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Obstacle Avoiding Autonomous Surveillance Robot

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Abstract - The proposed framework is an economical four wheeled observation robot utilizing an android device and an Arduino uno ATmega328. The surveillance robot comprises of an ultrasonic sensor that is used for obstacle detection, a pir sensor and a Bluetooth module (HC-05). The robot can be controlled utilizing manual mode on the android application or in an automatic mode that utilizes obstacle avoiding algorithms to control its own way. The robot involves pir sensor for intruder recognition and alarm the specific authorities who can then check the anomalies. The robot is remotely controlled with an android application connected via Bluetooth.

Key Words: IoT, Surveillance, Robot, Arduino, Obstacle Avoidance, Ultrasonic sensor, PIR sensor.

1. INTRODUCTION

A surveillance robot is a machine that utilizes sensors and other technologies to recognize its environmental elements and move around its current environment. Security robots move around in a constrained region automatically, with no administrator supervision. Pictures from its inherent cameras are sent to the security station. In the event that a sensor is set off, the robot changes its course and moves to the region of concern.

The rise of surveillance robots is a significant achievement inside the advancement of safety systems — an arising phase of technological improvement that brings the entire industry up to new principles of best practices expected inside the profession of securing individuals and property. Automatic surveillance robots intended for outdoor monitoring can decrease or totally dispose of the need for human guards to guarantee the security of our homes or even immense plots like organizations or workplaces. Security robots are prepared to give the most significant level of safety at an extremely unobtrusive expense.

It is our plan to design and construct a completely feature packed observation robot that has impediment evasion capacities to monitor the premises with least human endeavors and less cost.

The key main points of our proposed system are as follows:

A. Surveillance Robot

Surveillance robot is a sort of robot with the aim to wander around a domain and give sound and video data from the given surrounding, this data is then sent to the client. Clients have some control over the robot in various modes with the assistance of an application or a PC through Internet of Things (IoT).

B. Human Intrusion Detection

A human interruption identification framework is intended to recognize any unapproved passage into the property or a unauthorized space and deny such unapproved admittance to shield the faculty and property from injury or hurt.

C. Obstacle Avoidance

Obstacle evasion is one among the great issues related with autonomous movement of portable robots. It's anything but a reasonable decision to display whole environment in which the robot roams. To move in a dynamic surrounding, the robot must be fitted with an obstacle avoiding algorithm to manage hindrances which were not known in advance. It tends to be utilized for the vast majority various kinds of machines like modern robots, current vehicles, or Drones.

2. LITERATURE SURVEY

Surveillance is a necessary and important security property. A ton of research is done on the systems that exhibit obstacle avoidance property.

The most well-known existing framework incorporates an Arduino microcontroller and an Ultrasonic sensor for obstacle evasion included. This framework is introduced in paper [3] "IOT Based Surveillance Robot". The intruder recognition is an inevitable element for any Surveillance robot.

In paper [1] "Plan and Analysis of IOT-Based Intelligent Robot for Real-Time Monitoring and Control" presents the method for planning and carry out a versatile robot for obstruction identification and evasion in an ongoing premise. The framework is expensive because of Raspberry Pi. The

Raspberry Pi is a complex microprocessor which makes it hard to scale and accordingly is less adaptable.

In the paper [2] introduced "Smart Surveillance Robot", distributed in December 2018 at the First International Conference of Electrical, Communication, Computer, Power and Control Engineering ICECCPCE. The paper centers around plan and execution of versatile robot that can perform: obstacle aversion, face acknowledgment and discovery of burnable gases. They executed face acknowledgment on neural network on a FPAA which builds the intricacy of the framework. The intricate idea of the framework makes it extremely hard for additional upgrade and is exceptionally costly.

In paper [4] "Surveillance and Rescue Robot using Android Smartphone and the Internet" the proposed system is emphasized on the property of rescue rather than surveillance. The application to control the robot is built using zig-bee. The robot can travel on any terrain which enhances the rescue property of the robot. The bulky nature of the robot can be hinderance to movement.

3. ARCHITECTURE

The framework includes two significant sections- the client application and the robot segment. The remote-controlled vehicle is controlled by the clients using a PC or mobile device from a distant area. The robot can be worked in two modes: automatic and manual. The client application has a GUI to control the robot in manual mode or switch the operating mode to automatic mode.

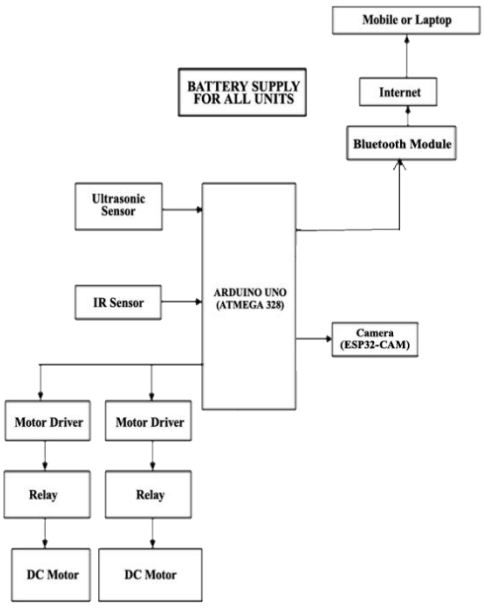

Fig -1: Block Architecture of System

The surveillance robot requires a number of fundamental hardware parts for appropriate working. The fundamental parts utilized in our project and their particulars and functions are as per the following:

A. Arduino Microcontroller

The Arduino Uno board is the handling unit in this robot and is the most essential part. Arduino Uno is a microcontroller board based on the ATmega328P. With the assistance of simple and advanced pins in the regulator the sensor and the engine is operated. The utilization of Arduino microcontroller as opposed to different regulators, for example, raspberry pi or PIC regulators is a direct result of the simplicity of programming any of the Arduino family sheets with something similar programming which is accessible as open source.

B. Bluetooth Module HC-05

HC-05 is a Bluetooth module which is intended for remote communication. This module can be utilized in an expert or slave design.

C. Ultrasonic Sensor

Ultrasonic Sensor has been available for quite a long time and is as yet viewed as a confided in innovation all through the business. The plan of the Ultrasonic Radar is exceptionally valuable for the majority applications like homes, shops, military and article discovery. The point of this work is to fabricate an ultrasonic handset which is fundamentally one sort of a radar framework to get accurate distance and plot for fixed objects put around the gadget in view of the speed of ultrasonic waves in outside.

D. ESP32-CAM

The ESP32-CAM is a little size, low power utilization camera module base on the ESP32. It accompanies an OV2640 camera. The ESP32-CAM is generally utilized in clever IoT applications, for example, remote video observing, Wi-Fi picture transfer, etc.

E. Passive Infrared Sensor

The PIR sensor is used to identify movement using the heat signatures given out by alive objects. PIR only detects the movement and gives a positive signal if heat body has entered the detection area, and a negative signal if the heat body exits the detection area.

F. Motor Driver Module

The L293D is a 16-pin Motor Driver IC which can handle a bunch of two DC engines all the while toward any path. The L293D is intended to give bidirectional drive flows of up to 600 mA (per channel) at voltages from 4.5 V to 36 V (at pin 8!). You can utilize it to control little dc engines. In some cases, it tends to be incredibly hot.

4. OBSTACLE AVOIDANCE SYSTEM

Obstacle avoidance has an utmost important role when it comes to security systems operating in automatic mode. To ensure the robot navigates in a dynamic environment without any hurdles we need it to be equipped with an obstacle avoidance algorithm. The most common obstacle avoidance algorithms used in various robots are:

A. Bug Algorithm

In bug tracking algorithm whenever a hurdle is experienced, the robot completely circles the item to track down the position with the shortest distance toward the objective. Then, at that point the robot leaves the border of the obstacle. The robot begins following the border of the obstacle, and leaves it when it crosses the line segment that associates the beginning point and the objective.

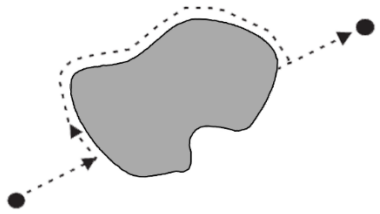

Fig -2: Demonstration of Bug Algorithm

Demerits-

1. Large memory and computation is required which results in lesser efficiency.
2. It is an exhaustive search algorithm.

B. Bubble Band Technique

The Bubble Band technique characterizes a "bubble" containing the most accessible free space around the robot, which can be driven in any path without experiencing a crash. The obstruction avoidance part of the bubble band technique becomes possibly the most important factor during robot movement. As the robot experiences unanticipated sensor values, the bubble band method is utilized to redirect the robot from its initially planned path in a manner that limits bubble band strain.

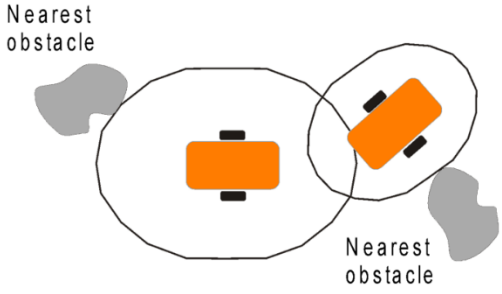

Fig -3: Demonstration of Bubble Band Technique

Demerits-

1. Does not provide smooth operation.
2. It requires a higher-level path planner.
3. It is vulnerable to sensor noise. All the limitations of the sonar sensor affect the operation of this algorithm.
4. Cannot guarantee reaching the desired point.

C. Vector Field Histogram Algorithm

The Vector Field Histogram (VFH) algorithm uses a measurable rendition of the robot's current circumstance through a two-dimensional Cartesian histogram network. The VFH strategy utilizes a two-stage process. In the initial stage the histogram lattice is diminished to a one-layered polar histogram that is built around the robot's area. In the next stage, the algorithm chooses the most reasonable area from among all polar histogram areas with a low polar hindrance density, and the controlling of the robot is lined up with that heading.

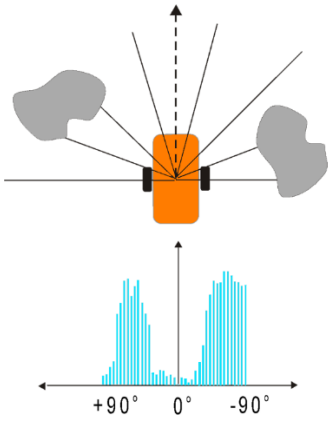

Fig -4: Demonstration of Vector Field Histogram Algorithm

Demerits-

1. It does not guarantee completeness, local minima might not be negotiated.
2. It can be problematic to pass through narrow passages using this method.
3. It does not consider the dynamics of the robot.

D. Potential Field Algorithm

In potential field algorithm, the objective point and obstacle point creates two virtual potential fields, one is gravity field around the objective point, another is repulsive field around obstacle, at last the two virtual potential fields cooperate and become one resultant potential field (similar to magnetic poles). Then, at that point, the robot will move along a way as per the artificial resultant field.

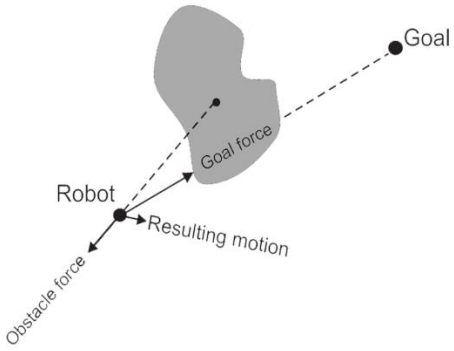

Fig -5: Demonstration of Potential Field Algorithm

Demerits-

1. Robot stops when it encounters a point of local minima.
2. It cannot detect devoid of passage between closely spaced obstacles.
3. Oscillations are an issue when it tries to negotiate with obstacles in its vicinity or passes through narrow passages.
4. This algorithm will be very difficult to use in real time applications.

5. PROPOSED OBSTACLE AVOIDANCE ALGORITHM

The ability to recognize and keep away from obstacles in real time is critical for any execution of the control framework for autonomous vehicles. Tragically, the vast majority of those solutions demand a significant computational capacity, which makes them troublesome, if not impossible, to execute on minimal expense microcontrollers.

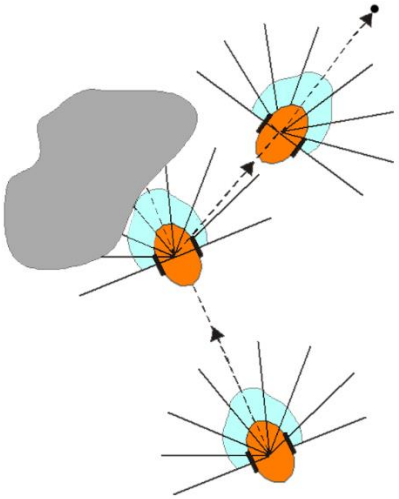

Fig -6: Demonstration of Proposed Algorithm

In our proposed algorithm, we utilize numerous ultrasonic sensors to create a virtual "sensitivity bubble" around the robot. Whenever any obstacle is detected inside the range of sensitivity bubble, the robot bounces back toward a path having the least density of hindrances, and proceeds with its movement toward this path until the objective becomes noticeable, or another obstacle is experienced.

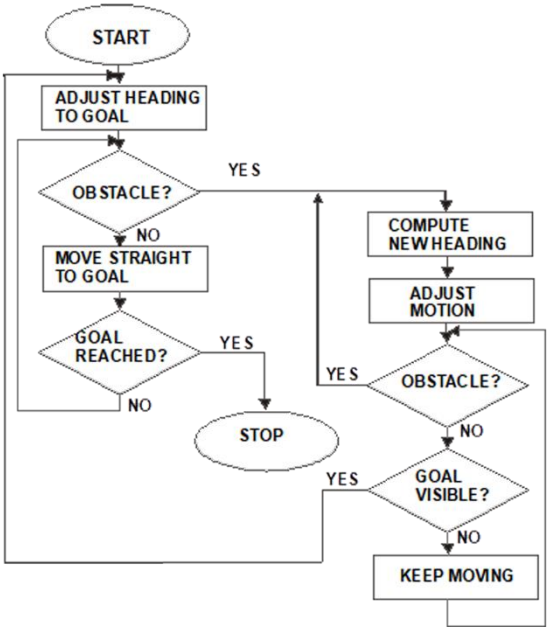

Fig -7: Flowchart of Proposed Algorithm

6. WORKING

The proposed Surveillance Robot uses an Arduino Uno ATmega328P as the microcontroller for all basic computing and sending instructions to further modules. We communicate between the Arduino and the Android Application built using MIT App Inventor, using a Bluetooth module HC-05. The L293D driver module is used to control the direction and speed of 4 DC motor which is being powered by an external power source. For detecting obstacles, we use the ultrasonic sensor module HC-SR04 which is connected to a servo motor SG90 to ensure we check obstacles in multiple directions. We use a PIR sensor module HC-SR501 to detect any intruders or a change in surroundings. Lastly the proposed model uses an ESP32-CAM to send live video feed through a Wi-Fi server.

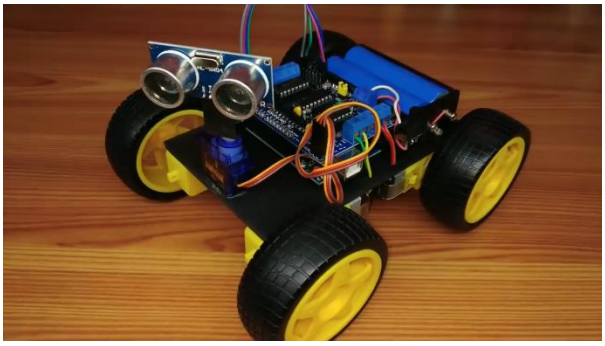

Fig -8: Working Model of Surveillance Robot

Our proposed surveillance robot basically works on two operating modes:

A. Automatic Mode

Automatic mode gets turned on and off by the "Auto On"/"Auto Off" Buttons. In this mode the vehicle drives on its own utilizing a turning ultrasonic sensor to keep away from impediments. Automatic mode can take out the requirement for manual observing and will likewise diminish the hazard of manual mistakes. Detecting and breaking down the exact information from the sensors can likewise save enterprises from disastrous conditions. Robots can do tedious errands without exhaustion that is ordinarily related with people and can prompt gotten to the next level productivity nature of result in activity.

B. Manual Mode

Turning on the framework the vehicle is generally in Manual mode. Here the client can direct the vehicle through stick on the application. By how you can change the moving rate using slide bar. Likewise, the ultrasonic is measuring in case there are deterrents toward the way straight on (the servo engine is turned off in this mode). Accepting you are about the mishap at a divider the vehicle will go aside. Anyway, you should be wary of driving unnecessarily fast.

In Manual Mode sending control requests to the robot's movement part, it is achievable to use the advancement capacity to clearly control the robot, moving it to various orientation at different speed levels, e. g., through a remote gamepad or console.

7. ANDROID APPLICATION

The Android Application is created using MIT App Inventor.

MIT Application Inventor:

MIT App Inventor is an incredible apparatus to acquaint fledglings with Android application programming. The screen is isolated by Design, for format, and by Blocks, which executes the usefulness. In every tab the various parts are separated by type to make them simple to find.

Application Inventor allows you to foster applications for Android telephones utilizing an internet browser and either an associated telephone or an on-screen telephone emulator. The MIT App Inventor servers store your work and assist you with following along of your activities.

Fig –9: MIT App Inventor Interface

You fabricate applications by working with:

• The App Inventor Designer, where you select the parts for your application.

• The App Inventor Blocks Editor, where you collect program obstructs that indicate how it would be ideal for parts to act. You gather programs outwardly, fitting pieces together like pieces of a riddle.

8. CONCLUSION

In this paper, we effectively discussed the system for making a robot for surveillance. We can handle the robot with the assistance of an android mobile/laptop in manual mode. Programmed monitoring is also possible by utilizing an obstacle avoiding algorithm. Our proposed robot is little in size accordingly moving into region where human access is incomprehensible.

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