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Obstacle Detector using Camera and Laser Line Generator

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Abstract: **Obstacle detection has been the focus of most research during the last few decades. One of the most important problems in computer vision having a wide range of applications such as surveillance, security, medical applications, etc. the researchers have focused on colored images where lighting is an important factor for images. Therefore, capturing a scene and detecting the objects is imperative. A laser and camera is essential in such a case. Military and civil users can use such techniques to navigate. The proposed system will be able to take in live feed from webcam and highlight areas where there are obstructions in the path and rest of the area will be termed as free space. It will make use of a laser line generator which will be helpful in detecting the proximity of the obstruction. Hence, in this paper we made an attempt to present an effective model for obstacle detection using Camera and Laser Line Generator so that the system can be mounted on various devices like robots, cars, helmets etc.**

Keywords: Image processing, Obstacle detection, Camera,Laser Line Generator.

I. INTRODUCTION

Obstacle detection is advancing at a rapid pace. It has gained a lot of attention and has a wide area of applications which includes image retrieval, driver assistance systems, security, surveillance and medical applications. Light has a significant role when the image is colored. The images acquired in this scenario should be utilized to detect and classify objects. Many computer vision applications that use image processing techniques rely on obstacle detection and tracking. A procedure in which an input image is turned into information is known as image processing. The primary goal of all image processing algorithms is to identify the item in question. Images are now stored digitally. It's crucial in a lot of computer vision applications that use image processing techniques.

To fulfil the industries requirement it has become mandatory to build automatic robots, which can move from one work station to another by avoiding obstacles coming in the path. To avoid this issue, Bot was built. This technology is used everywhere from industries and home appliances. This application can be used at places, where human intervention is difficult or signals are weak to communicate and observe. By storing the visuals of the path, it can examine the surrounding and better action can be taken.

The transformation of an input image into information is known as image processing. The primary goal of all image processing algorithms is to identify the item in question. The vast majority of images are now digitally preserved. The system combines visual object detection and a warning mechanism to examine this data. The object scene is taken by a low-cost camera mounted on the front of an automobile, according to the present invention. The picture is captured as an RGB image by the camera, which is then transformed to grayscale by image processing algorithms.

II. RELATED WORK

In the past decades, there have been various researches on obstacle detection with varying technologies like infrared sensor, ultrasonic sensor and others. Several papers and projects have focused on issues such as ultrasonic sensors, which are used to determine the distance of obstacles such as potholes or humps and warn the driver so that he can reduce his speed manually or by the automobile itself using Adaptive Cruise Control (ACC). However, because sound travels at a slower rate than light, light sensors can respond quickly and be queried more frequently. They can be manufactured very compact and watertight, which ultrasonic can't do [1]. This study by Anusha was proposed well but light is much faster than sound and in such cases a fraction of second is also crucial. A procedure in which an input image is turned into information is known as image processing.

The basic goal of all image processing algorithms in this study is to identify the item under examination. In 2017, an outlined and important survey of Image Processing for detecting obstacles was presented, in which two types of vision-based techniques were discussed, namely (a) Monocular vision-based approach (b) Stereo Vision-based approach, and the direct Image Processing is largely influenced by changing surrounding environmental conditions. [2].

The technique of detecting real-world items in a given picture, series of photos, or video is known as object detection. Object detection is critical in the realm of surveillance and security. Light plays an instrumental role in the case of colored images. Due to the focus on surveillance and security, image capturing may also be done in dark situations. Object detection and classification should be performed on images captured in

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this scenario. Infra-red images play an imperative role in such scenarios. Infrared imaging and thermal imaging play a vital role in darkness. As the body produces heat, everything emits rays that are invisible to the naked eye. The design and usage aspects of a low-cost knee-above obstacle detection system using directional ultrasound-based sensors for obstacle identification were also examined. Balakrishnan's solution was quite practicable, however the cane can only detect obstructions within 2 metres of the user, which is extremely risky. [3].

Using a single onboard camera that is backed on a cruised car in real-time for trainer assistance, the proposed algorithm recognizes all barriers on path. When a barrier appears in front of a moving vehicle, the morphological penetrating before the driver help scheme warns the driver to avoid an accident. The findings of the experiments point to a potential possibility for finding expressway obstacles. But with this system the client is still in danger of fatal accidents because of a mere warning. If the driver is half asleep then he might miss the signal and end up with crashing the vehicle [4].

An Obstacle Detector is made up of an infrared sensor that sends out a signal that bounces off the surface of an object and is received by an infrared receiver. The major problem is that it only supports low data transfer and a small range, which is inconvenient for large-scale application. [5].

Computer vision and image processing is a rapidly growing field, partly as a result of both cheaper and more capable cameras, partly because of the affordable processing power, and partly because vision algorithms are starting to mature.

III. TECHNOLOGIES USED

A. C Language

Dennis M. Ritchie created C programming in 1972 as a general-purpose, procedural, imperative computer programming language. It is a simple to learn, widely spoken, and influential language. It was created for designing system programs that communicate directly with hardware components like drivers, kernels, and so on. It is regarded as the mother language because it serves as a foundation for other programming languages. Other languages have inherited syntax and features from C, either directly or indirectly. The C programming language is the foundation for PHP, JavaScript, and other languages, including Java. The C++ programming language is nearly a superset of the C programming language (a few applications may compile in C but not in C++).

B. Laser

A laser pen or pointer is a tiny portable device with a power source (typically a battery) and a laser diode that creates a narrow, low-powered visible light beam to enlighten and draw attention to certain objects. The optical power of the laser, the reflectivity of the surface, and the chromatic response of the human eye all influence the perceived brightness of a laser spot. Lasers are useful because the human eye is particularly sensitive to low light levels.

Figure 3.1: Laser

C. ESP 32 Microcontroller

ESP32 is durable and capable of performing consistently in industrial conditions, with an operating temperature range of -40°C to +125°C. ESP32 is capable of dynamically erasing external circuit defects and adjusting to changes in external conditions thanks to enhanced calibration circuitry.

It may also be utilized as a slave device to a host MCU, which reduces the communication stack overhead on the primary application CPU. The ESP32 uses SPI, SDIO, I2C, and UART interfaces to connect to other systems and provide Wi-Fi and Bluetooth capability.

Figure 3.2: ESP 32 Microcontroller

IV. SYSTEM DESIGN AND IMPLEMENTATION

The proposed system will be able to take in live feed from webcam and highlight areas where there are obstructions in the path and rest of the area will be termed asfree space. To analyze and process scene photos taken by a camera, the camera will be mounted at the top of the site above the center of the site in such a manner that it covers the entire site in front and delivers enough image information. The system developed a representative site model, whose ingredients were gridded squares as a consequence of quantized spatial plane of site, using sequentially

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acquired photos that were altered by image processing, and then it began designing the intended routing path. The camera's input stream will be processed frame by frame.

Image processing:

a. Edge Detection

b. Image segmentation

Based on the input of a laser, blobs will be classified asobstacles or free space.

The data flow diagram for Obstacle Detection UsingLaser and Camera is shown below:

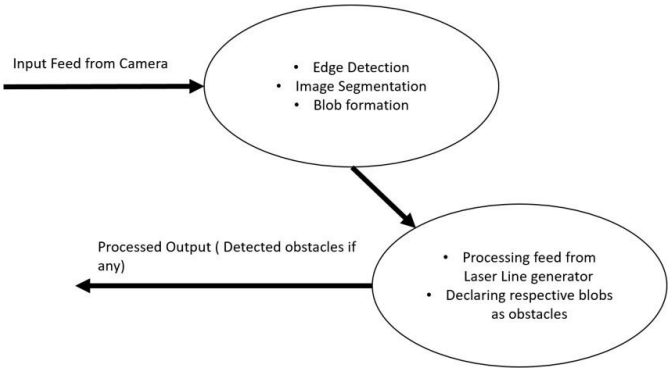

Figure 4.1: Data Flow Diagram

There are three units included Input, Process and Output.

1. Input:

The bot is made to work and simultaneously the microcontrollerwill start and the bot is activated. The Laser which is connectedto Bot which also turns on. The PC or Laptop is switched on and Camera starts to capture. Laptop is used for displaying thedata with the help of Desktop GUI. The UART is used for interfacing laptop and microcontroller.

2. Process:

Once the bot starts and along with it microcontroller is actuated.

Also the laser starts. The bot starts moving forward. While the Bot is moving, when any obstacle comes, laser line breaks. Due to which Laser's position is changed. When the Laser's position is changed, camera captures it and then this data is given to the system and object is detected. The Robot stops after detection of obstacle. This overall mechanism is displayed on Laptop by

Desktop GUI. The UART is used as an interface between microcontroller and laptop.

3. Output:

The result is revealed by the robot itself when it stops after detecting the obstacle. The output of this mechanism is shown on a PC or laptop with the help of desktop GUI. Two windowsare developed with GUI to display the data. One window showsthe Live Image of the process and other window shows the processed image when the obstacle is detected. This overall mechanism is based on Image processing.

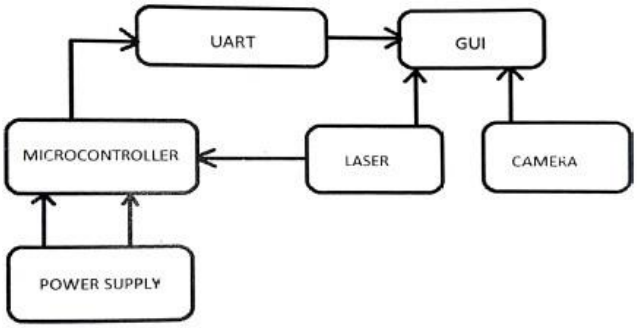

Figure 4.2: System Design

Following test image shows 2D method of object detectionusing 1D laser line:

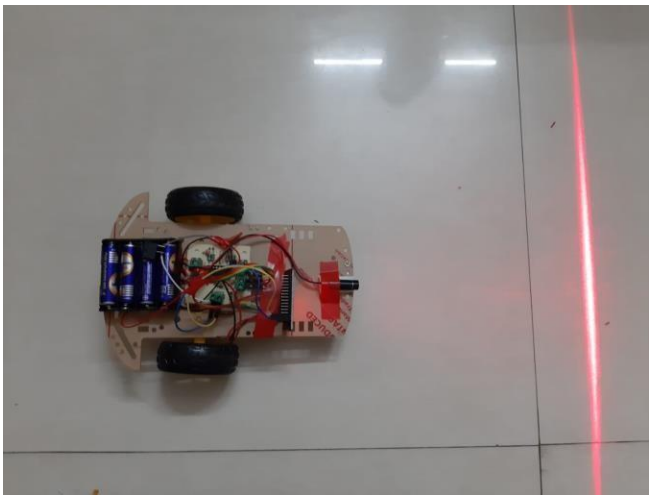

Figure 4.3: Bot with laser line projectionConvolution and Filtering in Image Processing:

Convolution is a mathematical function (integral) between 2 functions which expresses the amount of overlap (area under curve) that is created as one function say f(x) is shifted over another g(x).It produces a third function. F (f *g) which describes how the shape of one function will be modified by the other function. Convolution is the heart ofimage processing. When it comes to image processing the two function f(x), g(x) are replaced with 2 matrices, namelyImage and the filter. The filter is shifted over the image andas we convolve them we can extract certain characteristics from the image.

Depending upon the values of the filter we can extract anumber of operations such as:

- Edge detection
- Region Separation
- Line detection
- Blur
- Noise detection and smoothening

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V. RESULT

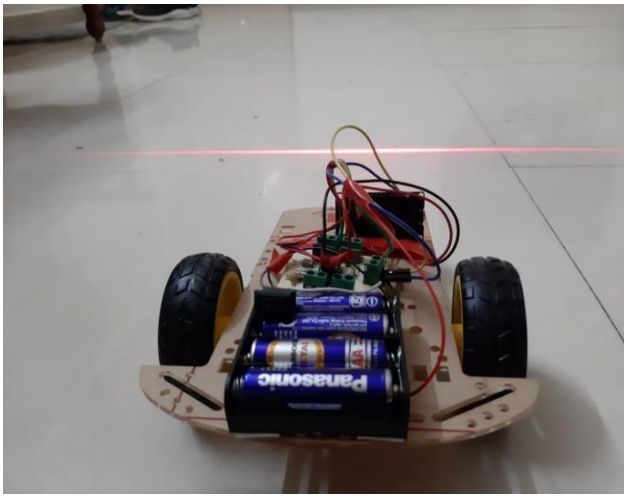

Figure 5.1: Bot moving in path without obstacle

Figure 5.2: Object before laser projection

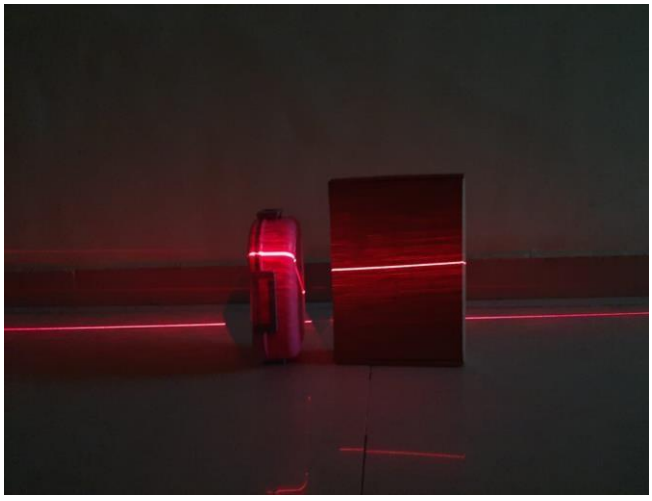

Figure 5.3: Object after laser projection
In the figure, the image of the laser line appearsshifted when hitting an obstacle

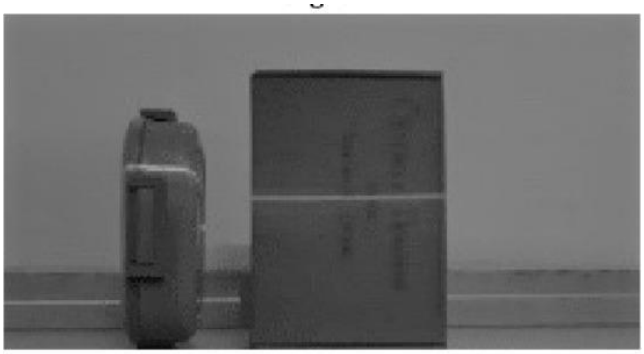

Figure 5.4: RGB to Grayscale Image

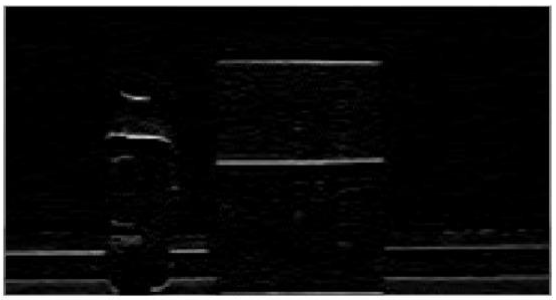

Figure 5.5: Image after Edge Detection

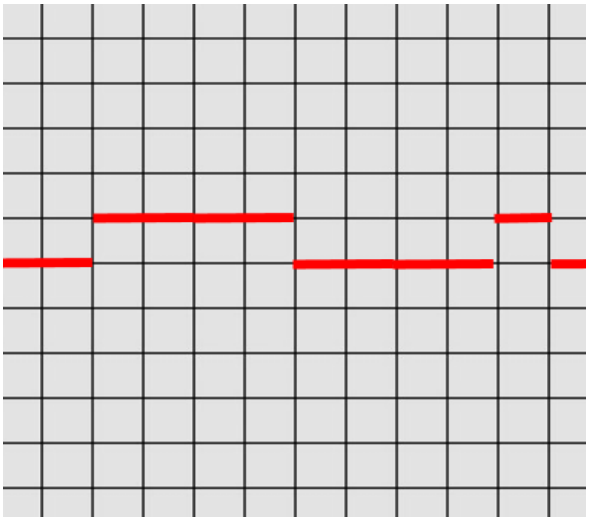

Figure 5.6: Distorted Blob Formed in UI depictingobstacle ahead

VI. CONCLUSION

Most computer and robot vision systems require the capacity to recognize obstacles. Although significant development has been made in recent years, and certain established approaches are now used in a wide range of consumer goods (e.g., face detection for auto-focus in smartphones). We have developed this project from the need of computer vision to how and why todetect objects. The proposed system has been explained in detail with all concepts of object detection and why it is so important in the modern era.

The results obtained were in real time. The object detection program can be implemented to detect and avoid obstacles in case of remote location and other domains. With little more modifications it can be readily used in surveillanceand obstacle detection processes on a large

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scale. When the Robot detects an obstruction, it shifts its position to the left or right and follows the way without human assistance, changing the course path. A microcontroller is simple to program and is a low-cost circuit. Noise is minimized to a greater extent when cameras and lasers are used instead of ultrasonic and infrared sensors. The laser used in this is safe for a human eye,so the overall system is safe for humans to use. Less power isconsumed. The ESP 32 microcontroller used in this project has high speed volatile memory simplify software design andspeed-up execution. The Bot which is used can accommodateenough equipment, so the robot does not require extra space.It is software based so the circuit is simple and convenient toimplement. By doing further modifications, this project can be used for higher level applications."

The concept of image processing is used so noise can bereduced to greater extent and precision is attained. The programming is flexible so any modifications can be done. It is not hazardous to the environment. It's simple to operate and has only been tested over short distances. Maintaining a lengthy range is not suggested since the robot will move forward and backward when it detects any obstruction, even if it is far away. The bot doesn't process pre-programed paths. Whenmodified it can be used by blind people to detect obstacles. By replacing with LIDAR, system can be used to measure the dimension of a particular area. It can be used on a large scale industries like in terrain where human intervention is not feasible.

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