International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 05 May 2024
Page No: 1115 - 1121
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0154

Design and Initiation of Lidar Based Visibility Distance Estimation Under Adverse Weather for Collision Avoidance in Fog

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Abstract
The vehicle detection in fog using LIDAR offers a practical solution for staying safe from the road accidents in the foggy condition. The purpose of our endeavor is to develop a vehicle detection system using LIDAR technology to identify and track vehicles within foggy conditions. The system is implemented on Raspberry pi for real-time testing. A camera captures the images and the computer vision is applied to identify whether fog and vehicle is present. If fog and vehicle is presented it send signal for LIDAR to turn on in which sensor fixed on a vehicle to look through the surrounding environment and generate a 3D point cloud depiction of the environment and which give the distance between vehicles. ultrasonic sensor which signals driver to concentrate when vehicle is close to the sides of road divider to avoid hitting them. It gives signal to DC motor which control the movement of the vehicle and motor driver which control the DC motor from giving the reverse current to the PCB of the Raspberry Pi. An electrical source supplies the necessary power for the working of various components. The software tool used is OpenCV with python programming. Finally, when LIDAR and laser module senses the vehicle and detects the separation between them it displays the result on the OLED display screen and indicate through the buzzer.
Keywords: *Raspberry Pi 4, Camera, Obstacle detection, TF LUNA LIDAR, LI-FI technology.*

1. Introduction

This chapter gives an idea of the state-of-the artwork of the field the report is about. It also explains the intention of carrying out this project and briefly outlines the report structure. Vehicle detection in fog poses a significant challenge for autonomous vehicles. Foggy conditions can severely limit the efficiency of traditional optical sensors, cameras making it difficult to identify and recognize objects including vehicles on the road. In such scenarios, Light Detection and Ranging (LIDAR) technology emerges as a crucial component for robust and reliable vehicle detection. LIDAR is a type of remote sensing technology that measure distances using laser light. Unlike traditional optical sensors, LIDAR is less affected by adverse weather conditions including fog, as it operatesAccording to the duration of time it takes for a laserbeam to return after hitting objects. This inherent capability makes LIDAR well-suited for overcoming the challenges posed by fog and enhancing the safety of autonomous vehicles in such conditions. Within the previous decades many driving help frameworks were intended to upgrade the security of the driver additionally travelers, many impediment location frameworks were presented which receive diverse dynamic sensors like illimetre wave radar [5], LIDAR sensor [9, 11], infrared laser sensor [7] and ultrasonic sensor [10]. Inserted innovation has increased colossal driving force in car ventures. So as to give security and transport proficiency, insightful car vehicles are utilized these days. The hindrance location framework is intended to decrease the unfavorable impacts of the mishap. This should be possible effectively by utilizing new innovations like radar, lasers, cameras and ultrasonic sensors to recognize

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impediments in the front side or back side of the vehicle.

2. Literature Review

Luz c.ortega et.al [1] Fuzzy inference system framework to priorities the application of resources in low visibility traffic conditions by Luz c.ortega and Luios Daniel Otero presents a fuzzy inference system framework to help transportation managers with prioritizing the deployment of resources to areas of low visibility originated by fog. Symbolic logic is considered a decision-making technique that could be effectively applied within the area of operational meteorology when dealing with ambiguous, imprecise and sophisticated variables like fog. e.g., visibility forecasting. The framework was developed using GUIDE, a User Interface design environment, and therefore the symbolic logic Toolbox of MATLAB. The application of symbolic logic provides decision makers the flexibility to feature, modify or maybe delete parameters and MFs supported their particular needs without having to incur in expensive architectural system modifications of the framework. The approach accustomed determines the priority of resource deployment in low visibility circumstances, which considers fog also as and road conditions. Rahul Singh et.al [2] Techniques of car detection in fog Dec 2016 by Rahul Singh, Sumeet Singh and Navjot Kaur have described the technique to identify a vehicle in a foggy environment. The image which is received from the camera within the foggy condition is distorted and blurred and it'll not clear up to the required level so the vehicle before is visible to us, so to deblur our image and make it clear we'll use Adaptive Gaussian Thresholding Technique. In this method threshold value is that what the weighted sum of the neighborhood pixel ideals that might strengthen our image clearer and clean as contrast to the initial image. Additionally, to the camera we are using low-cost LiDAR it includes a laser and a camera both of those devices are combined to live accurate distance up to 10 meters. This LiDAR are wont to gauge the gap originating from the front vehicle and supply warning in line with the measured distance. To utilize the structural information to assist vision-based techniques for vehicle detection and classification, use a low cost LIDAR model which is formed of the amalgamation of a camera and a laser. It accurate and of low cost in contrast to the LiDAR. LIDAR utilized in this technique cost is extremely high. Cost LiDAR which composed of a laser and a camera both of those devices are combined to live accurate distance up to 10 meters. This LiDAR are wont to gauge the gap originating from the front vehicle and supply warning in line with the measured distance. R.Surya kumar et.al [3] from the car crash avoidance system powered by a Raspberry Pi R.Surya Kumar, Kingstone Stanley they mentioned the Advance navigation system that recognizes and steers clear of the, is employed in self-sufficient cars to soundly maneuver through the trail. This technique recognizes the obstruction before of the car, sounds the alarm, and removes the obstruction. The lense is employed to detect Static or moving objects are captured via means of the camera. This design encloses the ultrasonic detector to computing the gap of moving in actual time and therefore the immovable object. the most work contributes to the identification of impediments sooner than the automobile. The system receives the alarm within the car with reference to the obstruction ahead, assisting the framework in preventing collisions. During this effort, the gap The identification of object using the ultrasonic sensor measure the separation between the car and the obstruction is finished via means of the camera. By fusingboth certain sensor readings the obstruction is identified and therefore the separation is additionally accurately calculated. The outcome of those heading to a far improved comprehension of the picture by using Open CV to detect things and using Python. Lohit Ujjainiya et.

3. Methodology

The hardware components utilized in the development of this project encompass the camera, raspberry pi 4, HC- SR04ultrasonic sensor, TF LUNA LIDAR, laser module, DC motor L298N motor driver, buzzer.[4] The vehicle detection framework is almost intended to give better wellbeing and make the vehicle self- governing. This framework is utilizing a Camera and a LIDAR for recognition of vehicle. These sensors recognize the vehicle, protest, passerby and so forth and give data to the principal control unit and it settles on the choice as per it and controls the vehicle and give the notice flag to the driver. This framework utilizes DC motor to control the vehicle action and L298N motor driver to control DC motor and audio speaker to indicate the driver through buzzer when vehicle is close to another vehicle. As shown in figure 1.

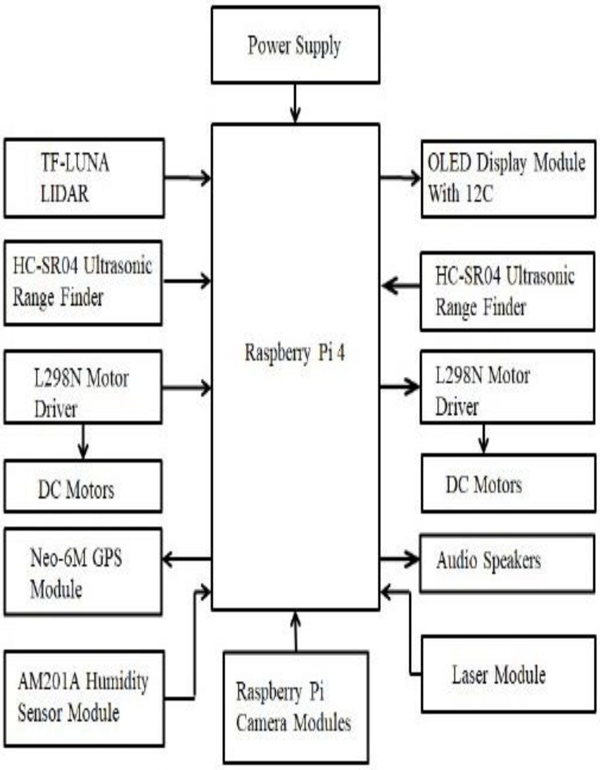

Figure 1 Block Diagram of Proposal System

This system can build an intelligent network for cars and there are numerous additional security-based applications like unlocking car shed shutter, collision prevention as well, this system can yield many more opportunities, which contributes to build the noiseless environment in transportation, the GPS module is employed for tracking and locating the accident location and an onboard GPS module is accustomed to communicate the coordinates via SMS. The obstacle's distance in front and rear of the vehicle is established by an Ultrasonic sensor. The main processing unit within the system is the Raspberry pi board which handles all data accumulation, analysis of that data, and taking actions based on that data show in Figure 2.

4. Flowchart

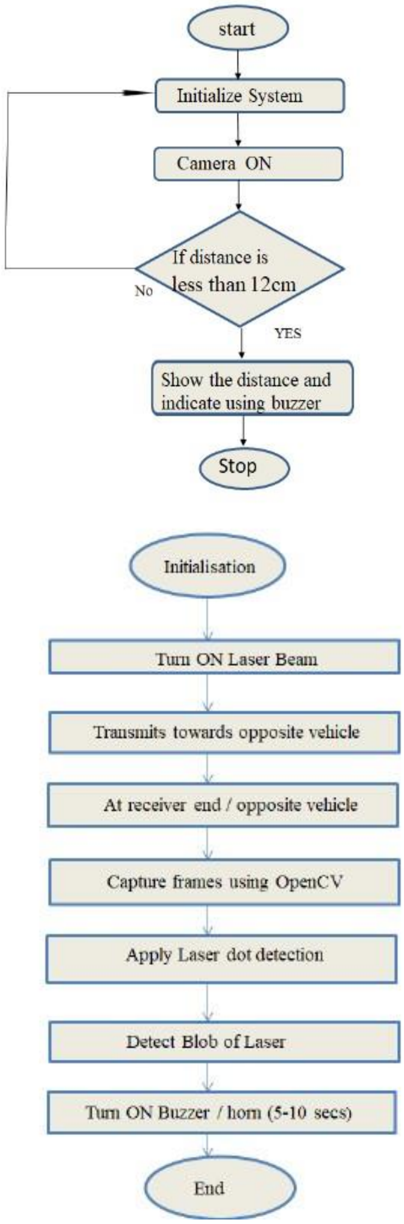

Figure 2 System Operational Flowcharts

The working principle of our project is illustrated in the above flowchart, Raspberry PI module which is coded with respect to Blue Dot application, where the robot is initiated Bluetooth connection is established between the Raspberry PI and Android app. The live capturing of surroundings is done by using camera module. [6] As the line following robots only move forward or backward directions, in order to move the robot left and right we are using Blue Dot application. [8] This Blue Dot application

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is mostly utilized to control the wheel's movement and once we release the Blue Dot the entire movement of Robot wheels will pause and it will move on the path of line automatically in forward direction after sometime as we programmed with time delay. These readings are uploaded to the cloud where the massive network that supports network devices.

5. Hardware Description

The main hardware components used in this work are Raspberry pi 4, TF LUNA LIDAR, Camera Module, Ultrasonic Sensor.

5.1. Raspberry-Pi 4

While maintaining backward compatibility and a similar power consumption, the Raspberry Pi 4 delivers improvements over the previous generation boards in terms of processing speed, multimedia capability, memory, and networking. Desktop performance from the Raspberry Pi 4 is on par with that of entry-level x86 PCs. For even more speed gains, the Raspberry Pi 4 is available with three different capacities of on-board RAM: 2GB, 4GB, and 8GB.

Figure 3 Raspberry – Pi 4

A high-performance 64-bit quad-core processor, dual display output through two Micro HDMI ports, hardware video decoding at most up to 4Kp60, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and POE capability are some of this product's key features. Up to 4K resolution is also supported. As show in the following Figure 3.

5.2. TF LUNA LIDAR

A single-point ranging LIDAR that operates on the Time of Flight (TOF) concept is called TF-Luna. Its primary application is in high-frame-rate, reliable, and accurate range detection.[12] This LIDAR provides exceptional distance measuring performance in challenging application sectors and scenarios since it is constructed using algorithms using that are tailored to fit a variety of application contexts. It also supports two interfaces for communication: UART and I2C and the configurations and parameters on this LIDAR can be adjusted according to your application needs. As show in the below Figure 4

Figure 4 TF LUNA LIDAR

5.3. Camera Module

The Raspberry Pi 5MP camera board is a custom designed camera board that is equipped with a flexible ribbon cable, making it compatible with Raspberry Pi boards.[13] The camera board is integrated with a fixed lens that possesses a resolution of 5 megapixels. This camera board can capture beautiful moments with a resolution of 2592 x 1944 pixels and can record high quality videos that supports support 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 format. As show in the below Figure 5.

Figure 5 Camera Module

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6. Software Required

The basic software required for this work in Raspberry – Pi is OpenCV and the programming language adopted here is Python. A real-time programming library for computers and machine learning vision, OpenCV (computer vision Open source) is available for free.[14] It was officially launched in 1999 by Intel Research and currently supported by Willow Garage and Itseez. OpenCV is free for both to use commercial and academic it was designed to be used and provide under an open-source BSD licence. bolster the usage of mechanical perception for commercial products and provide the foundational framework for computer vision applications. The modification of code is easily done in OpenCV. The OpenCV library contains more than 2500 optimized codes and algorithms such as face detect, tracking movements, video capturing, extraction of 3D model of objects, produce 3D points clouds from stereo camera, Hough transform etc. The primary interface of OpenCV is written in C++ but it supports other interfaces also such as C, Python, Java and MATLAB/OCTAVE. The operating systems which support OpenCV are Linux, Windows, Android, FreeBSD, Open BSD and Mac OS. In this system the programming language used is Python. It is an advance computer language which allows expressing the concept with the help of inbuilt libraries.

7. Results and Discussion

Figure 6 Image of the Robotic Vehicle

To create the Robot available for the monitoring and capturing the images of the crop it should move towards the plant which is made possible by wheels attached to the Robot and controlled by Blue Dot application.[15] By controlling the entire Robotic System, the system can reach destination point for performing desired objectives. The system is also integrated with camera to be able to capture the object including the motion data of the object Through which we can save the existence of human being. As shown in Figure 6. The movement of the robotic vehicle is controlled using "Bluedot" android application, Bluetooth will be enabled in both raspberry Pi and Android phone, after establishing the connection between android and raspberry Pi, a blue colored circle will be displayed on android phone. The movement of the robot is founded on the region which is pressed.

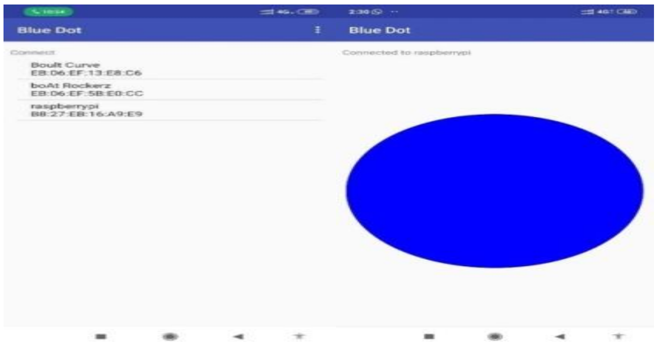

Figure 7 Bluedot Connection Between Android and Raspberry Pi

If the top region of the circle is touched then it will move in forward, direction, similarly if left, right and bottom regions are pressed, the robot will move that direction. The speed of the robot can be controlled by pressing inward regions and speed can be increased by pressing the edges of the circle. As shown in Figure 7 &8.

Figure 8 Sensor Readings on OLED Display

Distance and Temperature is displayed on OLED screen when LIDAR starts to perform its task is show in Figure 9.

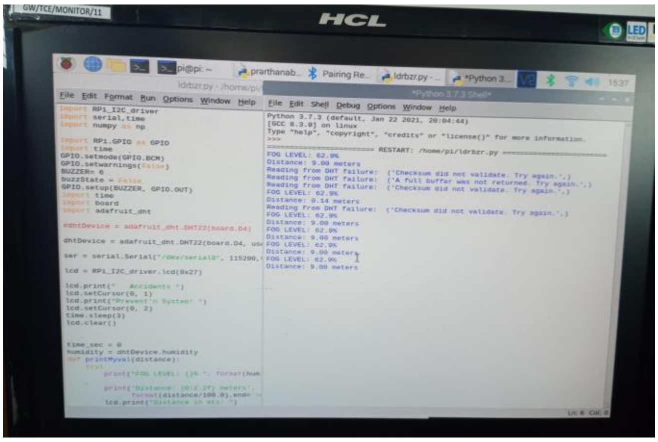

Figure 9 Snapshot of The Output

8. Future Scope

The following shows the advancement that able be done to improve the detection technology. vehicle detection in fog using LiDAR technology is promising and has lots of potential to use in a range of automotive industry and beyond. A Some of the important areas of future development and **application include:** Improved accuracy and reliability: Continued advancements in LiDAR technology will lead to higher resolution sensors, better signal processing algorithms, and enhanced data fusion techniques, resulting in more accurate and reliable vehicle detection in foggy conditions.

Application in smart cities: LiDAR-based vehicle detection systems can be deployed in smart city infrastructure to monitor and manage traffic flow, optimize transportation systems, and enhance overall urban mobility. This can lead to more efficient transportation networks and reduced congestion in urban areas.

Environmental monitoring: LiDAR technology can also be applied to environmental monitoring tasks like tracking and identifying vehicles in foggy conditions to assess air quality, emissions, and pollution levels. Policymakers can benefit from this data make informed decisions to improve environmental sustainability.

Conclusion

This project explains a novel static road side technology intended to identify potential obstructions and avert collisions. Specifically, a computer vision system that uses infrared system detects and classifies moving obstacles to be able to trigger an alert in case some potential risk is proposed. The system is capable of work with different illumination and weather conditions. The proposed solution requires a single camera which can be fixed on the roadway side or placed onboard a vehicle or high-speed sensors. Our approach provided visibility range estimates that are close.

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