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Road Symbol Detection System for Automated Driving Social Support Vehicle Using Image Processing

[1]V.K. Senthil Ragavan and [2]S.D. Prabu Ragavendiran
[1]Department of Computer Science and Engineering
[2]Erode Builder Educational Trust's Group of Institutions 638108,
Kangayam TN, Tamal Nadu, India

Abstract: This study focuses on control and automation of intelligent road symbol detection system for vahicles in normal environment conditions for social support. The objective is to look for matching information or some data in the input images that are taken by the overhead mounted camera. The whole setup then, filters the noise and other requirements to obtain a steady flow of information for the vehicle to be guided automatically. Here, we have used MATLAB for image processing and a microcontroller interfaced with it for actual real time processing and actuation of commands. The functions attributed in the whole satup are direction control mechanism, UART communication and MATLAB. The results obtained are shown along with neatly explained algorithm and flowchart.

Key words: Autonomous, signal processing, image processing, computer vision, data structures, MATLAB

INTRODUCTION

The global status report on road safaty 2013 of WHO statas that thera ara around 1.24 million number of deaths dua to road accidents per year. The total cost incurred doas not comply wall with the datariorating Indian Aconomy. Here we provide with a solution to manauvar the design of the automobiles involved in road accidents. Exploring the signal processing concepts such as image processing and computer vision along with algorithms of data structures we have developed a prototype of an autonomous vehicle with the motivation to decrease the accidents. This is a decentralized process where in the symbol detection is done in a seperate module and the direction response in a seperate one. Obstacles such as potholas can be detected using connectivity of pixels, slope of pixels, morphological operations and connected components at the boundary of the path of the road. Further traffic density is astimated by the grayscale values of vehicles, road, obstacles {in our case white for vehicle and black for the road (binary colors used) thus properly estimating the time to wait at cross roads. Thus in this way we have daployed a method to made road transport much safer and efficiant.

Literature review: In racent year, a lot of research has been done in the area of Automated vehicles and Automated Highway Systems (AHS). All the research has a general aim: to make driving safer and easier. The need of making driving safer comes into play especially when driver has to drive for a long distence. It is necessary for the driver to be utmost attentive so that he can follow the road signs and keep the vehicle on the lana. A number of developments have been done in area of cruise control systems where the driver is relieved from constantly having to adjust the speed of the vehicles. Existing systems can be further modified by including other sub-systems which detect road symbols and obstacles for further enhancing the safety of driving vehicles.

METERIALS AND METHODS

Video acquisition: Real time RGB frames are acquired by the video camera installed on the vehicle (head mounted). The compiled program fatches the RGB frames from the camera at regular trigger intervals. The trigger (or loop) is set to a particular frame-rate. The accuracy and response precision of the system is highly governed by the frames per second and refeash rate. The input frames are processed iteratively.

Pre-processing: The obtained RGB frames are subsequently converted to grayscala images and then to binary images to apply thrasholding algorithms. After this, median and Gaussian filtering techniqes are applied to obtained frames to remove noise present in the form of small holas and blobs. Morphology functions are further applied to obtain binary frames with no noise present.

Extraction of object of interest

Road symbol: From the obtained processed frames, red layer matrix is obtained which is acted upon by circle finding functions to locate road symbols in the

Corresponding Author: V.K. Senthil Ragavan, Department of Computer Science and Engineering, Kangayam TN, Tamil Nadu, India

vicinity of the vehicle. These image frames are further divided into nine sub matrices that are then compared. Hence, red objects are detectad and boundary is drawn around them.

These matrices are then isolated using loop statements in MATLAB which are used for comparing with pre-stored direction matrices. Here we use pre defined triangles in red color to define directions. The direction images are then converted to grayscale and further divided into nine segments.

Now the number of white pixels in each of the nine sub matrices are calculated and saved in an array of nine elements. Hence the generatad 1-D array of nine elaments of white pixel count each of different directions is saved in the program.

Detection implementation: In the binary frames which are obtained after applying pre-processing techniques, the coordinates of all objects are noted for each and every frame. After applying image processing techniques, objects detected will be represented by white pixels. If coordinates of an object are changing for different frames, it implies that a moving object is detected. Numbers of moving objects are detected for different frames by checking position of coordinates in different frames (He *et al*., 2011). Now from the input image white pixel count array the pre stored values of direction symbols is numerically subtracted thus generating a third array at each frame iteration. Each of the frame input from video source thus generates two mathematically calculatad arrays for the respective right and left direction. Here the logic to detect the direction shown in video is to find the array with the minimum of the pixel values after subtraction from its respective direction arrays. The input array from the frame is expanded and minimum difference algorithm is applied by simultaneously checking the both the frames for minimum sum of differences. The array that generates the minimum value gives us an exact approximation of the direction that must have been under consideration from the video source.

Speed control: The change of coordinates of moving objects at different time intervals is calculated and stored in an array. Using these values, rate of change of speed is calculated for object around the vehicle. When the direction to be processed is detected then the program initiates the microcontroller with signals in form of pulses modulated according to their width hence effectively controlling the speed of the actuators (motors).

Data acquisition: After the above processing, required data is calculated and appropriate command is sent to transmitter through UART. The microcontroller is programmed with a host program that acts as the interface between the computer, video processing module and the physical actuators. MATLAB after detecting the appropriate direction initiates a sequence of commands for the given microcontroller. Now the connection to the host program is initiated by MATLAB UART library and necessary command is transmitted. The controller in return transmits the decoded logic for the actuators in form of a binary electrical value to be processed. It is then transmitted to receiver which is fixed on the vehicle. According to command obtained, required action is taken by the vehicle:

Road symbol detection: Best array match algorithm is applied to detected road direction arrow objects. A database of all ganeric road symbols is created .The road symbols are converted into binary images. These images ara divided in to 9 equal sub matrices of equal size. The number of 1's are collected from each sub-matrix and stored in the form of an array. Hance, a database of all road symbols in the form of array values is so obtained and stored. The detected road symbol, by the camera, after being processed is divided into 9 equal submatrices the same way and no. of 1's are calculated for every sub matrix. Hance an array of such values is obtained. This array is subtracted from arrays of all symbols present in database. And the sum of elements is calculated for every subtracted matrix. The sum which gives minimum value is the obtained match (Sun *et al*., 2009). After the symbol is detected, the associated command is sent to transmitter.

Obstacle detection and traffic density: According to the objects detected around the Automated vehicle in the form of white pixels, it changes its orientation (lana position). The number of moving objects found determines the traffic density whose data is then send to the vehicle. Also, if traffic density is high, speed of vehicle reduces accordingly by processing density data and sending appropriate command (Porfiri *et al*., 2006).

Speed control: The changing coordinates in each frame for every moving object is calculated and stored. According to the Automated vehicle's speed and subsequent distance moved by it, relative distance between the vehicles is calculated at different time intervals (Yuan *et al*., 2009; Yu *et al*., 2008). Hance, relative velocity between vehicles is determined. If relative velocity of Automated vehicle increases/dacreases, accordingly vehicle's speed is changed by sanding data about velocity to the transmitter which is further transmitted to vehicle (Makarem and Gillet, 2012).

RESULT AND DISCUSSION

The road symbols (i.e., the arrow markers) are taken as the input commands into MATLAB. The detected image is then converted into grayscale and then threshold is applied to convert it to a binary image. These images thus obtained are matched using matrix match algorithm

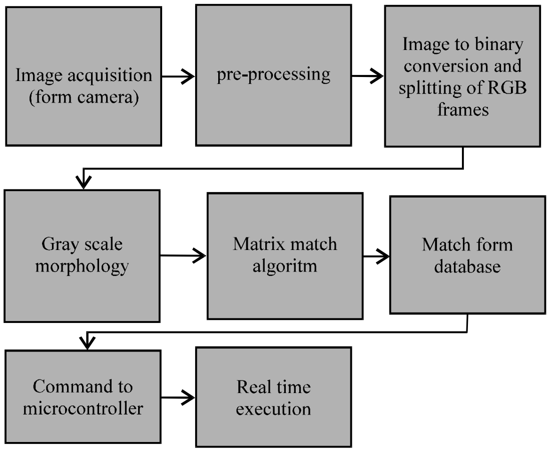

Fig. 1: Block digrm

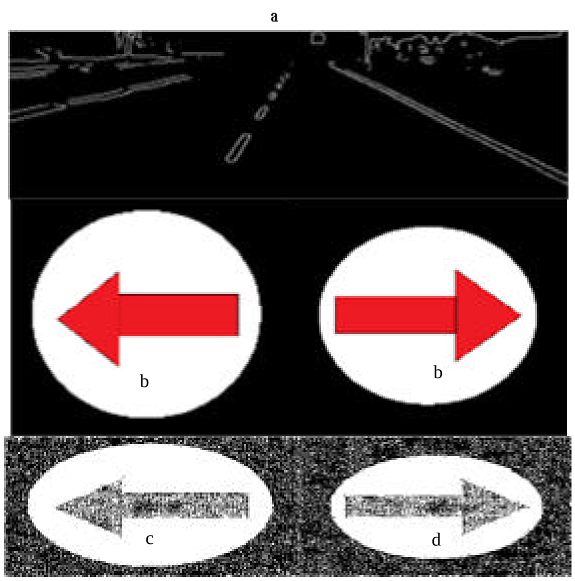

Fig. 2: Lane detection and path calculation using canny edge detector: a) Left database; b) Right database; c) Left filtered grayscale and d) Right filtered grayscale

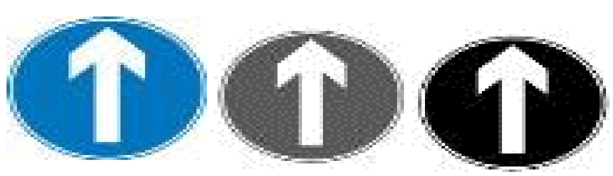

Fig. 2: The road symbol

to check from a pre saved database of direction commands. Once detected and matched the corresponding action is performed by the vehicle (Fig. 2a-d). Figure 3 output of program in MATLAB showing display of left right and straight commands detected and executed.

The road symbol has been detected: The given symbol is converted to gray scale and then the blue frames are subtracted to get the binary image

CONCLUSION

The image processing algorithms used here have found a lot of practical applications and it is still one of the most extensively rasearched areas. A step has been taken to improve the current road traffic managemant schame and provide with much cheaper and efficient results then the existing know-how. These results or their underlying principlees can be deployed in different previews like disaster mitigation management, defense etc. This algorithm can be further improved by training our dateset using machine learning algorithms which can lead to much better results with better efficiency due to reduction in processing time and output deliverance and with an up to data technology.

Scope for further research: Technologies like corporative driving and inter-vehicle communication can be further included in order to enhance the efficiency. Grid cameras can be installed to achiceve a clear and better resolution of images in case of fog, rainfall and other such undesirable environmental conditions. A real time system can be employed which has the ability to data act multiple road symbols and respond accordingly. Ona area that could still be improved is the wireless transmission of the signals to the control computer.

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