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Development of Smart Road Line Detectors Based IoT Architecture for Accident Avoidance

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Abstract: The lack of safety equipment on cars is one of the causes of road accidents. As a result, the car is not in the best possible condition. The majority of automobiles lacking safety features are low-cost or basic models. The objective of this study conducted was to see the extent of the effectiveness of road line detectors when placed on vehicles. In addition, study appropriate methods for road line detectors and finally build an affordable line detector for all vehicles. In this project, one method for lane detection are uses which is Bird's eye view or perspective view. From this method the canny edge detection will be applied to detect the line from the camera capture, and it will appear the result by using OpenCV. The result will show, and it will send the warning through the buzzer if the car slight right or left.

Keywords: Line Detector, Image Processing

1. Introduction

The increase growth of society calls for the increase of mobility. With the developments of the industrial world, owning a car has become easier and more affordable for everyone. Unfortunately, advancements in vehicle accessibility do not coincide with advancements in vehicle security, which actively assures and prevents vehicle drivers and passengers from being involved in accidents. Several automobile accidents have occurred because of a vehicle drifting off the lane, the majority of which were caused by human error elements on the part of the driver of the car who did not have any system in place to alert or actively help the car in staying on the lane [1]. According to previous research, over 90.00 % of traffic accidents are caused by human error, and almost 60.00 % of road deaths are caused by accidental lane departure [1].

The Advanced Driver-Assistance Systems (ADAS) are a useful active safety assist technology that was designed to assist drivers in avoiding on-road crashes, therefore enhancing road safety. Safety assist technology can help to reduce fatalities caused by human error while driving, such as failure to yield right of way, failure to obey signs and signals, failure to see objects, improper turns and lane changes, low driving skill level, inexperience, and unnecessary risk-taking behaviours, traffic violations, reckless

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driving, and drunk driving [16]. Recently, ADAS systems, such as Adaptive Cruise Control (ACC), Lane Keep Assist (LKA), Lane Departure Warning (LDW) and Intelligent Speed Assistance (ISA) are already popular among car manufacturers or are being developed [15].

The goal of this project is to create a smart line detector that uses IoT architecture to prevent accidents. This smart line detector will be used in Malaysian cars because most Malaysian cars do not have a safety system. The smart line detector is then constructed to guarantee that the pricing is reasonable to the Malaysian population.

2. Literature Review

For previous project, there are many projects that his aim to improve the ADAS to make sure the car has fully safety when it on the road such as Lane Keep Assist (LKA), Lane Departure Warning (LDW) and other. Another part of ADAS is Adaptive Cruise Control (ACC), this technology maintains a safe gap between the driver's vehicle and the cars in front of it. And then Forward Collision Warning (FCW), it will detect the vehicle in front of driver's automobile. Besides, Intelligent Speed Assistance (ISA) that influences the speed at which a car is driving. The maximum speed may be pre-programmed or determined using GPS data. Lastly, Lane Change Assistance (LCA), it is a group of technologies that address blind spots and rear-view issues. It employs sensors to identify things and vehicles that the driver would otherwise be unable to notice due to a blocked vision.

From the previous study, the present all ADAS is to make sure the vehicle has fully safety and can reduce accidental death rates. This is because mostly the accident or collision occur at car no other vehicle. Table 1 shown that car is the common vehicle that involve in accident in Malaysia.

Table 1: The statistic of vehicle that involve in accident in Malaysia

Categories and year	2010	2011	2012	2013	2014	2015	2016	2017
Car	1421	1389	1435	1399	1258	1358	1489	1269
Bus	77	29	32	60	29	20	29	23
Van	97	93	86	80	73	71	65	62
Lorry	202	247	194	210	221	223	186	199
Other	67	97	147	100	146	112	122	123

From the Table 1, the rate of accidents involving cars is higher than other vehicles. The death toll caused by car accidents is higher than in vans and lorry. If this situation continuous occur, perhaps the mortality rate will be more recorded. The factor of accident is occurred is shown in Table 2 below:

Table 2: The factor of accident

No	Factors	Description
1	Attitude	Careless while driving and do not take it seriously.
2	Safety system	Most Malaysian car don't have safety system because it very expensive.
3	Awareness	Low awareness to build a safety system in car.

From the previous project, there are many methods to detect the road line and sensor that have use to capture the line which is camera sensor in Lane Keeping Assist. The data from the camera will sent into a fuzzy controller and then analyzed on a microcontroller to provide a decision on how to drive the experimental car's motor to keep it on the lane [1].

Besides, there are project that use three methodologies for lane detection which is Blob analysis, Hough transformation and Birds eye view. This is method about the image processing. A camera is

used to collect data from the surroundings, which is sent wirelessly to Simulink through Raspberry-Pi. The data is processed by the controller, which then uses serial communication to provide the required output control to Arduino [5].

Next, another method that have use in previous project is they use the charge-coupled-device (CCD) camera, which detects the lane markers and calculates the lateral deviation in real time. An adaptive lane detection method with dynamic calibration was developed to improve picture recognition precision [4]. The CCD camera is positioned behind the rear-view mirror on the windscreen to take photos of the road surface ahead of the automobile. Then, using pattern recognition hardware, these pictures are analysed to extract road information such as lateral displacement, road slope, and curvature. Lane departure detection is a four-step method that includes lane recognition, coordinate conversion, road parameter estimate, and perspective calibration.

Lastly, from previous project, to determine lane borders, the proposed approach analyses each individual picture taken from the input video. The RGB input picture is converted to Lab colour space. The shadows are identified using average and standard deviation criteria for the suggested technique to be lighting resistant.

3. Materials and Methods

This chapter will cover the details explanation of methodology that is being used to make this project complete and working well. For this project, there are hardware and software that use to make the prototype function. All hardware and software are shown below:

3.1 Hardware

For the hardware, the Raspberry Pi model 3 that show in Figure 1 have use as microcontroller to control the and run program in this project. The Raspberry Pi 3 was chosen as the platform since it is a credit card-sized computer. The Raspberry Pi 3 offers a number of major hardware improvements over prior versions.

Next hardware that uses in this project is Pi camera. The Raspberry Pi camera that shows in Figure 2 module was used as the picture acquisition device. A five-megapixel picture sensor with a maximum resolution of 2952 x 1944 pixels is used in the camera module. This camera was selected since it is specifically built for the Raspberry Pi and is very easy to use.

Figure 1: Raspberry pi model 3

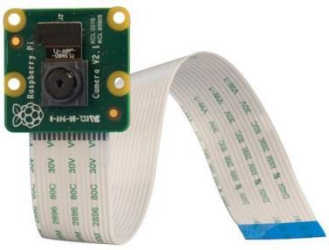

Figure 2: Pi camera

In this project, the RC car have chosen to assemble with all components which are Raspberry Pi, Pi camera and buzzer. The factor of chosen of RC car is because it has same as vehicle that have use on the road.

In this project, power sources were used on the prototype. The Realme power bank are use in this project. This was directed towards the Raspberry Pi. The power bank is a 10,000- milliamp-hour power source with 15 V USB output ports, allowing more than one component to draw power from it at the same time.

Figure 3: Remote control car

Figure 4: Realme powerbank

3.2 Software

In this project, there are some software are use which Geany that it has at the Raspberry Pi OS and use Open CV to appear the image from the camera. The language that uses in this project is C++, the coding is running at Geany. Geany is a strong and lightweight Raspberry Pi programming environment. It's basically a text editor with GTK+ plugin and Scintilla library support that can be used to create code in over 50 different languages.

For this project smart line detector, there are some testings to make sure it functions with smoothly and can apply at any car. The testing is:

I. Coding testing
II. Run prototype.
III. OpenCV testing

4. Results and Discussion

4.1 Physical Model

The final design was assembling all component at the RC car. The components are pi camera, buzzer, power bank and Raspberry Pi 3 Model B. All this component mounted at the top of RC car. The camera is place at the centre of the car to make sure it can detect the line with correctly and the position of camera inclined 60 degree to the road.

Figure 5: Physical model prototype

4.2 Code Walkthrough

This section will show the flow at the program, and it function. The block diagram is shown below.

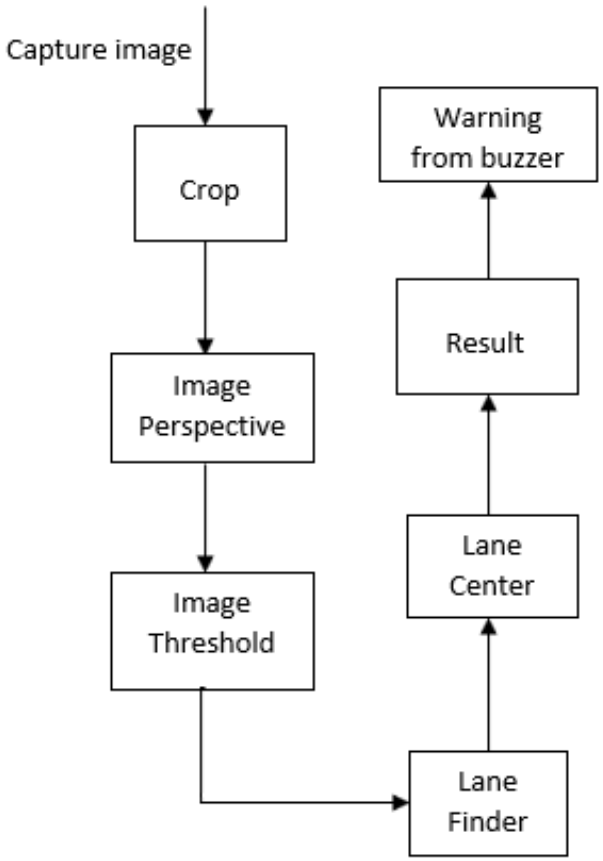

Figure 6: Code walkthrough

When the camera takes the image in this area, the road lane will appear in the frame that was created. The image from the raw image will then be transformed into a perspective image, in which the image appears to be looking down from above, as provided by OpenCV. The application creates picture thresholding from the perspective image. Picture thresholding is a basic image segmentation technique. It's a technique for converting a grayscale or full-colour image to a binary image. This is usually done to help image processing by separating object or foreground pixels from background pixels.

After the image threshold, the canny edge detection will apply in this program to appear the green line at the road line. There are 3 green lines at the road line, which is left, right and centre. This line is setting to always to follow the road line that we pick at the histogram line before this. The last step for image processing is apply the blue line the centre of road. The blue line at the centre of road will help car to stay at the centre of road. This blue line also will appear the result which if the car at the centre of road, the result will show value 0.

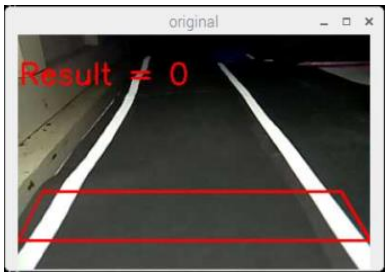

Figure 7: Image capture

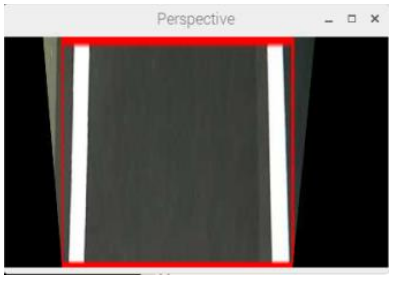

Figure 8: Perspective image

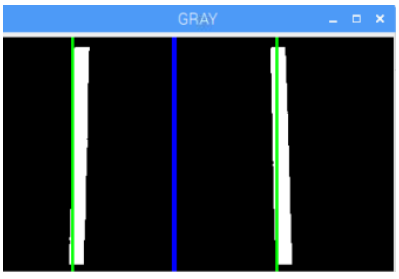

Figure 9: Canny edge detection

Figure 9 show the canny edge detection, the center line are important to determine the result. Adequate lighthing are important at this process to make sure the result can give accurate result. The other factor also is the resolution of camera. This quality Pi camera not same with handphone camera. That why the more lighting must provide during the testing or can do at outdoor.

4.3 Result from coding

Table 3: Result for position of car

Result	Information	Position car	Buzzer
0	Centre of road	Centre	Off
1-20	still on the road	Left	Off
21-27	On the white line (left)	Left	On
27 above	Slight left	Left	On
-1 - -9	Still on the road	Right	Off
-9 above	Slight right	Right	On

The result will show positive number when the car turns left. When result show negative number, the car had turns right. According to the Table 3 the buzzer will turn on when the car approaching the left and the right line but when the position of car on the road and not approaching the side of the road, the buzzer does not give warning and the car are in good condition.

5. Conclusion

Conclusion, the method that use for detecting line are very effective where it gives the results when the car slight right or left and also will give warning to driver. And then, the line detector can be classes as an affordable device because it only uses a few tools and component which is Raspberry Pi, Pi camera and buzzer.

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