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Planning Mobility for City's Sustainability

MAINTENANCE FREE PLANNING OF A TRANSPORTATION SYSTEM- AN IMAGE PROCESSING APPROACH

By
Ankita Khatri
PhD Scholar
PEC University of Technology
Chandigarh, India

INTRODUCTION

- In India, transport sector accounts for a share of 6.4 per cent in Gross Domestic Product (GDP).
- The road transport has emerged as the dominant factor in India's transportation sector with a share of 5.4 per cent in country's GDP.
- As per the statistics, India owns the second largest network of roads in the world, next to USA with a total road length of about 5.3 million kilometers.
- The increasing urban population in rapidly expanding cities has further resulted in growing urban travel demand.
- The urban population in India grew from 159 million to 377 million in past 30 years.
- There is a tremendous increase in the total number of registered motor vehicles in India from about 5.4 million (1981) to 172.9 million (2014).

NEED FOR MAINTENANCE

- Increasing demand from road traffic requires continued construction and improvement of roads, in both urban and rural areas.
- India has recently undergone a huge investment programme for the construction of road networks which provides all season access to various parts of the country.
- Apart from construction of new road infrastructure, emphasis should also be made on preserving and improving the performance of existing road networks.


JKING
Judging by all the parts that fell off our car, I must've have hit more potholes than I thought.
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- The failure or deterioration of roads occur due to various factors like age, traffic, environment, material properties, pavement thickness, strength of pavement as well as subgrade properties which affect the mechanical characteristics of a pavement.
- Performance of a road network can be monitored by observing its structural and functional performance.
- Generally, road condition can be evaluated on the basis of four aspects i.e. riding quality, surface distress, structural capacity and skid resistance.
- In a road maintenance management system, the assessment of road surface distresses is one of the important tasks for developing repair and maintenance strategies.

SURFACE DISTRESSES ON BITUMINOUS ROADS

The four major categories of surface distresses are:

1. Cracking
2. Surface deformation
3. Disintegration
4. Surface defects

Cracking


1. Fatigue cracking


2. Longitudinal cracking


3. Transverse cracking


4. Block cracking


5. Slippage cracking


6. Reflective cracking


7. Edge cracking

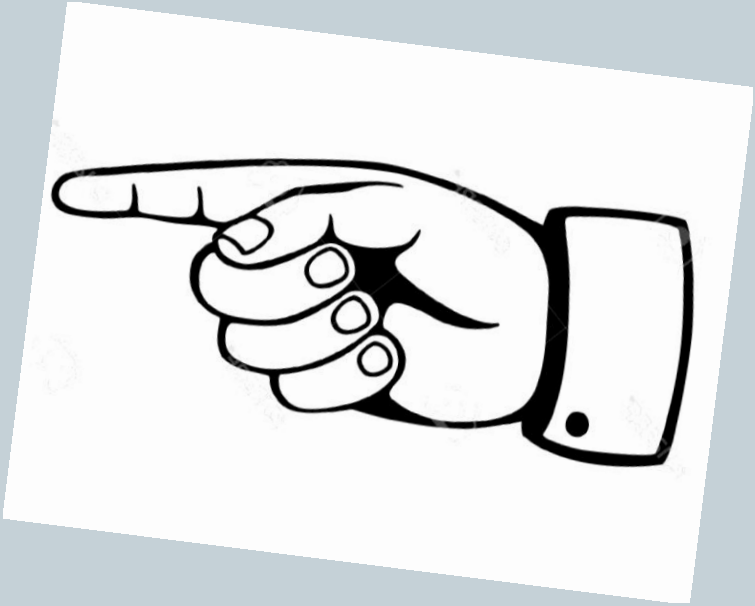
Surface deformation

Disintegration

Surface defects

ASSESSMENT OF SURFACE DEFECTS

- Currently, road distress data assessment is done in many ways, which may be grouped into three categories
- Manual
- Sensor based systems
- Imaging based systems

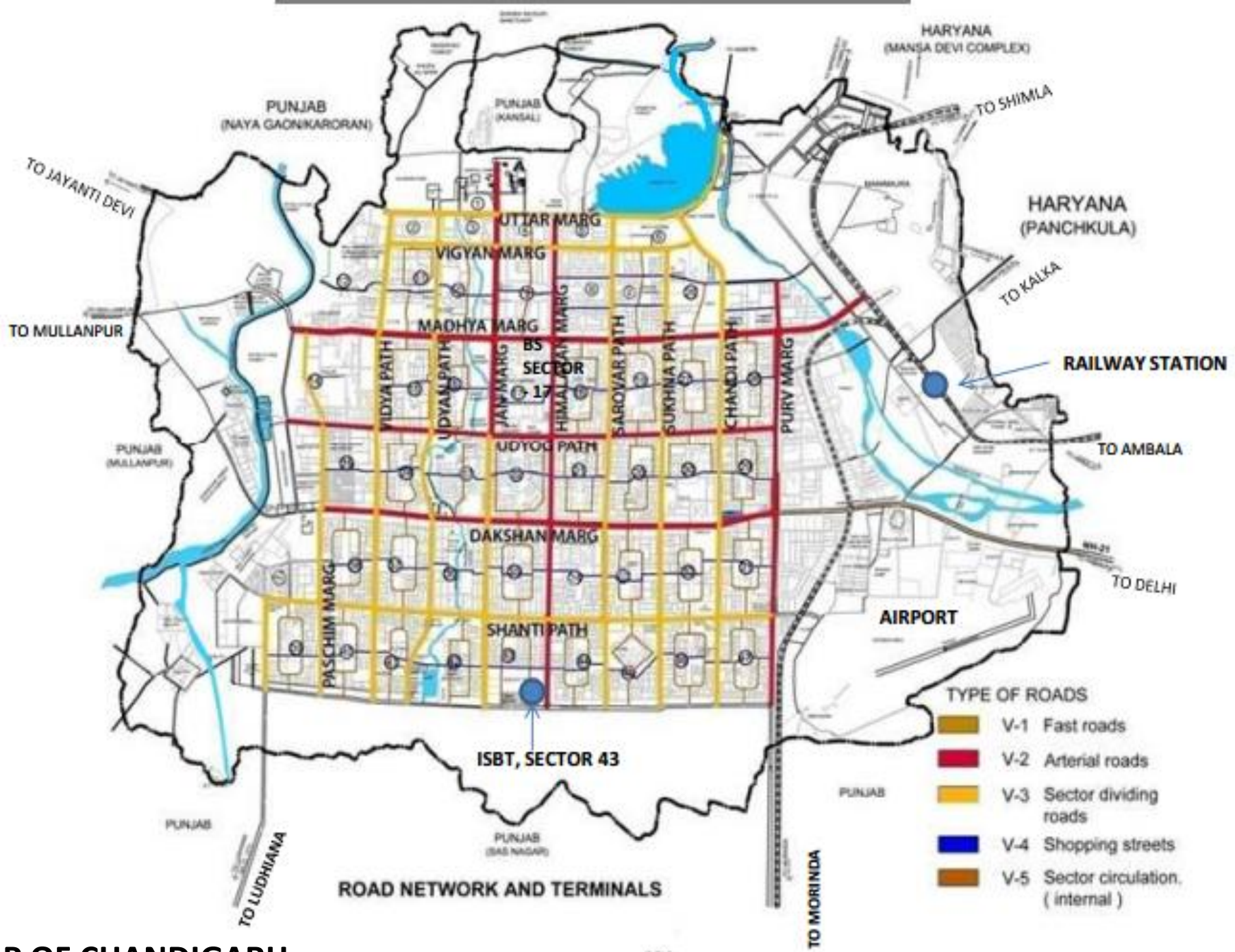


PRESENT WORK

- Assessment of pavements is not a new criteria. It is the primary step for pavement maintenance.
- What is new, is the technique for assessment.
- Earlier manual inspection was carried out in order to monitor the pavement condition.
- In the past few years, various automated methods have been developed for the identification of some of the distresses like potholes and cracks using various image processing techniques.

STUDY AREA

- The road network in Chandigarh has a unique feature that the roads are classified in accordance with their functions.
- Le Corbusier conceived the master plan of Chandigarh as analogous to human body, with a clearly defined head (the Capitol Complex, Sector 1), heart (the City Centre Sector-17), lungs (the leisure valley, innumerable open spaces and sector greens), the intellect (the cultural and educational institutions), the circulatory system (the network of roads, the 7Vs) and the viscera (the Industrial Area).
- The concept of the city is based on four major functions: living, working, care of the body and spirit and circulation.



MAP OF CHANDIGARH

METHODOLOGY

- The data was collected in the form of videos.
- For the analysis of the road video data various image processing techniques were applied using MATLAB.

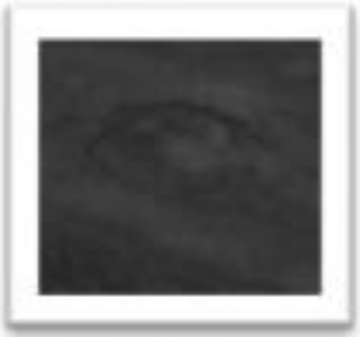
a) Extraction of frame

b) Selecting its blue channel

c) Apply median filtering

d) Apply adaptive thresholding

e) Apply morphological erosion



f) Apply morphological dilation

g) Apply morphological erosion again

h) Finding out the gradient magnitude

i) Detected pothole

VARIOUS IMAGE PROCESSING TECHNIQUES

Median Filtering

- The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of further processing.
- There may be many reasons for doing filtering but for the current study it is will be used to reduce noise or camera artifacts developed during road data collection.
- This filter replaces each pixel by the median or middle pixel in a square neighbourhood around the centre pixel.

Adaptive Thresholding

- Thresholding is the simplest way to segment objects from a background.
- In **adaptive threshold** , the threshold value at each pixel location depends on the neighboring pixel intensities.
- Adaptive Thresholding with Histogram Equalization was done.

Morphological Operations

- Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image.
- Morphological operations, such as, erosion, dilation etc., can be used for different purposes like removing noise, isolating individual elements, joining disparate elements and finding intensity bumps or holes or gradients in an image.
- In the current study, it will be used for the extraction of visual properties from the imae.

- The **Sobel operator**, sometimes called the **Sobel–Feldman operator** or **Sobel filter**, is used in image processing particularly within edge detection algorithms where it creates an image emphasizing edges.
- The **Canny edge detector** is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images.

RESULTS

Section	V1 Road	V2 Road	V3 Road	V4 Road	V5 Road	V6 Road	V7 Road
Length (m)	250	250	250	200	200	200	250
Data acquisition Time (min)	3-5	3-5	3-5	2-4	2-4	2-4	3-5
Data processing Time (min)	2-4	3-4	4-6	3-5	2-4	2-4	2-4
Automated Survey Result	3	2	9	6	2	5	8
Manual Survey Result	4	2	7	5	2	4	10

CONCLUSION

- The proposed study for detection and quantification of potholes on Chandigarh roads clearly indicate that the distress data collection is increasingly being automated by using various imaging systems.
- The analysis of the collected raw videos/images for distress assessment is still mostly being done manually. This approach is expensive, time consuming and slows down the road maintenance system.
- On the other hand, the average processing time taken by the proposed methodology has been found to be 2-4 minutes depending upon the total number of potholes in the video.
- Thus, the advantages of implementation of image processing techniques for road distress detection will minimize the amount of time, the efforts required in manual approach as well as assist in accurately characterizing the road distresses.

SCOPE

- Image processing techniques have lot of potential in effectively detecting the potholes from images extracted from cameras fitted in moving ground vehicles.
- These techniques have been limited to detection of cracks, potholes and patches, and not much work has been done on the detection of other bituminous road distresses.
- Therefore, the detection of other types of road distresses can be explored further.
- Moreover, very few studies on identification and detection of road distresses using image processing on Indian roads have been observed.
- Thus, the application of image processing for maintenance of roads can lead to timely maintenance and prevent user cost escalation and will be beneficial in the development of an effectively working transportation system.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