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PC Controlled Car for Terrain Detection

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Abstract: It is difficult to determine the structures like caves where the humans cannot enter. Remotely controlled car can enter in such spaces and can give a user the experience of structure he may be entering, before he could even get into it. The idea behind the proposed system is to show the approximate structure of the area on the system. The user can then study and analyze it for any changes that would occur. We have put forth a method to plot the structure of the terrain using ultrasonic sensors along with the use of Arduino to accomplish this purpose. This paper improvises the way in which it is accomplished.

Keywords: 3D mapping, sensors, terrain detection, Arduino, unmanned car

1. Introduction

In various applications, determining the structure of the geographical area for study or analytical purpose is needed. But, if terrain has zigzag structure then manually measuring the distance is tedious and terrain like caves where humans cannot enter then determining the structure becomes difficult. In such a scenario, the user is unable to do so due to one or more of the reasons like area of the region is too small for the human to enter, risk of health hazards of the user when toxic influents are present in the region, entering the region may endanger one's life, lack of light, manually calculating the distance and plotting on the graph is tedious and lack of accurate readings. There were many solutions built to overcome the problem and accomplish this goal.

In the existing system, a user to study and analyze the terrain structure uses camera held by a car which is controlled by a remote control for the movement of the car and the scene captured by the lens of the camera is displayed on the screen at the user end. This approach unable the user for analytical study as the measurements are inaccurate and at times not clearly visible due to lack of light. Further, the lens of the camera was replaced by the distance sensor to overcome the drawback which proved to work in the absence of light as well. But, this could not detect the close objects as the objects which were at a distance less than the sensor detection range [1].

In this paper, we propose PC controlled car for terrain detection project which is an application to give user an experience of the structure of the terrain, he may be entering before even one could get in it. The application will provide the approximate structure of the region on the system with high accurate readings to study and analyze the terrain which can be used for analytical purpose. PC controlled robotic car with a distance sensor held on it is traversed through the terrain. The sensors provide short to long distance detection which helps in detecting the close objects or obstacles. This overcomes the drawback as it provides high accuracy with reduced time delay, economically feasible and can detect the objects at short distance due to its better detection range than IR sensor.

2. Design

The proposed System is easy to use and simple. The system consist of a GUI interface which will directly interact will the unmanned car which will return the environmental readings to the GUI and the computer will process to form a proper environmental replica of the environment around the car.

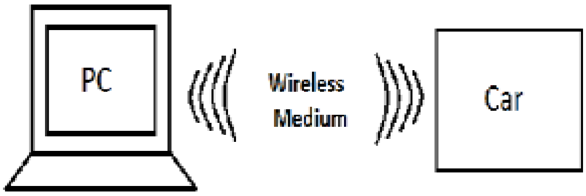

Fig 3.1 Basic design of the system

The diagram depicts the basic view of the system. The PC will send signal to the car and then the car will execute the instruction received and operate accordingly.

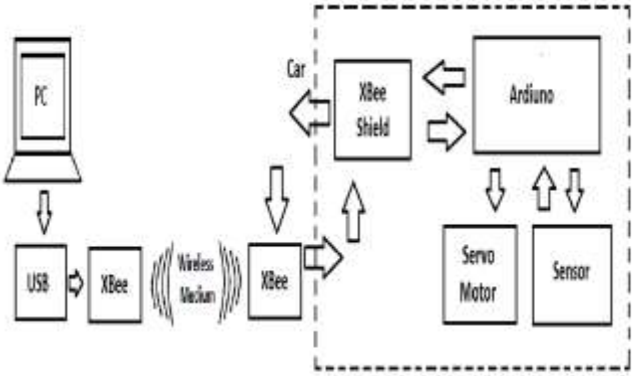

Fig 3.2 Detailed design of the system

The above diagram depicts the detailed diagram of the system.

The Arduino Uno is a micro-controller board intended to build interactive objects or environments. This micro-controller will be used to interact with the car by sending appropriate signals and guide it.

The distance sensors are used to get the coordinates of any obstacle in its way.

Servo motor is used to guide the distance sensor and get the appropriate co-ordinates.

XBee antenna is used as the communicating medium with the car. It provides with a decent range for the purpose.

3. Working

The distance sensor begins by measuring the distance when the servo angle is 0 degree and goes up to 180 degrees, moving 1 unit in the Z axis. On basis of these co-ordinates the terrain structure is mapped on the screen. The robotic version of the car will be remotely monitored and controlled. This will enable the user to study the region and to analyze the terrain for analytical purpose The car would be carrying Ultrasonic Distance sensor which would calculate the distance from the car to the surroundings and would be able to draw layout of the terrain on which the car is present and the User would have a complete understanding of the structure of the place which would be accurate and clear.

4. Flowchart

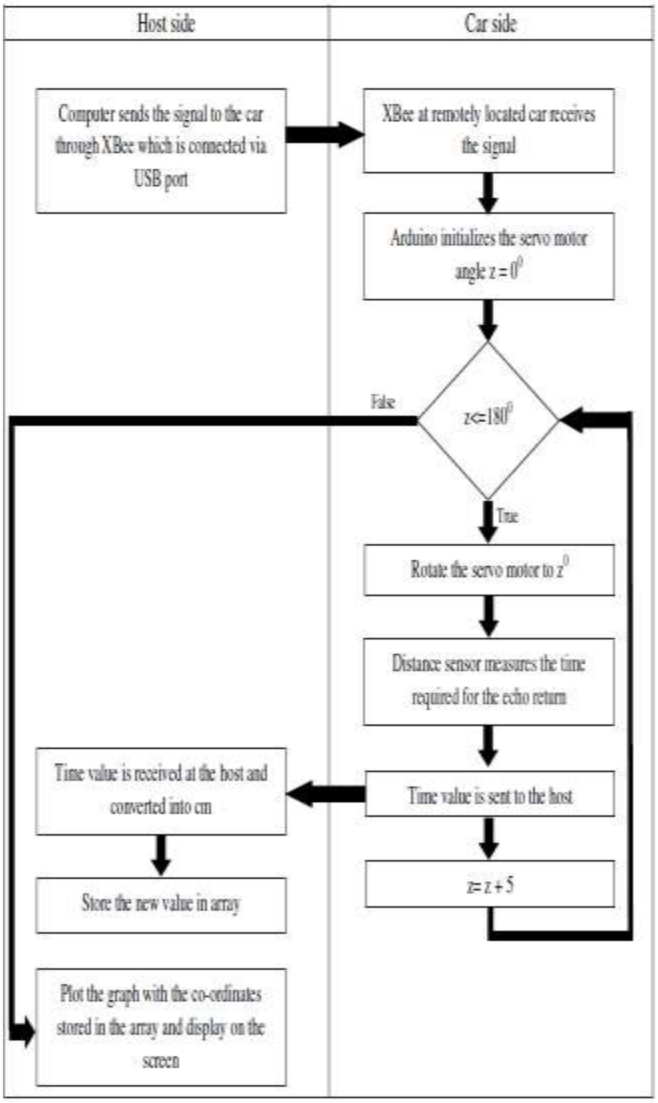

Fig 4.1 Flowchart of the system

5. Hardware and Software Alternatives:

5.1. Hardware:

5.1.1 Infrared Distance Sensor

Fig 5.1.1.1 Sharp GP2Y0A21 Distance Sensor (GP2Y0A21)

The Sharp distance sensors are a popular choice for many projects that require accurate distance measurements. The detection range of this version is approximately 10 cm to 80 cm (4″ to 32″).

The GP2Y0A21 uses a 3-pin JST PH connector that works with our 3-pin JST PH cables for Sharp distance sensors (not included), as shown in the upper picture on the right. These cables have 3-pin JST connectors on one end and are available with pre-crimped male pins, pre-crimped female pins, and with unterminated wires on the other end. It is also possible to solder three wires to the sensor where the connector pins are mounted (see the lower picture to the right). When looking at the back, the three connections from left to right are power, ground, and the output signal.

Feature summary:

- Operating voltage: 4.5 V to 5.5 V
- Average current consumption: 30 mA (note: this sensor draws current in large, short bursts, and the manufacturer recommends putting a 10 µF capacitor or larger across power and ground close to the sensor to stabilize the power supply line)
- Distance measuring range: 10 cm to 80 cm (4″ to 32″)
- Output type: analog voltage
- Output voltage differential over distance range: 1.9 V (typical)
- Update period: 38 ± 10 ms
- Size: 44.5 mm × 18.9 mm × 13.5 mm (1.75″ × 0.75″ × 0.53″)
- Weight: 3.5 g (0.12 oz) [2]

5.1.2 Ultrasonic Distance Sensor

Fig 5.1.2.1 PING ultrasonic distance sensor

This sensor is a high performance ultrasonic range finder. It is compact and measures an amazingly wide range from 2cm to 4m. This ranger is a perfect for any robotic application, or any other projects requiring accurate ranging information. This sensor can be connected directly to the digital I/O lines of your microcontroller and distance can be measured in time required for travelling of sound signal using simple formula as below.

With the time it takes for the signal to travel to an object and back again, we can calculate the distance using the following formula.

$$Speed = \frac{Distance}{Time}$$

The speed of sound is variable, depending on what medium it's travelling through, in addition to the temperature of that medium. However, some clever physicists have calculated the speed of sound at sea level so we'll take our baseline as the 340m/s. We also need to divide our time by two because what we've calculated above is actually the time it takes for the ultrasonic pulse to travel the distance to the object and back again. We simply want the distance to the object.

34000 = Distance / (Time x 2)
17000 = Distance / Time
Distance= 17000 x Time
Therefore, Distance = 17000 x pulse_duration
If the width of the pulse is measured in uS, then dividing by 58 will give you the distance in cm, or dividing by 148 will give the distance in inches.

uS/58=cm or uS/148=inches.

The module works on 5VDC input and also gives an output signal directly for detection of any obstacle up to 4M.

It is suggested to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.

Feature summary:

- Working Voltage : 5V(DC)
- Working Current : 15mA
- Working frequency : 40HZ
- Output: 0-5V (Output high when obstacle detected in range)
- Beam Angle : Max 15 degree
- Distance : 2cm - 400cm
- Accuracy : 0.3cm
- Input trigger signal : 10us impulse TTL
- Echo signal : PWM signal (time required for sound signal to travel twice between source and obstacle)
- Size : 45mm*20mm*15 mm [3]

5.1.3 Laser Sensor

Fig 5.1.3.1 ODSL 30 laser distance sensor

The ODSL 30 has a 1mm optical resolution, providing precise measurement readings. This resolution makes the sensor capable of detecting from up to 65m on bright colored samples, as well as black colored materials from 30m distances. The sensor uses a built-in display to view measurement readings and values in a given application.

The ODSL 30 is a laser distance measuring device with a large area of application. The equipment is available in different versions with analogue outputs, digital outputs, or switching outputs. The distance measurement uses the phase measurement principle. The measurement range lies between 0.2 … 30m. Integrated in the device are a keypad and a two-line LCD display which can be used to program the ODSL 30. During measurement operation, the display shows the current measurement value.

Feature summary:

- Measurement range: 0 ... 30,000 mm
- Geometric resolution: 1mm
- Accuracy of measurement, short range: 2%
- Accuracy of measurement, distant range: 1%
- Measurement time: 30 ... 100 ms
- Supply voltage: 18 ... 30 V, DC
- Light source: laser, Red
- Laser class: 2, IEC/EN 60825-1:2007
- Light spot size: 6 mm [10,000 mm]
- Dimension: 79 mm x 69 mm x 150 mm [4]

Table 5.1.1 Key Differences between IR distance sensor, Ultrasonic distance sensor and Laser distance sensor

Parameters	Infrared Distance Sensor	Ultrasonic Distance Sensor	Laser distance sensor
1. Distance	10 cm to 80 cm	2cm - 400cm	0.2-30m
2. Cost	Cheapest	Costlier but economically feasible	Costliest

5.2. Software:

5.2.1 OpenGL

OpenGL, the standard software interface for graphics hardware, allows programmers to create interactive 2D and 3D graphics applications on a variety of systems. It acts as a layer of abstraction between graphics hardware and an application program. With OpenGL you can create high-quality color images. OpenGL makes it easy to build geometric models, change the viewing position, control the color and lighting of geometric primitives, and manipulate pixel and texture map images. It's a low-level graphics rendering and imaging library which only includes operations which can be accelerated. It provides API to produce high-quality, color images of 3D objects (group of geometric primitives) and images (bitmaps and raster rectangles). OpenGL is an open source application programming interface and does not require any licensing fees for development tools. It also makes the code easier to compile across platforms which makes it to work cross platform (Windows, Linux, Mac, other handheld devices).

5.2.2 MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research. MATLAB has many advantages compared to conventional computer languages (e.g., C, FORTRAN) for solving technical problems. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. It has powerful built-in routines that enable a very wide variety of computations. It also has easy to use graphics commands that make the visualization of results immediately available. Specific applications are collected in packages referred to as toolbox. There are toolboxes for signal processing, symbolic computation, control theory, simulation, optimization, and several other fields of applied science and engineering. MATLAB is a technical language to ease scientific computations. It frees you from coding in high-level languages (saves a lot of time). MATLAB is not an open source tool and therefore requires licensed version. MATLAB can be used in interactive mode or in full compiled version (platform specific mode). In interactive mode MATLAB scripts are platform independent (good for cross platform portability).

Table 5.2.1 Key Differences between MATLAB and OpenGL

Parameters	MATLAB	OpenGL
1. Coding & Development time	Does not use high level languages and hence saves development time.	Uses high level languages and hence development time increases.
2. Cost	Requires licensed version	Open source tool. Hence it is free.

6. Conclusion

The "PC Controlled Car for Terrain Detection" will conquer the drawbacks of the existing system and will prove to be accurate and effective tool to study the terrain with the help of a PC controlled robotic car which holds a distance sensor. It will draw the structure of the terrain through the co-ordinates measured through the distance sensor which increases accuracy. As an ultrasonic distance sensor will be used, the blurring effect is also eliminated. Hence, studying the terrain accurately and ease to control the car through PC is achieved. It also proves to be very useful to protect the health of the user in a case where entering the terrain can endanger ones health and analyzing accurately the structure of the terrain has to be carried out where human cannot enter.

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