Machine Vision Based Intelligent Traffic Management Tool

Sunil Nayak
Assistant Professor, Instrumentation and Control Depafrtment
SAL Institute of Technology and Engineering Research,
Affiliated to Gujarat Technological University,

Ahmedabad, Gujarat, India

Kushal Patel
Assistant Professor, Electronics and Communication Department
SAL Institute of Technology and Engineering Research,
Affiliated to Gujarat Technological University,

Ahmedabad, Gujarat, India

Ekta Vasani
Assistant Professor, Electronics and Communication Department
SAL Institute of Technology and Engineering Research,
Affiliated to Gujarat Technological University,

Ahmedabad, Gujarat, India

Krishna Katakiya
PG Scholar, Electronics and Communication Department
SAL Institute of Technology and Engineering Research,
Affiliated to Gujarat Technological University,

Ahmedabad, Gujarat, India

Abstract— Traffic congestion is becoming big issues now a day which causes pollution, high consumption of fuel, more travel time and due to this property damage, gradual economic growth. Traffic congestion is more due to rise in population, lack of public transport, less use of public transport, increase in the number of vehicles, failure of the signals. We cannot expand the existing infrastructure according to traffic immediately due to land availability. So, one of the available solutions is efficient traffic management and it is the biggest challenge and it needs new innovative technology and better approach to improve traffic conditions. Using machine vision in traffic management, algorithm will be developed to maintain the traffic signal status to smoothen the traffic. In this project, Various traffic management schemes will be observed and will be integrated in various algorithms by using an image or video processing. The system uses image processing and also optical character recognition (OCR) to read license plates of the vehicles and it will map the number with the connected database.

Keywords—safety instrumentation, traffic engineering, image processing, transportation engineering, MATLAB, Smart City, Urban Development,

I. INTRODUCTION

Smart cities mission is launched by the government of India under the "Ministry of Housing and Urban Affairs" in 2015. There are several programs running under the umbrella of the smart city mission one of the area is the development of an intelligent transport system which is selected as this thesis topic[1].

Traffic comes from the Arabic word "taraffaqa". It means to walk along slowly together. Traffic means movement of people and good from one place to another place. Traffic management is that it is planning, controlling and purchasing of transport services needed to physically move vehicles. [26].

Intelligent transport system contains several sets of application and management tool to improve the traffic problems and safety of the transport system[2]. It is an advanced application to provide new innovative services to various modes of transport system.

Vision based intelligent traffic management is a system that controls the real-time traffic on road by counting vehicles with the help of measuring traffic density near the traffic signal[3]. In recent era machine vision used to more compare to computer vision in monitoring purposes. In machine vision, cameras are widely used with the computer algorithm according to the application[4].

II. DECISION MAKING IN TRAFFIC ENGINEERING

A. Manual Or Open loop Traffic System

In manual traffic management traffic police officer was used to give signals and traffic was maintained accordingly [7]. Afterwards, there was street lights signs were used to give way to vehicles or pedestrian; as per rules red, yellow and green lights have been used to maintain stop, start and go accordingly [5].

B. Maintaining the traffic by different colors signs of directions

Right, left and straight colored signs for drivers and pedestrians were installed for efficient traffic management in pick hours [6]. And due to heavy traffic on certain directions of roads particular signs were used to maintain long queues in certain affected lanes and emergency as well [8].

III. ARTIFICIAL INTELLIGENCE IN TRAFFIC MANAGEMENT

As soon as the cameras were discovered it was possible to monitor traffic virtually. But still it was semi-automatic way to handle the traffic [10]. Traffic density is analyzed by human and accordingly the decision is taken. But limitation is that still human is needed for the operation [10].

Traffic management means it manages the organization, arrangement, guidance and control of both stationary and moving traffic, including pedestrians, bicyclists, ridden and herded animals and all types of vehicles. Its aim is to provide for the safe, orderly and efficient movement of persons and goods, and to protect and, where possible, enhance the quality of the local environment on and adjacent to traffic facilities. There are various traffic management methods[11].

1. Traveler information system is that it provides traffic information on roadways such as congestion, accident, delay, etc. And travel options allow information about the most efficient route and mode. This reduces travel time and make efficient use of the transport system.

2. Active traffic management is that it manages traffic flow, reduces accident, decrease congestion by providing managed lane or smart lane. Different types of sensors are used to monitor the real time traffic while the computer system is used to developed algorithm to smoothen the traffic.

3. Freeway management and arterial management is that it is used in urban and interurban area which provides a technique to decrease traffic congestion and improve traffic flow such as ramp metering, variable speed limit.

4. Transportation management center is that it observes, the real time traffic and collects the data. It provides coordinated transportation management on roadways. The devices which helpful in traffic control, should be upgraded from time to time.

5. The traffic management rule is that by applying some enforcement law like speed limits, careless driving.

6. General rules for traffic management is to install speed control board for heavy vehicles. To achieve road traffic discipline as traffic signals, traffic monitoring, etc. Traffic flow can be controlled by creating service road, turn lane, etc.   Safety awareness program is carried out as "road safety week".

7. The traffic management method is carried out by the coordination of the network operator and controller with reference to some predetermined traffic management policies and plans and upgrades it with time to time according to requirement[12].

IV. Issues in Traffic Management

- Traffic congestion is becoming more serious problem day after day due to the high volume of vehicles on the road.
- An increase in growth of population is one of the reason which causes traffic congestion
- Obstacle such as double parking, road work, an accident, lane closure due to utility work on the road causes blockage and merger
- sometimes the technology is used not in sync and proper work e.g. The traffic light signal.
- Commuters are going to their work which causes traffic congestion during peak hours.
- Alternate routes are less in the city area.
- Lacks of proper infrastructure causes traffic congestion. [13].

V. Proposed Scheme For Traffic Management
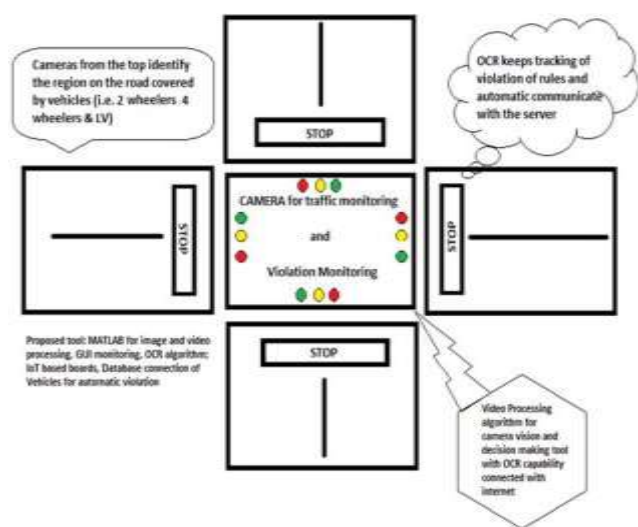
Figure 1 Intelligent tool for traffic monitoring and violation controlling

The proposed scheme inhibits various aspects of monitoring traffic density and puts some limitations on traffic violations as well.

Raspberry Pi can be used with integrated camera and MATLAB to monitor real time traffic. This monitoring for each lane

approximates queue length and amount of traffic decides which lights to be made ON and OFF to maintain the lowest traffic as possible [14].

Although in pick hours various traffic management strategies can be monitored

If anyone tries to violate the rule then OCR can be used to extract the number plate of the vehicle and send e-memo on the email address and phone number from the database stored on server, furthermore constant communication with server helps continuous monitoring as well.

VI. Proposed Scheme For Traffic Management

The manipulation of traffic region or capturing raw data for intelligent traffic management is gathered through various methods which are:

Figure 2 Image Acquisition

Image acquisition is achieved by a suitable camera. The camera is fixed on the pole which is placed near the traffic light signal at the junction. Video is captured by the camera. The video is converted into a number of frames. Initially reference image of signal junction is taken. The reference image is the plain or empty image of road without a vehicle. Image capture is an image acquired at regular interval of time at the junction. Then reference image and capture image are processed [15]..
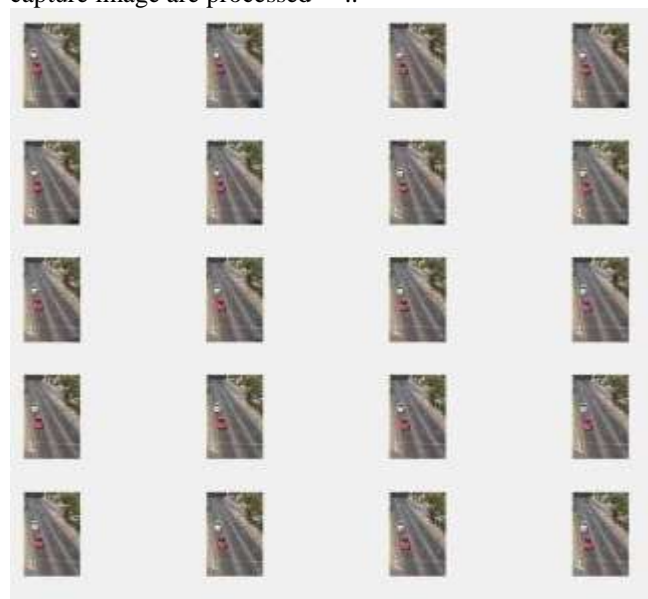
Figure 3 Original Image and Reference Image, Number of Frames From Video

VII. Manipulate traffic density by extracting vehicles

Manipulation/calculation of vehicle density at any junction or on the given stretch is mainly calculated by Image Matching.
Image Matching:
Image Matching is calculated by converting the figure 2 in gray scale and comparing the vehicle covered area with clear road.
Vehicle density count/ image matching is the process in which two models of the same object are paired together than one image is compared and evaluated against all the edges on the other image. These Edge detected images are matched and accordingly the traffic light durations can be set.

total_matched_percentage =

   67.3051

OUTPUT_MESSAGE1 =

   ' Hence the pictures have not been matched, DIFFERENT PICTURES '

total_matched_percentage =

   66.6223

OUTPUT_MESSAGE1 =

   ' Hence the pictures have not been matched, DIFFERENT PICTURES '

Figure 4 Image Matching

VIII. MAINTAIN ON-OFF LIGHTS BY TRACKING THE LENGTH OF THE TRAFFIC

Vehicular traffic is controlled by a traffic light. A traffic light is operated automatically to control the traffic at road junction, pedestrian crossing and roundabout.

The traffic light is also called signal light, traffic lamp, stop light, etc. Traffic light is necessary to avoid traffic and accidents. Traffic light uses three control light or signal, which provides instruction to the driver.

• Red light: It instructs the driver to stop at intersection.

• Yellow light: It instructs the driver to wait in case of red light is next or it instructs the driver to proceed in case of green light is next.

• Green light: It instructs the driver to leave the intersection.

There are three different directions of the vehicles at the junction which are left, right and straight.

The traffic light sequence changes: green to yellow, red to yellow, yellow to green or red light. Green light never changes to red light directly or vice versa.

Automatic turn On-Off of lights can be done by using the smart traffic light system. This system uses many sensor data of traffic density count as described earlier. Now this traffic density data is fed to the predefine sets of algorithms which decides green time and red time for respective signal light. This processed data, then communicated to traffic light on-off sensor to maintain the traffic signal status to smoothen the traffic [16]..

e.g. Green light is ON for the longest time when traffic is heavy and green light is ON for a short time when traffic is less.

The three LED like green, yellow and red are kept at 4-way junction. All LED are connected with the Arduino board at I/O pins. Traffic light controls based on following condition.

1. If matching is <10%, green light on for 45 seconds

2. If matching is in between 10% to 50%, green light on for 30 seconds

3. If matching is in between 50% to 70%, green light on for 20 seconds

4. If matching is in between 70% to 90%, green light on for 10 seconds

5. If matching is >90%, red light on for 45 seconds

matching...

total_matched_percentage =

   73.9182

OUTPUT_MESSAGE2 =

   ' GREEN for 10 seconds '

Figure 5 Traffic Light Control Based on Density

According to logic as shown in figure the output message indicates that green light needs to be ON for particular lane and same thing can be shown using arduino and MATLAB with HIL-Hardware in loop method [17].

Arduino with MATLAB integration steps are shown below: -

Now for raw data collection like capturing real time traffic feed from traffic junction will require a camera, processing device which can also store and communicate data from camera to control center or central processing unit. To fulfill above requirement Arduino board can be used [18].

Arduino based traffic light controller also can be used as primary controller in an intelligent traffic management system. It is very easy in implementation of the system. It is an open source circuit board based on easy to use hardware and software which can be easily programmed. It is inexpensive, cross-platform, simple & clear programming environment, extensible software and extensible hardware.

Specifications:-

There are different types of board available like Arduino UNO, Arduino due, Arduino mega, etc. with different characteristic like processor, memory, digital I/O, analog I/O, etc. Arduino UNO is the most popular board of the **Arduino board family** [19].

The Arduino Nano board is also available which is complete, small and bread board friendly board. It can be powered through the Mini-B USB connection. It has the same functionality as in Arduino UNO. It is programmed with the Arduino IDE.

Arduino Integrated Development Environment (IDE) software which is used to write and upload computer program code to the board. Arduino programming language is very easy hardware programming language like C language [20].

Integration with MATLAB
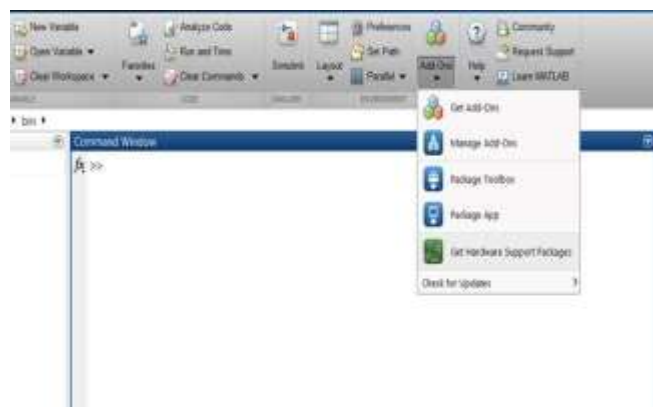
Figure 6 HIL Hardware Support Packages

To interface Arduino with MATLAB, click on add on menu, then click on get hardware support package and install the package. Once the package is installed, Arduino board is connected to the PC and writing a command in the command window. MATLAB will communicate with the Arduino board and MATLAB will display the property of the Arduino board to the PC

Figure 7 Connection Information MATLAB

Figure 8 Arduino UNO

IX. OPTICAL CHARACTER RECOGNITION (OCR) IN INTELLIGENT TRAFFIC MANAGEMENT

In transport and traffic management system, tracking of vehicle on the road is very important aspect. The easy and most used way is by recognition of number plate. Automatic Number Plate Recognition (ANPR) is a special form of Optical Character Recognition (OCR) which identifies the vehicle from its number plate automatically to create vehicle location data.

A vehicle registration plate is a metal or plastic plate attached to a motor vehicle or a trailer for Official Identification purposes. It is placed on the front and back of the vehicles. It was invented in 1976 in the UK. The registration number is a numeric or an alphanumeric code that uniquely identifies the vehicle within the issuing region's database. ANPR Cameras are specialized types of CCTV camera that have software built into it to help ID and capture license plates on still and moving vehicles. With the increasing number of accidents and traffic rule violations, identification of a number plate is prime important.

Systems commonly use infrared lighting to allow the camera to take the picture at any time of day or night because retro reflective plates reflect this kind of light very well and human eye cannot detect it also it gives good image quality. This technology is also called license plate recognition, car registration system, Intelligent Transport system, Automatic vehicle identification [21].

It uses two system models:

1) Software model which uses MATLAB (image processing techniques)

2) Hardware model which uses IR sensors, PC, camera, storage, microcontroller

Working of Automatic Number Plate Recognition (ANPR)

The system has input as a color image of the vehicle and output has the recognized vehicle registration number. The ANPR process is divided into the following steps:

1. Vehicle image capture
2. Pre-processing
3. Plate region extraction
4. Segmentation and recognition of character in extracting plate
5. Display vehicle number

Application of Automatic Number Plate Recognition (ANPR)

• Need for the law enforcement agencies to enhance the enforcement and investigate

• A surveillance operation and assist in traffic enforcement

• Toll booth automation [22].

• Enable implementation of automatic parking and ticketing system

• Recovery of stolen car

• Monitoring of Highly security area and border area

Advantages

•To recognize the vehicle number, ANPR systems are using registration plates that all cars already have, so there is no need to additional transmitters or special signs to vehicles which results in saving towards the implementation of the system.

•The photograph of the car and the driver can be stored and retrieved if there is a need for evidence in disputes or crime situations.

• It is faster than the other techniques.

Figure 9 Automatic Number Plate Recognition

After OCR of vehicle registered number plate, the resulted data will be exported to excel, database, then it will compare with the pre-loaded Vehicle Owners database to find respective contact information of that particular vehicle owner for further administrative actions.

Figure 10 Number Plate of Vehicle

Figure 11 Comparison with stored database

CONCLUSION

We can conclude that to improve current scenario of traffic management, there is a necessary of the intervention of IOT based smart technology in traffic management using image /video processing.

By using machine vision, we can develop algorithms for efficient and effective traffic management.

Limitation of this implementation is that here we have used the MATLAB as processing tool mechanism but for remote usage Raspberry Pi can be used as RTOs based board on which various processing of video frames are executed after extraction along with OCR.

FUTURE SCOPE

Server configuration with IoT based implementation can be set up in master slave configuration and load balancing and scheduling algorithms can be used for proper smooth flow of traffic in all the city as well. Traffic queue can be monitored for all cross road and sequential execution needs to be made concurrent using parallel computing. It may further rise up to distributed computing as well if processing is much larger and complex [26].

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