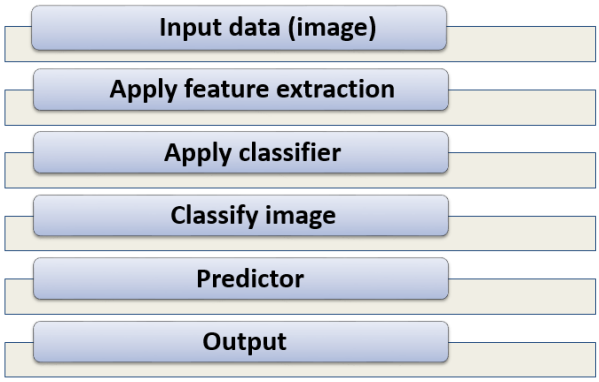

Fig 6:- Flow chart of system overview for detection

➢ *Step: 2 (Pothole analysis)*

In the second step: After the detection of pothole now to determine the measurement of dimensions (area, depth) the following algorithms are used:

- Manhattan algorithm
- Euclidean algorithm

The Euclidean and Manhattan distance algorithms are used to calculate geographical information system (GIS) between the two points. The difference between Euclidean and Manhattan algorithm is describes as:

Manhattan distance: Manhattan distance algorithm which is also known as block distance. It computes as the sum of two sides of the right triangle but not the hypotenuse. The equation to calculate Manhattan distance is :

$$MD_{(x,y)} = \sum_{i=1}^{n} |x_i - y_i| \quad \ldots\ldots\ldots\ldots\ldots(1)$$

Where (x_i, y_i) are the coordinates of two points between whom the distance is to be determined and (n) is the number of variables, the distance between two item is the sum of difference of their corresponding components. The Manhattan distance may give longer distance between the two points.

Euclidean Distance: the Euclidean distance is uses in all applications. It computes as the hypotaneous like in the Pythagorean Theorem.

The mathematical equation to calculate the Euclidean distance is :

$$ED_{(xy)} = \sqrt{\sum_{i=0}^{n} | x_i - y_i |^2} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

Where (x_i, y_i) are the coordinates of two points between whom the distance is to be determined. It is square root of the sum of the difference between the co-ordinates of the two points. It always gives the shortest distance between two points.

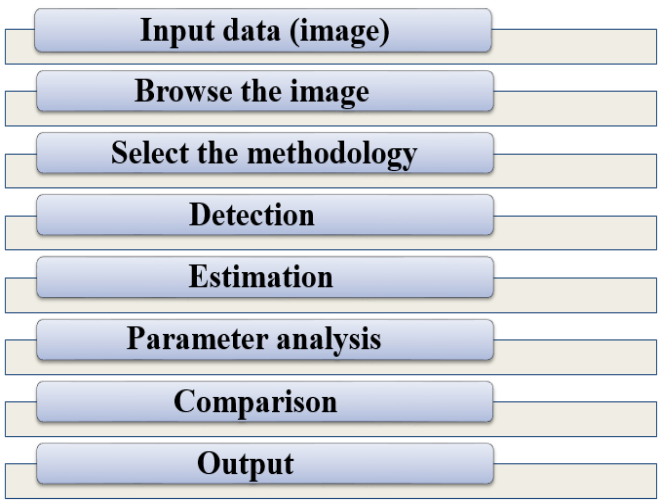

Fig 7:- Flow chart of system overview for analysis

C. Implementation

Step 1: In the first step different images of roads and potholes are inserted in the system to classify the pothole images.

Fig 8:- Pothole on road surface

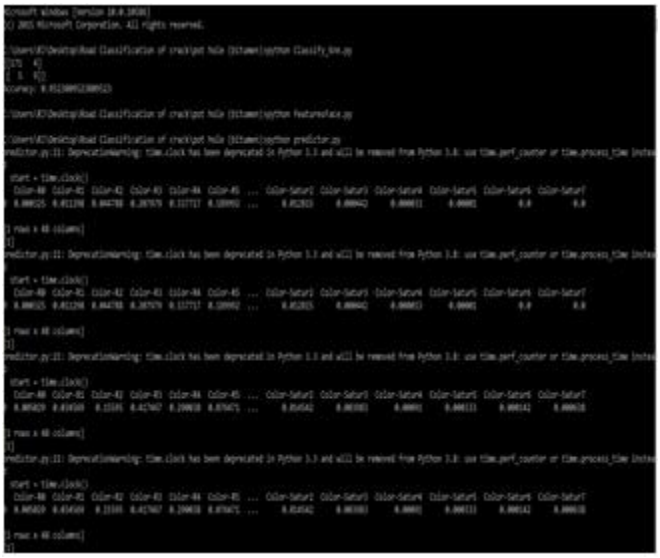

Fig 9:- Execution of running code

Step2: In the second step original image of pothole is inserted in the system to determine the measurement of pothole.

Fig 10:- Original Image

Fig 11:- Image converted into gray scale

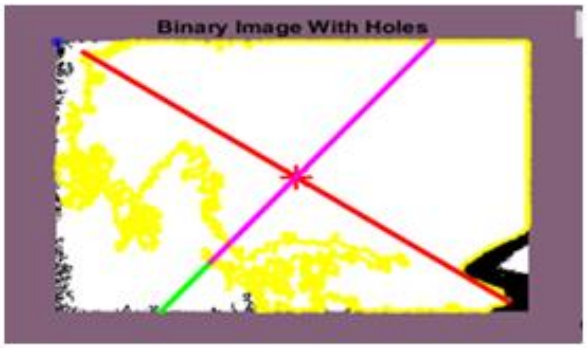

Fig 12:- Binary images with pothole

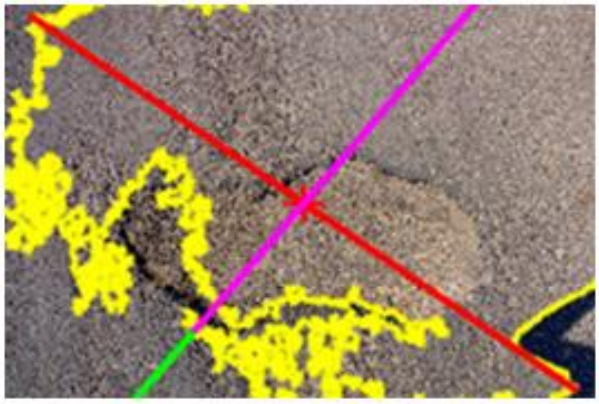

Fig 13:- Original images with detection

Fig 14:- Image with optimized estimation

V. RESULT AND DISCUSSION

➢ *General*

A total 150 stereo images were taken for training purpose figure 5.1 shows the result of selected images with the accuracy of 100% and total 5 images were randomly chosen from 50 original images for testing purpose. figure 5.2 shows the result of selected images for testing with the accuracy of 89%.

Step 1

S. No.	Image Training	Accuracy
1.	No. of stereo images =150	100%

Table 1:- Result during image training

S. No.	Image Testing	Accuracy
1.	No. of original images =5	89%

Table 2:- Result during image testing

S.No.	FileName	Class
1	Predict_folder\DSC01264.JPG	pot holes
2	Predict_folder\DSC01264.JPG	pot holes
3	Predict_folder\pothole 3.JPG	pot holes
4	Predict_folder\pothole 3.JPG	pot holes
5	Predict_folder\pothole 5.JPG	pot holes
6	Predict_folder\pothole 5.JPG	pot holes
7	Predict_folder\pothole--2.JPG	pot holes
8	Predict_folder\pothole--2.JPG	pot holes
9	Predict_folder\pothole_4.JPG	pot holes
10	Predict_folder\pothole_4.JPG	pot holes

Fig 15:- Output of running code

Step 2

Actual dimension			
Area	max. depth	min. depth	mean depth
1850 cm^2	55.88	31.24	41.12

Table 3:- Actual pothole measurement

Manhatten algorithm			
Area	max. depth	min depth	mean depth
639.28	428.9	149.04	224.02

Table 4:- Measurement obtained by Manhattan

Euclidean algorithm			
Area	max depth	min depth	mean depth
475.58	499.3	238.12	372.06

Table 5:- Measurement obtained by Euclidean

Errors							
Manhatten				Euclidean			
Area	max depth	min depth	mean depth	Area	max depth	min depth	mean depth
11.36	7.8	3.48	2.03	8.1	9.24	3.85	6.45

Table 6:- Comparison of error percentage

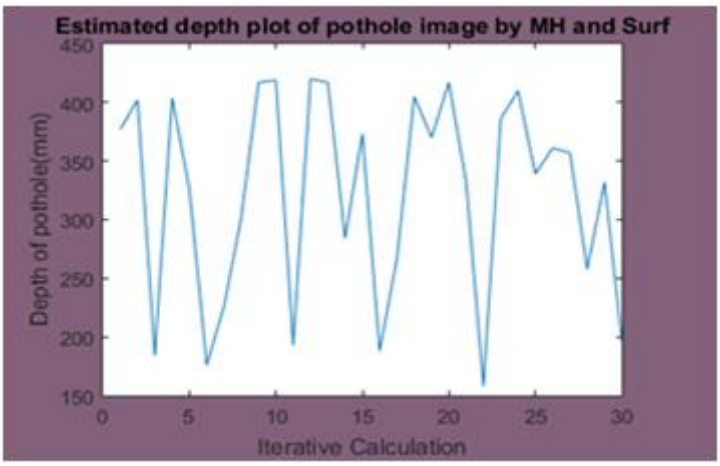

Fig 16:- Graphical estimation by Manhattan and Surf

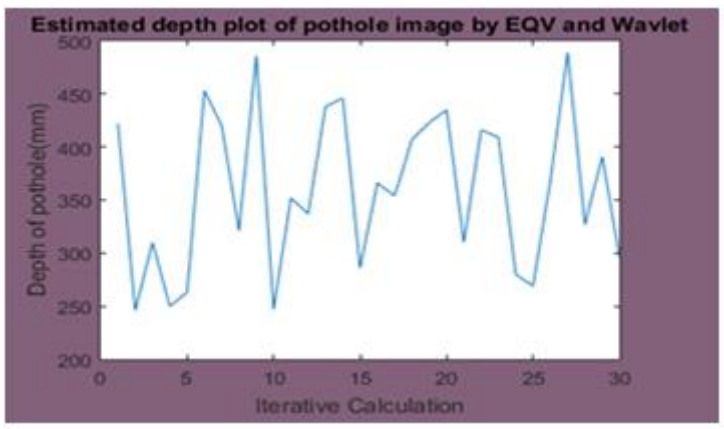

Fig 17:- Graphical estimation by Euclidean and Wavelet

VI. CONCLUSION AND FUTURE SCOPE

A. Conclusion

Based on the study following conclusion were made:

The results obtained in the first phase during training phase with the accuracy of 100% while in testing phase with the accuracy of 89%. In the second phase the overall algorithms are used for analyzing the pothole images. Performance is checked by comparing the system result with manual result which gives the accurate calculations of pothole depth values through MATLAB.

B. Future Scope

Based on drawbacks of the research, the study has following future scopes:

- Work can be done in a more efficient way after improvising the system.
- The accuracy of the system will increase as there is difference in error percentage.
- We can also calculate the maintenance cost and also we can use camera for on spot calculation.
- Also, a mobile navigation system can be designed to interface with the vision system in dynamic environment.

REFERENCES

[1]. A. Mednis, G. Strazdins, R. Zviedris, G. Kanonirs, and L. Selavo, "Realtime pothole detection using Android smartphones with accelerometers, "in Proc. Int. Conf. Distrib. Comput. Sensor Syst. Workshops, Jun. 2011pp. 1–6. 2

[2]. . A. Mikhailiuk and N. Dahnoun, "Real-time pothole detection on tms320c6678 dsp," in Imaging Systems and Techniques (IST), 2016 IEEE International Conference on. IEEE, 2016, pp. 123–128 3.

[3]. Akshata Bhat1 , Pranali Narkar1 , Divya Shetty1 , Ditixa Vyas2 (March-2018) Detection of Potholes using Image Processing Techniques .International Conference on Innovative and Advanced Technologies in Engineering.IOSR Journal of Engineering (IOSRJEN) 2278-8719 Volume 2, PP 52-56 52.

[4]. Anik, F. S., Ahmed, A., Maheen, A., & Alam, P. (2018). Identification and comparative analysis of potholes using image processing algorithms (Doctoral dissertation, BRAC Univeristy).

[5]. C. Koch and I. Brilakis, "Pothole detection in asphalt pavement images," Advanced Engineering Informatics, vol. 25, no. 3, pp. 507–515, 2011.

[6]. C. Koch, K. Georgieva, V. Kasireddy, B. Akinci, and P. Fieguth, "A review on computer vision based defect detection and condition assessment of concrete and asphalt civil infrastructure," Advanced Engineering Informatics, vol. 29, no. 2, pp. 196–210, 2015.

[7]. Pranay Kailas Patil, Amit Kumar Sharma, Sanvid R Remane, Saurabh Chaudhari, N.M.More.(2019). Potholes Detection Using Ultrasonic Sensor. IJIRCCE.

[8]. Fan, R., Ozgunalp, U., Hosking, B., Liu, M., & Pitas, I. (2019). Pothole detection based on disparity transformation and road surface modeling. IEEE Transactions on Image Processing, 29, 897-908.

[9]. S Gayathri, Menita Patil, Mamatha R G, Manasa B, Sanjana B M, 2019, Automatic Pothole Detection System, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) NCRACES – 2019 (Volume 7, Issue 10)

[10]. Patil, S. V., & Ghonge, M. M.(2018) Automatic Road Crack Detection Techniques: A Review.

[11]. Makone, A. B., & Rathod, A. G. (2015). Review, Mean-Shift-Based Speckle Filtering of SAR Data. International Journal of Engineering and Management Research (IJEMR), 5(4), 80-84.

[12]. Mustaffar, M., Ling, T.C., & Puan, O.C. (2008). Automated pavement imaging program (apip) for pavement cracks classification and quantification a photogrammetric approach.