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Simulation of Navigation System for Semi-Autonomous Vehicle

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ABSTRACT: *This paper provides a navigation system for the semi-autonomous vehicle, via a Lane adherence system and an obstacle evasion technique. The lane adherence system allows the robot to navigate within that particular lane and the obstacle evasion technique is used to evade any obstacle either by total evasion or by using intelligent speed control. The proposed algorithm uses Hough's transform to detect lines and Blob Analysis to detect the presence of obstacles. This semi-autonomous vehicle allows the user to choose the path by means of a remote control. The system is simulated using MATLAB.*

Keywords - *Lane adherence System, Navigation System, Obstacle evasion, Semi-autonomous Vehicle.*

I. INTRODUCTION

The automotive industry, which was booming a few years ago, is not able to produce any new innovations anymore. Now that almost 60% of every automobile is electronics, new ideas for innovation are running out. We have ingenious systems like the ABS (Anti-lock braking system) and Automatic Cruise Control. But beyond that, little is new in this industry. The next big thing that can come up in this industry is autonomous vehicle control. The autonomous vehicle is one which can drive itself without the intervention of a driver. It has the capabilities to think and decide the next course of action- change speed, stop, swerve, etc. Massive research is going on in this field, and a lot is being spent on R&D. This project attempts to implement basic decision making capabilities like obstacle avoidance, speed variation and lane guidance.

In literature, several methods were proposed for the design and control of un-manned vehicles. In Ricardo Acevedo-Avila et al, 2011 [1], a technique called Inverse Perspective Mapping is done to create a trapezoid where the lane exists in the image and stretching it to create two parallel straight lines. Hough's Transform is used to detect the lane and add a coloured pixel to the centre of each lane. Now the relative distance of the lanes is compared and used to determine a lane departure. In Selma and Chouraqui, 2013 [2], Adaptive Neuro Fuzzy Inference System (ANFIS) is used to create scenarios from the path and resolve those using a fuzzy inference system. In Correia et al, 2010 [3], a Field Programmable Gate Array (FPGA) was used to implement the control of a car with a human machine interface using LabView and algorithms by linking humans to control using keyboard to take the decision of navigation and parking assistance while allowing for unmanned transportation capability by relaying the video if the car to the driver. Finally it was tested on a real-time car for control capability. In Petrovskaya and Thrun [4] the method for the detection of dynamic vehicular movement detection and explains use of Light Detection and Ranging (LIDAR) systems. In Stavens [6], 2011, a complete guide to the algorithms, the experimentation method and the results are given in detail. In Petrovskaya and Thrun [7], 2009, it describes the moving vehicle detection and tracking module that was developed for the autonomous driving robot Junior.. In Fu et al, 2010 [8], a fuzzy logic controller is designed for vision based autonomous road-following. In Macdonald, 2011 [9], the dissertation describes a simulated autonomous car capable of driving on urban-style roads. The system was built around TORCS, an open source racing car simulator.. In Levinson et al, 2011 [10], a summary of their recent research towards the goal of enabling safe and robust autonomous operation in more realistic situations is given.. In Pereira, 2011 [11], this dissertation is the integration of two types of simulators, namely a robotics and a traffic simulator. In Aly, 2008 [12], it deals

with only lane detection. The method proposed is IPM, then Gaussian spatial filters to filter for vertical lines, line is identified using Hough's Transform followed by a RANSAC line fitting step and a RANSAC spline fitting step for differentiating between straight and curved lanes. In Tsui et al, 2008 [13], the use of fuzzy logic and Neural networks are explored for parking and wall following.. Lin and Su, 2011 [14], it explains a vision based solution in intelligent vehicle application often needs large memory to handle video stream and image process which increase complexity of hardware and software

II. METHODOLOGY

Every video consists of frames and usually, video processing is done frame by frame. Every frame of the video is converted to 2 formats: Intensity (gray scale) and YCbCr. To reduce processing time and to get more accurate results, the field of view is confined to the lower portion of the images. Then a 2-D FIR filter is implemented to remove the noise in the images. The algorithm is shown in Fig.1, Fig2. Now the image is converted to binary form by using an auto threshold function. This function automatically finds the appropriate value of intensity after which the pixel is made white. Before that intensity value, the pixels are black creating a binary image. Next Hough's Transform is applied on the image, and from its output, the peaks are detected. This is done by taking pixels, row by row and finding the polar coordinates of the maximum intensity point of every row. When this is done for all rows, the peaks of the whole image are obtained. This will give the lanes to which our vehicle has to conform to. The polar coordinates are converted to Cartesian coordinates to facilitate line drawing.

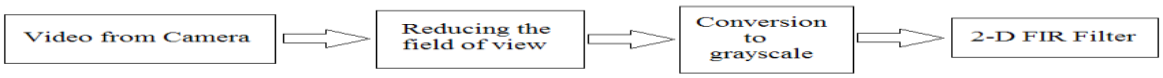

Figure 1: Pre-filtering process

Now that the two side lanes are found out, we can use that to find out lane departure, if any. If the vehicle moves towards any one lane, the number of pixels from the vehicle to that particular lane will be lesser than that to the other lane. So, by counting pixels we can find out if lane departure exists, and toward which lane the vehicle is tending to.Lines of different colour are drawn for the 2 side lanes. This is coded into a microcontroller to generate a corresponding Pulse Width Modulation (PWM) signals which is fed to a servo motor to rectify its direction if need be.

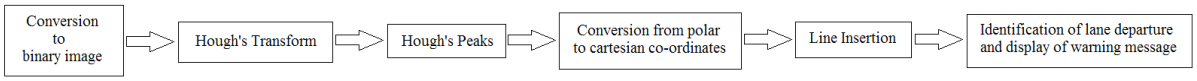

Figure 2: Post-filtering process

For object detection, the image in intensity is processed using Blob Analysis which gets the centroid of the object and the co-ordinated for drawing a bounding box around the object. If this lies in the path of the lane, the microcontroller is coded to reduce its speed to prevent collision.

III. SIMULATION RESULTS

The proposed methodology is simulated using MATLAB R2012b. The simulation is tested in real-time in college campus.

Fig.3 shows the snapshot of the output. The figure shows the road marked with two lane markersin white. The image when processed using the proposed algorithm, the lane markers are identified and outlined by yellow and pink lines. This shows that the lanes are detected and that the vehicle is conformed within the lane.

Figure 3: Detection of the lane

Fig.4 shows the event of a lane departure. When the vehicle gets close to the either of the lane markers, a lane departure event is onset. This event triggers a warning message to show that the algorithm is capable of recognizing a lane departure event. In the image, a right departure event is onset. This means the vehicle has deviated from the path and will leave the lane. So a warning message is displayed indicating the departure.

Figure 4: Lane departure event

IV. CONCLUSION

The technique implemented has demonstrated a successful detection of the lane. The best feature of this method is that the lane was detected using the same frame as a reference frame and the auto threshold feature ensures usability to detect in lesser lighting conditions. This allows detection of the lanes allows for the autonomous vehicle to adhere to a lane system and navigate on roads. The limitations are that it is fixed for a single lane and shadows on the roads will interfere when could be extended for multiple lanes. This could be implemented on hardware and tested for real-time capability and performance.

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