Obstacle Detection Using Microwave Radar Sensor *

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***Abstract*— The detection of infirmities (obstacles) is a critical issue for driver assistance systems and driverless vehicles. vehicle navigation tasks, and it must be performed with high reliability to avoid collisions with cars in front. Because motorway infrastructure is limited, vision-based obstacle detection systems are deemed promising. However, the deployment of this system in passenger vehicles necessitates precise and dependable sensing. An obstacle detection system based on mi-crow radar sensors is created in this research. Following the first detection, the system employs an obstacle tracking algorithm. The suggested system can identify obstructions in front, such as leading cars and vehicles crossing the lane. The sound of a buzzer may then be used to detect whether or not there is an obstruction within a radius of 5 metres. The suggested obstacle detection system is installed in a passenger automobile, and its performance is tested. To obtain more favourable results, we tested it on a real bicycle or two-wheeler on the road in this study. *Index Terms*— Doppler effect, Obstacle Detection, Radar, Sensors, Microwave Radar Sen-sor, Wireless Sensor Network, Object Detection**

1. Introduction

The research community has carried out extensive studies on driver assistance systems over the past thirty years in an effort to reduce the frequency of traffic accidents and their effects, thereby enhancing passenger safety. In order to de-termine whether a vehicle's trajectory is unsafe as well as to shield the driver from potentially hazardous barriers, the system can provide vehicle and absolute road obstacle localization. In order to prevent any potential collisions with the front car, obstacle identification is a major issue for both driver assistance systems and autonomous vehicle guidance. Vision-based obstacle detection systems are popular because they need less roadway infrastructure seen as potential threat for this use. However, accurate and reliable sensor performance is needed for these systems to be practical in passenger cars.

One of the main goals of an autonomous car is to detect obstacles and maintain awareness of the lane and route. Front and/or rear mounted ultrasonic sound sen-sor bumpers are used in an obstruction detection system. In the immediate vicini-ty of the front or back bumper, these sensors can gauge the separation between your vehicle and nearby obstructions. Beeps on the dashboard display warn the driver.

In this project, an Arduino-based obstacle detection system will be constructed. The RCWL Microwave Radar sensor and buzzer are the major components of this system. The sensor transmits the obstacle's detection to the buzzer when it is be-tween three and five meters away. This solution can aid us in preserving a secure driving environment. The technology can provide vehicle and absolute road ob-stacle localization to determine whether a vehicle's trajectory is risky and to shield the driver from potentially hazardous impediments.

2. Literature Review

Laser scanners are ideal as a separate sensor system or as an addition to an existing system. IBEO has released the LD A AF, a low-cost, simple-to-use sensor with a wide range and high accuracy. This sensor produces high loop images. It includes signal processing, object recognition, and tracking techniques. This application converts measured data into objects with characteristics such as size and speed. Objects are sent to the host computer over the CAN interface. [1]

The field of vulnerability detection is very broad and diverse. Almost all obstacle detection systems use a combination of passive and active technologies, and the best solution is generally achieved by using a vision system combined with a range sensor such as radar or laser. Perhaps the cheapest system is a system that only integrates the vision system, but the disadvantage in this case is the lack of distance information. Fault detection systems have been developed in this area in recent years. [2]

A quick assessment of TVWS technology using the SLEPT model reveals that the technology is socially acceptable, legal concerns exist in some countries, economic models are the way ahead, and current research topics are TVWS technology's major emphasis. Many technological obstacles confront TVWS technology in the absence of political intent based on spectrum liberalisation. [3]

OD may be accomplished utilising readily sensors available, such as monocular cameras Currently in use computer vision techniques, such as Convolutional Neural Network (CNN), can be integrated with deep learning technologies to create vision-based autonomous driving systems. [4]

We present a brief overview of stereo vision-based obstacle detection in this paper. methods defining and comparing the most interesting concepts for intelligent ground vehicles To present an overview of this strategy, it was chosen to limit the research to algorithms that have made important contributions in unsupervised real-time trials. [5]

In most agricultural robotics, To travel effectively, the robot vehicle must identify obstructions in its route. In the table, the data gathered by Kinect shows obstacle detection from the sensor and the suggested technique. We shown that the system produces acceptable results (all obstacles are identified with only a few false positives) and is fast enough to operate on many computers. [6]

an new approach for surface and obstacle detection is presented. The high accuracy of the method allows to identify road islands as a separate class. The 3D data obtained from the solid stereo is converted into a digital elevation map that is rectangular (DEM). There are two classifiers proposed: density-based and over-path. The proposed real-time algorithm has been tested in urban settings and could be used in a variety of sophisticated applications such as collision avoidance and traffic planning. [7]

Hyperboloid mirror image sensor for mobile robot visual navigation. It's called The HyperOmni Vision. This sensor system is capable of use hyperbolic mirrors to obtain an omni-directional view of the robot's surroundings in real time. We present a prototype of a mobile robot system with HyperOmni Vision and a method to estimate robot motion and detect unknown obstacles. [8]

Vehicle monitoring, medical applications, robotic motion control, etc. Many applications use distance measurement of an object. This can be done using various sensors - ultrasound, IR, radar, laser, etc. Measurements using ultrasonic sensors are the cheapest and most reliable among several individuals. In this post, we discuss the use of this sensor in vehicle distance measurement and compare it with a small car prototype using a Raspberry Pi to perform obstacle detection. [9]

This document explains the obstacle identification and tracking algorithm used for Boss, the 2007 DARPA Urban Challenge winner from Carnegie Mellon University. We explain the surveillance subsystem and demonstrate how it works within the context of the wider system. sensory system. The surveillance subsystem allows the robot to understand complex collision-avoidance driving scenarios to safely operate near other vehicles. [10]

This study discusses waveform design, various radar architectures, estimate methods, implementation complexity and resolution, and adaptive processing for complicated settings. Car radars have particular issues, such as pedestrian detection. This review article, we think, draws together some contributions to the literature to give an initial starting point for new researchers as well as a bird's eye view of the existing research community. [11]

Two types of vision-based methods are discussed, namely (a) visual approach (b) stereo vision-based approach. The questionnaire also discussed other approaches described above. The survey discusses the characteristics of SURF and SIFTS, analysis of related works in the literature, monocular vision-based approaches, texture features, and ground plane obstacle detection. [12]

This article reviews the latest developments using Doppler radar sensors to find a person living in dust or behind a wall. This is a non-invasive method of locating people and employing microwave sensors to measure vital indicators such as breathing rate and heart rate. Researchers in this subject have recently created several hardware designs, signal processing techniques, and integrated systems. The objective is to increase vital sign detection and location accuracy while reducing energy use. [13]

With the rapid progress in the field of autonomous driving, the need to develop new systems and improve existing obstacle detection systems. In this paper, we propose an intelligent obstacle avoidance system with navigation capabilities for obstacle avoidance and collision. The system uses X-band Doppler RADAR to detect moving objects. Doppler radar is primarily a special radar that uses the principle of the Doppler effect to generate velocity information about distant obstacles or objects. [14]

Human-related research is playing an increasingly important role due to the emergence of applications that include search and rescue, security and surveillance, and other critical operations. Radar offers several distinct advantages over other technologies. Below are emerging applications of radar sensing in smart home health and human biometrics. [16]

Autonomous vehicles represent the future of transportation systems that promise to improve road safety. As significant progress has been made in adopting automated environments, detecting roadblocks remains a major challenge. We test our approach on the OLIMP database, which contains complex environments with varying driving conditions and class symbols.The results obtained show that the LSTM-based system is superior to the implemented methods in terms of obstacle detection. [17]

3. Proposed Methodology

In this project, we used microwave radar sensors to detect an obstacle for a car or motorcycle. To start with the methodology, the microwave radar sensor is connected to the Arduino and the power is supplied by the laptop device. Whenever it detects any obstacle within a range of about 5 to 7m, it will display "OBSTACLE DETECTED" on the Arduino uno's serial monitor. Similarly, if no obstacle is present within a given radius of 5 to 7 m, the Arduino uno's serial monitor will display "PATH IS CLEAR".

On the other hand, we also tried to do this project by experimenting with a buzzer for beeping and a battery for power. In this second part of the project, the battery will be connected to the radar and buzzer. Whenever there is an obstacle around the above radius, the buzzer will start beeping and stop once the obstacle is outside that radius. This proposed methodology is useful for vehicles such as cars, bicycles, etc Fig

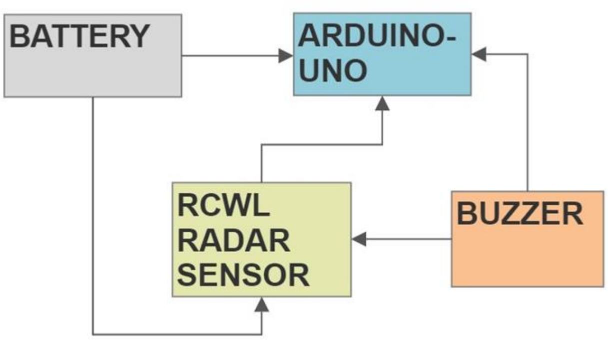


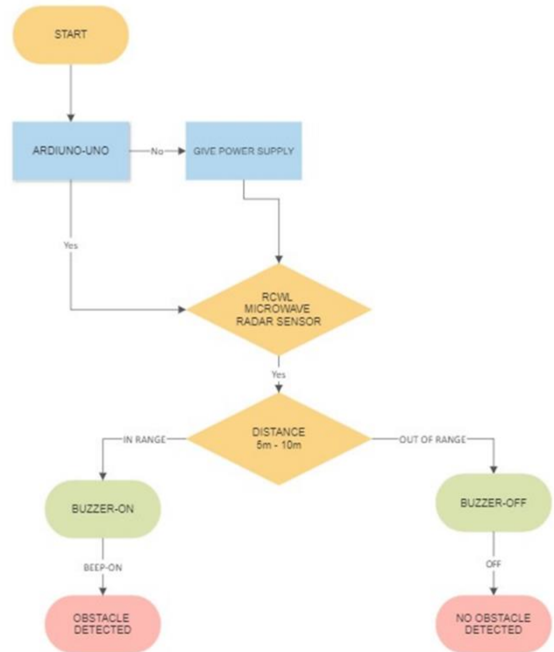
Fig. 1. Block Diagram Representation

1. represents block diagram and fig 2. represents the flowchart of proposed method.

Block Diagrams

4. Results & Discussion

Obstacle detection using microwave radar sensor gives a visual output by indicating an obstacle well in time rather than driving aimlessly. Obstacle detection uses sensing devices such as Arduino, radar sensor, buzzer and battery etc. to determine where the obstacle is and aware the driver in advance. Detecting an obstacle One of the key goals of an



autonomous car, Hence the driver will get to know about the obstacle [illegible] the people s [illegible] nts real time implementation of the proposed method.

Fig. 2. Flow-Chart Representation

Fig.3-a: Real Time Analysis of Obstacle Detection from the front side of vehicle.

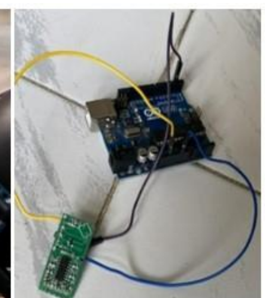


Fig.3-b: Circuit of Obstacle detection, duino connected with RCWL icrowave radar sensor.

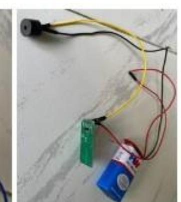


Fig.3-c: Circuit of Obstacle detection, Sensor connected with buzzer.

Fig.4-a: System is mounted on the two-wheeler vehicle in the front side.

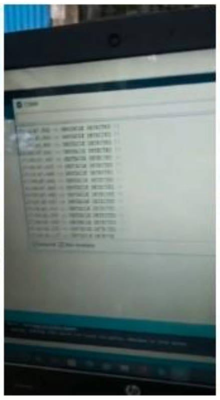


Fig.4-b: Visual Represent of obstacle detected in the front side of vehicle

Fig.4-c: Obstacle as a car in the front side of vehicle mounted with the system

5. Future Scope

As we have two type of Driving system to apply the obstacle systems are: Active (Driver Assistance Systems: DAS) and (2) Passive. Collision avoidance systems, automated braking, adaptive cruise control, and lane departure warning systems are examples of active systems, whereas passive systems often include seat belts, air bags, crumple zones, and laminated windshields. As a result, obstacle detection and track detection fall under the umbrella of active vehicle safety systems.

Sensor-based approach

(1) The sensor-based technique is the most frequent and commonly utilised strategy for both obstacle identification and track tracking. In the literature, a variety of sensors and associated technologies have been addressed. addresses practically all general types of sensors used for collision avoidance, including as acoustic, radar, laser/LiDAR, optical, and sensor fusion. It also addresses their benefits and drawbacks. Sensors can be broadly classified into two categories: (1) Co-operative sensors and (2) Non-co-operative sensors. The most commonly used sensors in autonomous vehicles are LiDAR and RADAR that are discussed below:

(2) **LiDAR sensors**
For obstacle identification and tracking, a 2D laser sensor is employed. In, an autonomous obstacle detection system that combines 3D Light Detection and Ranging (LiDAR) and 2D image data for efficient inter-distance and anti-collision management was introduced. A downward-looking LiDAR sensor was employed in a more advanced road border and obstacle identification technique. Another study presents a LiDAR and wireless sensor-based real time obstacle detection method.

(3) **2.2 RADAR sensors**

Many studies have been conducted on the use of radar sensors for obstacle detection, as well as the use of vision and radar data fusion systems for ground-based navigation, as well as the use of radar and vision sensors for accurate obstacle detection.

Camera-based approach

The camera-based technique is the second most prevalent way for recognising the track and obstacles in autonomous cars. Although some academics consider it a subcategory of sensor-based approaches, it has been presented as a separate category due to the diversity and breadth of camera-based detection systems.

Camera-based detection approaches are divided into three categories: (1) knowledge-based detection, (2) stereo vision-based detection, and (3) motion-based detection. These categories have been outlined in, identification and tracking of obstacles is done using a camera installed on a vehicle with the goal of assisting the driver. outlines two approaches for monitoring people and things using an autonomous UAV:

Bio-inspired approach

(1) A somewhat unusual and unique strategy is to employ a monocular camera to emulate human behaviour in vehicle obstacle identification and avoidance. It is a sub-category of camera-based techniques, but due to its uniqueness from traditional camera-based approaches, it has been presented as a separate category. Similarly, presents a bionic vision-inspired technique that employs radar and visual data.

Computer-vision-based approach using PID controller

(1) A mechatronics system comprised of a PID controller that predicts and controls the vehicle heading angle in order to avoid obstacles is another approach discussed in the literature.

Laser scanner-based approach

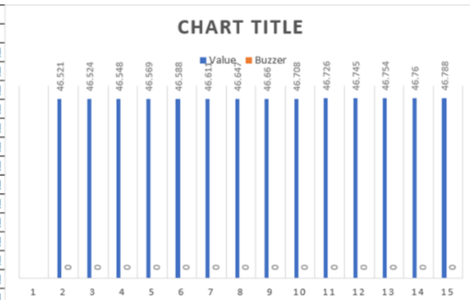
(1) Some research show the use of a laser scanner/rangefinder to detect obstacles in an outside area. In situations such as diverse weather conditions (e.g., sun, rain, and fog), and different road appearances, this method surpasses frequently used camera-based

vision algorithms (e.g., clay, mud, gravel, sand, and asphalt).

6. DataSet & Implementation

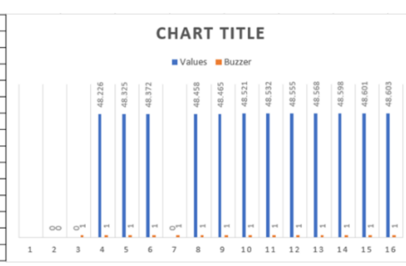
We attempted to provide a graphical representation of the dataset and accuracy in this part. The dataset is classified into three major categories. The first column contains the values or distance of the sensor from the obstruction, which allows us to assess if the path is clear or whether there is an impediment present. The last column mentions whether or not the obstruction is present as "way is clear." The buzzer column in the centre signifies 0 and means that there will be no beeping of the buzzer because there is no impediment present at that time.

Sr no:	Value	Buzzer	State
1	46.521	0	Path is Clear!
2	46.524	0	Path is Clear!
3	46.548	0	Path is Clear!
4	46.569	0	Path is Clear!
5	46.588	0	Path is Clear!
6	46.611	0	Path is Clear!
7	46.647	0	Path is Clear!
8	46.66	0	Path is Clear!
9	46.708	0	Path is Clear!
10	46.726	0	Path is Clear!
11	46.745	0	Path is Clear!
12	46.754	0	Path is Clear!
13	46.76	0	Path is Clear!
14	46.788	0	Path is Clear!



In this part, we attempted to provide a graphical representation of the dataset and accuracy. The dataset is classified into three primary columns. The first column contains the values of the sensor's distance from the obstruction, which allows us to assess if the path is clear or whether there is an impediment present. The last columns specify whether or not the obstruction is there as "obstacle detected." The centre column, buzzer, represents 1, indicating that the buzzer will beep if an obstruction is present in that radius.

Sr no.	Values	Buzzer	State
1	48. 276	1	Obstacle Detected
2	48.226	1	Obstacle Detected
3	48.325	1	Obstacle Detected
4	48.372	1	Obstacle Detected
5	48. 425	1	Obstacle Detected
6	48.458	1	Obstacle Detected
7	48.465	1	Obstacle Detected
8	48.521	1	Obstacle Detected
9	48.532	1	Obstacle Detected
10	48.555	1	Obstacle Detected
11	48.568	1	Obstacle Detected
12	48.598	1	Obstacle Detected
13	48.601	1	Obstacle Detected
14	48.603	1	Obstacle Detected



7. Conclusion

We tried two models, one of which was a buzzer, in that if an object comes into range of the radar, the buzzer beeps. and in another model, we have tried to de-velop a circuit and implemented its real test on a two-wheeler to get real time and accurate results whether the object is detected or not on the laptop screen.

Temperature calibration feature: The speed of sound is known to vary with tem-perature. 331.5m/second at 0°C. 3555 m/s at 40°C. When we measure the dis-tance, we estimate the speed of sound in air to be 343 m/s, only at 27°C. If the temperature is different during the measurement, the measured distance is obvi-ously inaccurate. This shortcoming can be easily corrected by adding a tempera-ture measurement circuit to the module and the calculation for the distance measurement can be modified accordingly.

Range improvement: An option is possible to increase the extraction range.

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