Dual Mode (Android OS) Autonomous Robotic Car

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***Abstract*— This paper is addressed to build an autonomous obstacle and edge avoider robot i.e. like an autonomous tracing car. The car can run in dual mode that is in autonomous mode and manual mode. It is also suitable for controlling with android OS. Road accident is major problem in our country. The total system is able to avoid any danger obstacles and edge falling. I think it helps to minimize hill side road accident. This system developed by some sensor fusion. Here different types of sensor like infrared, ultrasonic sensor and camera module are used for obstacle avoiding and edge detection purpose. Wireless communication interface is used to operate it manually with android OS. This paper focused on simplicity and flexibility of the robotic car.**

***Keywords*— Ultrasonic, IR, Bluetooth, servo, arduino, slave, interface, andriod OS, GPS, RADAR.**

I. INTRODUCTION

For robot autonomy, it is very important to use different types of sensor. An autonomous robot has to face new environment continuously. Human has sense which can help to collect information from environment where an autonomous robot is unsupervised. So it has to collect information from environment using sensor. It is not easy to make a robot which is automatically performed a specific task because only one sensor is not enough. Sensors combination is needed for perfect operation. No robot can run perfectly by using only one sensor [1]. Here many sensors are used like infrared radiation, ultrasonic sound radiation and camera. The path finder decision is very important in this term. This process is done in various robots with complexity. But simple sensor fusion is effective in this operation [3].

There are different types of sensors available such as, infra-red sensors, ultrasonic sonar sensors, LIDAR (Light Detecting and Ranging) [5, 6], RADAR (radio detection and ranging) [7-9], vision sensor etc. For obstacle detection and avoidance, many of the above sensors can be used to generate a map of the local environment. In range based detection sensors scan the area for collecting proper information from environment.

A. Why Autonomous Robot Car is needed

Autonomous robot plays a vital role in our modern life. This system is helpful for ensuring a specific task where humans often make some mistakes. Suppose road accident is a very familiar topic in our country. To minimize this type of accident autonomous robot car can help us. Not only in road track but also in industry, rescue field, for searching difficult task like nuclear research, natural disaster and other sections

B. Related Works

Robot autonomy system is very familiar. In some research autonomous system are based on RADAR technology which are used to observe environment and maps [5]. To avoid obstacle and sharp edge many systems are used in different drone copter, such as military car etc. In another research, system developed by technology system which helps robot to generate map [4]. On the other hand, some researcher has been developed by stereo camera and radar to accurately estimate the location, size, pose, and motion information of a threat vehicle with respect to a host vehicle. The goal is to detect and avoid potential collision. To do that first fit the contour of a threat vehicle from stereo depth information and find the closest point on the contour from the vision sensor. This system also used in different type of autonomous rescue robot, drone copter, autonomous robot car etc. In this system image processing plays a vital rule.

II. SYSTEM DESIGN

whole system is divided into several parts. The main part is processing unit where Arduino (contains ATmega microcontroller) motherboard is used. Sensory unit reads data from environment and sends it to microcontroller for processing. A servo motor used for scanning left to right or right to left. Servo scan performs when sensors detect any object or edge to find out a suitable road. In manual mode, Bluetooth module receives instruction from android OS device. Then robot moves to desire position. The camera module sends real time video to PC or android OS. The interface system between camera and pc is based on Bluetooth.

In autonomous mode the major task is obstacle detection and then decision making [1]. To avoid an obstacle at first robot must have to identify the obstacle , find out the distance of object and then required a certain angle starring. For obstacle detection, ultrasonic or infrared sensor plays a vital rule. These types of sensors also measure distance. Sonar sensor is suitable for both indoor and outdoor travel where infrared sensor has some limitation.

A. Page Layout

At first sensor read data from environment and send data to microcontroller. Servo helps to scan environment. Motor driver take instruction from controller and drive motor. In manual mode android OS sends instruction to controller unit and then perform task as desired. The camera sends real time video from environment. This whole system can express as follows in figure 1.

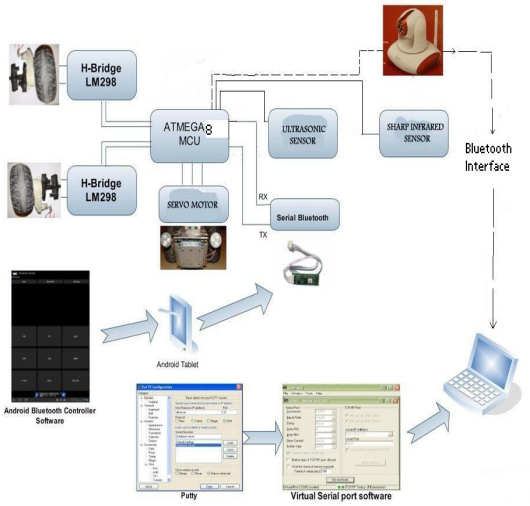


Fig. 1 Block Diagram of proposed system

B. Ultrasonic Sensor (Sonar Sensor)

An ultrasonic electric telemeter module can measure a distance within 0.03-3M effectively [12] and transform the data into impulse with different width. By employing ultrasonic intelligence software processing technology, the reliability of measurement as well as the capability of anti-jamming has improved. Sensor sends a brief chirp with its ultrasonic speaker and makes it possible for the BASIC Stamp to measure the time it takes the echo to return to its ultrasonic microphone. The BASIC Stamp starts by sending the sonar sensor a pulse to start the measurement. Then, the sensor waits long enough for the BASIC Stamp program to start a PULSIN command. At the same time the sensor chirps its 40 kHz tone, it sends a high signal to the BASIC Stamp. When the sensor detects the echo with its ultrasonic microphone, it changes that high signal back to low. The BASIC Stamp's PULSIN command stores how long the high signal from the sensor lasted in a variable. The time measurement is how long it took sound to travel to the object and back. The duration of high level T3 will be ensured by the distance between the object and the telemeter. The host computes the distance though the impulse width input by the electronic eye module:

$$S=(V*T3)/2.$$

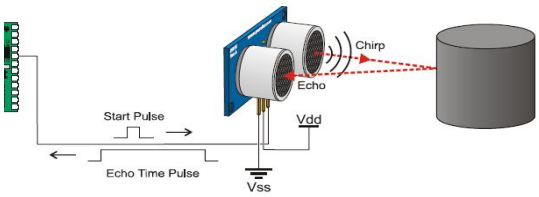
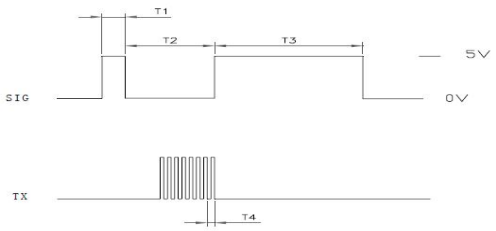


Fig. 2 Working of Sonar sensor.



T1 (Trigger): >5µs
T2 (Postpone): 200µs
T3 (Pulse width): 0-19.5ms
T4 (Cycle) : 25µs

Fig.3 Signal for detecting obstacle.

C. Sharp Infrared Sensor(IR Sensor)

This sensor helps also used for detecting an edge with its proper depth. It's contains high quality sharp infrared ray transmitter led and a receiver led. In this case signal processing circuit process this signal and measure distance of surface with the help of algorithm [13].

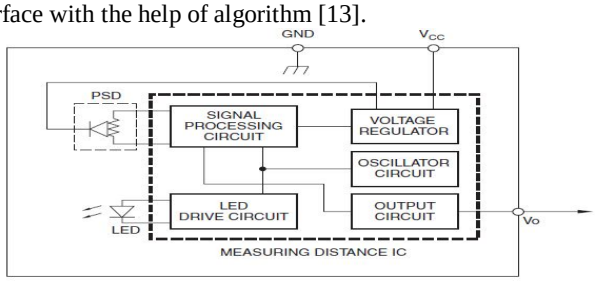


Fig.4 Block diagram of Sharp IR sensor.

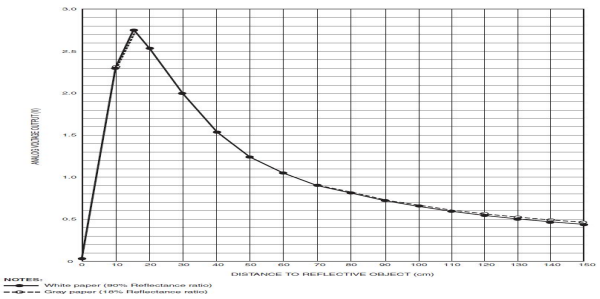


Fig.5 Performance diagram of Sharp IR sensor(In Gray and White surface).

D. Servo Motor

When an object detect then its need to find out a road which may be left or right. In this operation servo helps to view from different angle. There is a minimum pulse, a maximum pulse, and a repetition rate. From Fig.6 servo motors can usually only turn 90 degrees in either direction for a total of 180 degree movement [11]. The servo motor expects to see a pulse every 20 milliseconds (ms). Here a 1.5ms pulse will make the motor turn to the 90-degree position. Shorter than 1.5ms moves it to 0 degrees, and any longer than 1.5ms will turn the servo to 180 degrees, as diagrammed below

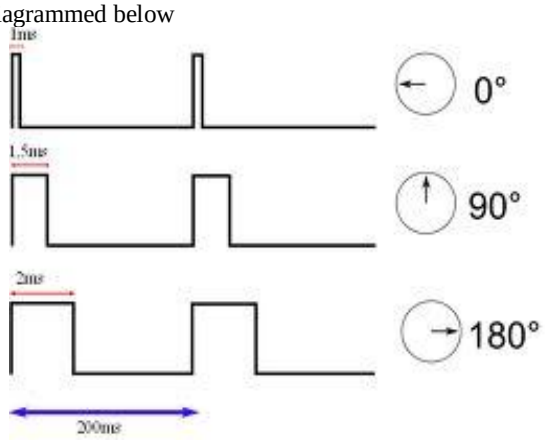


Fig.6 Rotation process of Servo motor

E. Bluetooth module

In this paper Bluetooth module is used because, Bluetooth radio modules avoid interference from other signals by hopping to a new frequency after transmitting or receiving a packet [4]. Software controls and identity coding built into each microchip ensures that only those units preset by their owners can communicate.

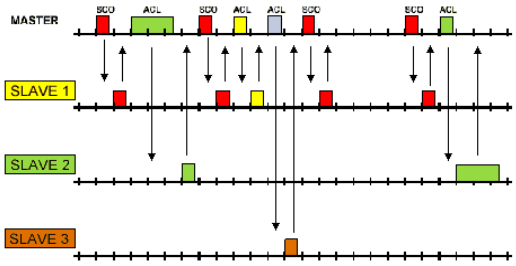


Fig.7 Communication system of Bluetooth Module.

F. Android operation system

Android is open source and Google releases the code under the Apache License. This open-source code and permissive licensing allows the software to be freely modified and distributed by device manufacturers, wireless carriers and enthusiast developers. Additionally, Android has a large community of developers writing applications ("apps") that extend the functionality of devices, written primarily in a customized version of the Java programming language [16]. This operating system needed to control robot manually. For sending a message or signal to robot we must need interface and referred that this system is comfortable to interface with Bluetooth module.

G. Camera(Build in Bluetooth System)

This device is very important for observing environment. Though our main aim to observe from remote area then we need an interfacing system with camera module. In this paper Bluetooth interfacing system is used.

H. Processor Unit(Arduino Board)

This is the challenging part of a robot. To perform this task an Arduino motherboard is used. Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino Uno R3 has I/O Pins14 (of which 6 provide PWM output), Analog Input Pins 6, DC Current per I/O Pin 40mA, DC Current for 3.3V Pin50 mA, Flash Memory 32KB (ATmega328) of which 0.5KB used by boot loader, SRAM 2 KB (ATmega328), EEPROM 1KB (ATmega328), Clock Speed 16MHz [10][14-15].

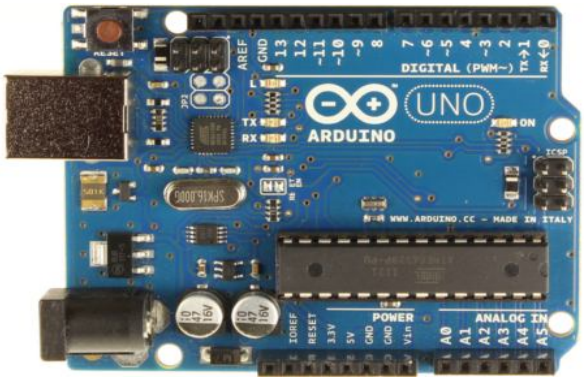


Fig.8 Arduino Uno R3 Board.

III. Detecting Objects

A. Case-1

For detecting an object sonar sound range and robot's body shape is very important. Here a mathematical term related to that is given as follows In Fig.9. 'α' is the source angle of ultrasonic sound. Let 'r' is the distance from sensor to robot edge 'q'. If we draw a straight line from robot edge which is straight with robot side wall. Then pm and qm intersect at point 'm'. So we have to set threshold distance greater than point 'm'. Otherwise an object does not detect by sonar sound with safely i.e. occur collision with body.

If angle between 'd' and 'pm' is β then, let pm=s

$$\text{Cos } \beta = (d/s) \text{ or } d = s \times \cos \beta$$

So it clear that if 'α' is increasing then 's' decreasing and 'β' increasing. We can adjust a certain angle to provide a certain threshold distance which can avoid collision.

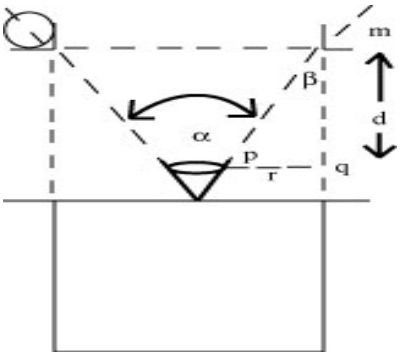


Fig.9 Process of avoiding collision.

B. CASE-2

To avoid collision robot car must rotate with a certain angle. When left wheel rotates anti-clockwise and right wheel rotates clockwise then robot move to right and vice-versa. The calculation can be expressed as follows in fig.10-

Let robot moving straight direction. The degree of turning depends on wheel diameter as well as running duration of wheel. The relation between surface moving angles of robot is proportional to the duration of wheel rotation. If 't' is rotation duration and 'θ' is the degree of turn with straight line. Then we can say

$$t \alpha \theta.$$

It is important that for constant time duration, if diameter increases then we have to reduce speed for same angle. Let for we want to move it θ angle.

So we can write

$$d \alpha (1/\text{speed}) \text{ [if angle constant]}$$

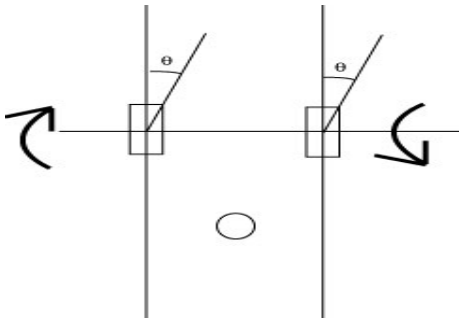


Fig.10 Robot Rotation Process.

C. CASE-3

In this case robot detects an edge with a depth. So mathematical term can express as follows-

Let ray source height from ground is 'h'. so we have to provide an addition distance to continue moving with desire depth. If additional depth is 'l', then it's able to read less or equal to (h+l) depth. So if edge depth is greater than l from ground surface then robot does not continue. The depth of edge depends on angle shown in Fig.11.

So it is clear that, for proper edge detection sensor have must catch turning point within distance's'. Where's' is the distance between sensors to middle pint of front wheel.

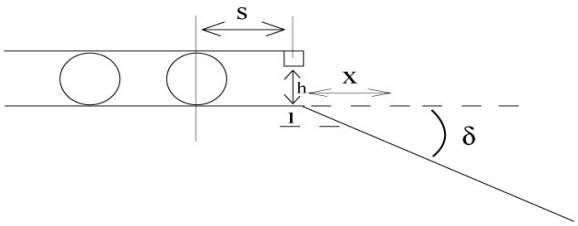


Fig.11 Process of edge detection.

D. CASE-4

If the robot is in manual mode then we can effectively racked this robot without any calculation. Because in this case camera provides real time video of environment and that is very easy to control form remote distance using android OS device.

IV. ALGORITHM

The total algorithm system is divided into two main parts. One is manual mode and another is autonomous mode. In autonomous mode these cycle repeat again and again to perform goal automatically.

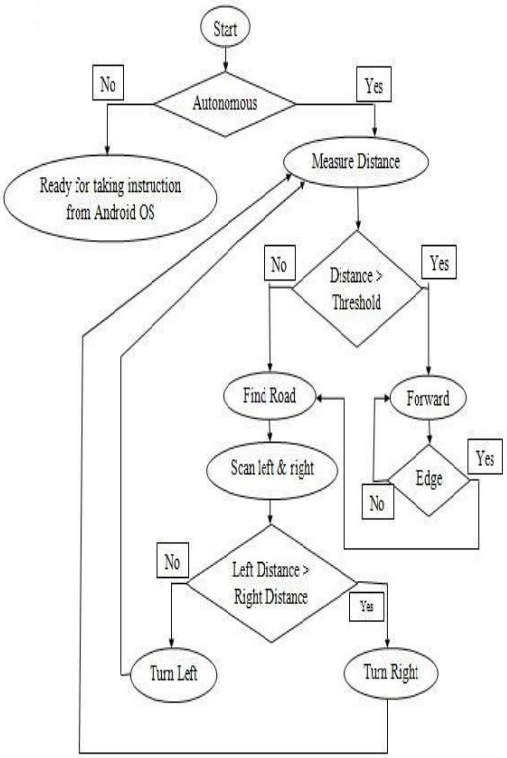


Fig.12 Algorithm for system design

V. RESULT

To complete final design both hardware and software part are required. Moving kinematics .is very important to avoid any collision. Object types and shape also important here. Proper angular velocity, threshold distance and radius of wheel give proper output in autonomous mode.

A. Total Hardware Structure

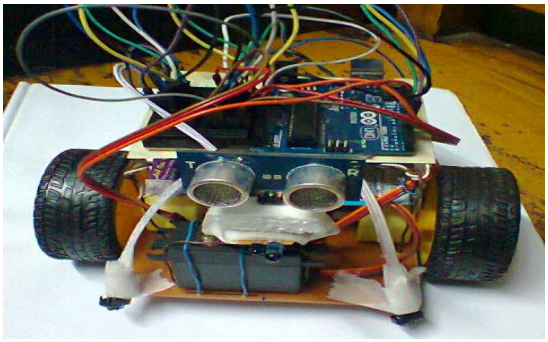


Fig. 13 Hardware structure

B. RESULT

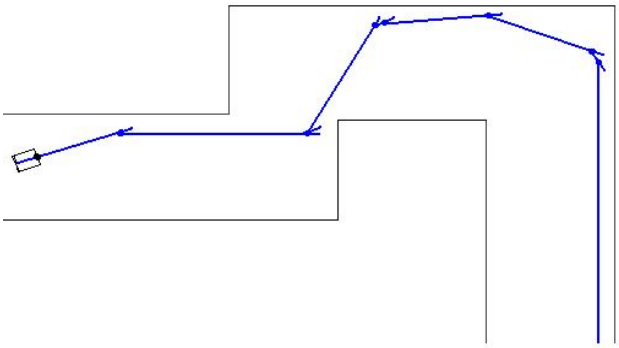


Fig. 14 Resulted path for this automated car

VI. CONCLUSIONS

The degree of robotic autonomous system depends on its application field. A powerful autonomous system also depends on sensor types and processing unit. Autonomous robot is more effective than others because of its accuracy. It is important that the degree of accuracy depends on robot's proper shape, mathematical terms, algorithm and proper platform. This is a simple process to make an autonomous obstacle and edge avoiding robot. If here use more powerful system like image processing, GPS and RADAR based indication and detection system are used then it will turn into a powerful robot.

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