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An Intelligent Speech Recognition and Obstacle Detection Robot

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***Abstract*— With the population booming decade by decade and with the advent of new technologies it is necessary that both of them work hand in hand to provide a sustainable service for the aging population mainly in medical fields. Present scenario demands such technologies which are credible and versatile and upon which humans can rely. This paper describes an augmentative human companion which can perform multiple tasks at the same time. We have developed a robot which has features close to a humanoid which is a path follower with obstacle detection with a voice feedback feature. It also recognizes human speech and performs the desired tasks. We will be using different sensors and configure the voice module to recognize our voice and program the controller and the conglomerate will then detect the hindrances, to follow a path and this output will be directed to drive our response circuit and make the robot perform intelligently.**

***Index Terms*— humanoid; medical fields; voice recognition; path follower; obstacle detector; response circuit**

INTRODUCTION

A robot is a high precision machine which performs tasks according to the commands built in or given to it by the master. This is quite helpful to implement skills of an intelligent mobile robot .This is an integration of software controlled algorithms and hardware circuits which make it suitable for automation. It can perform many functions like collecting information from hazardous places which is out of human reach. It is also used as metal detecting, pick and place purposes. More, specifically it is used in industries where large machine-power is required where man-power proves insufficient. With the advent of various robot based applications, the need for multitasking robots has become a need for the hour .This is because the automation has become the basic requirement in almost every aspect of technology. Thus, we are developing a prototype of a multitasking robot. This robot features detecting obstacles in the vicinity and responding to free its path with the help of some playback hardware. It is also is a self-operating robot that moves along a particular colored line on the floor which will make it

efficient to reach a desired destination aptly. The introduction of speech recognition feature in this robot allows it to act as a actual companion by following his/her commands and performing accordingly. With the development and maturity of speech recognition, speech is becoming an important form of man machine interface[9]. As, a man-machine interface, the speech recognition system should provide the mutual communication function. To facilitate its usage for people, it is expected to be able to speak some prompts to guide the recognition process and give corresponding information when the recognition is over. Speech is an ideal method for robotic control and communication. The speech recognition circuit we will outline, functions independently from the robot's main intelligence It's welcoming the people entering the room is a subtle part which actually gives the people a sense of cordiality. All this features make this robot a complete package and a perfect example of a human subordinate.

II. SYSTEM DESIGN

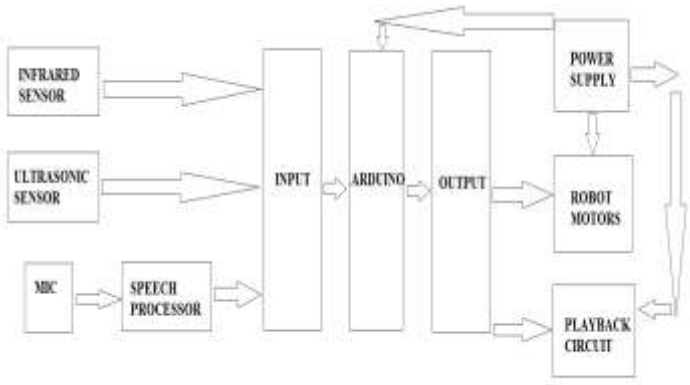

Fig.1. Block diagram of the speech recognition and obstacle detector

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Block Diagram Description

The above block diagram mentioned in Fig.1 depicts the entire workflow of our project. It consists of sensors, a voice module, three main blocks and a playback circuitary described as follows:-

1) Input Block
The input block acts as an interface between various sensors and the microcontroller to drive the robot. In this case a mic, ir sensor and ultrasonic sensor is used to recognise speech ,detect the path, and the obstacle respectively.

2) Arduino Uno
The Arduino uno which we are using is the brain of the entire project. It takes the inputs from the mic and the sensors, processes the program burned into it and provides the desired output.

3) Output Block
The output block is driven digitally by the Arduino to trigger the playback circuit and the motors simultaneously thereby deploying the robot into action.

III.LITERATURE REVIEW

1. Micro-controller Flag Based Line Follower:-

This system focusses on a intelligent line follower robot for serving the health care management. A line following robot carrying medicine has been designed for providing the medicine to the patient whenever they need it. [5]. A switch with IR sensor has been fitted near the patient, which connection has been made by the robot too. If the patient presses the switch then a flag bit set in the microcontroller, from which line following robot follows the line and reaches near the patient and provide the medicine to the patient with the help of dc motor. Along with the line follower they have used proximity sensors which is used to stop the robot when any object comes into its path. So in our project we have inherited the obstacle detection trait but the proximity sensors which on a industrial level are much more costly and also the line of sight for the ir wave should be properly aligned. So instead we have included ultrasonic sensor which is much more economical and provides efficiency even in harsh conditions.

2. Experimental Analysis of the Infrared and Ultrasonic sensors:-

The paper " Using Ultrasonic and Infrared Sensors for Distance Measurement" by Tarek Mohammad proposes the use of IR and US sensors for reliable and efficient distance measurement. It focusses on various factors such as reflectance properties of the surface, angular orientation of the IR sensors and ultrasonic sensors to provide the coarse readings of the distance and a remedy to the limitation for the visual systems. The calibrations and the experimental observations done for both the sensors in this proposed concept infer that for small distances US sensor has better resolution than IR sensor. From this paper we learnt that depending upon the irregularities in the surface, the output readings may vary so it becomes essential for us to use an array of IR sensors instead of a single sensor and augment all of them to obtain approximate output near to precise ones.

3. Position and Anglular Orientation of the Ultrasonic sensor:-

Experimental analysis performed in this process focused on the technical issues which evaluated three test cases. In the empiric experiment the parameters of the system has been optimized. Then for evaluation of the system, it's performance during the three different test cases has been analysed and results are presented [1]. Out of the three cases, we have focussed on one case. In this case, first the ultrasonic sensor is kept stationary and the obstacle is mobile. Once the sensor encounters the obstacle it performs the predefined task. Secondly, the obstacle is kept stationary and the ultrasonic sensor is made to move. the output is similar as the previous case. From this paper, in order to design a efficient obstacle detector the sensors position must be such so as to obtain maximum reflectance from the obstacle.

4. RFID tags for Robot Navigation and Orientation:-

This system emphasizes on overcoming the basic navigation techniques of a mobile robot by using RFID tags.[6] Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. This method is essentially inefficient for recognising tags for long distance as the power of electromagnetic induction which it uses proves insufficient for distant commands. However it is not feasible to afford so much

of power outage and also use of RFID tags for a huge industrial scale is also not economical. So our robot has a orientation which is assisted by ultrasonic obstacle detection which when inactive will again put the robot automatically in motion.

5. Speech Based man-machine platform:-

The main idea behind making a robot intelligent is its speech recognition functions along with a feedback system to the recognition using record and playback hardware. As the man-machine interface the speech recognition system should provide the mutual communication functions to facilitate it's usage for people [8]. The playback concept used in this paper will be used in our project as a feedback to the obstacle detection as well as any person entering the room.

a) Applications in Different Domains

The primary applications of such intelligent robots mainly acts as a benefactor in the medical domain. Robotic surgery can accomplish what doctors cannot because of precision and repeatability of robotic systems. Besides, robots are able to operate in a contained space inside the human body. All these make robots especially suitable for non-invasive or minimally invasive surgery and for better outcomes of surgery. Along with defence applications of our project this paper has helped us learn that our robo-companion can prove patient friendly in most medical applications like surgeries and provide more precision in tele-surgery. Medical robotics, and particularly autonomous surgical robotics, is still in an preliminary stage and for different surgeries different programs need to be updated in the controller taking into consideration various parameters such as type of surgery, severity of the patient amount of pressure to be applied in order not to damage crucial body entities.

b). Design Consideration

This deals with the detailed working of the entire project. Various sensors and modules are interfaced together and programmed such that they will perform simultaneously to the inputs given.

1. Sensors: IR sensors and Ultrasonic sensors are used to follow a particular coloured line and detect an obstacle.
2. Arduino, Power supply, Arduino IDE: To process and interpret the program and to construe it into actual physical actions
3. Relays, Motors, Speakers: The Arduino drives the relay which switches to trigger the playback circuit and depending upon the input from sensors or the mic the motors rotate.

We implemented in software and hardware a model, which involved connections for detecting an obstacle by interfacing arduino to ultrasonic sensor. Initially the sensor was tested, the voltage drop was analysed which indicated the proper functioning of the sensor. It was then interfaced with the Arduino (Celestino) board. The program was studied and desired changes were done accordingly.The program was debugged and was burned in the hardware. When the sensor detects an obstacle the serial monitor changes its value based on the distance of the obstacle from the sensor.

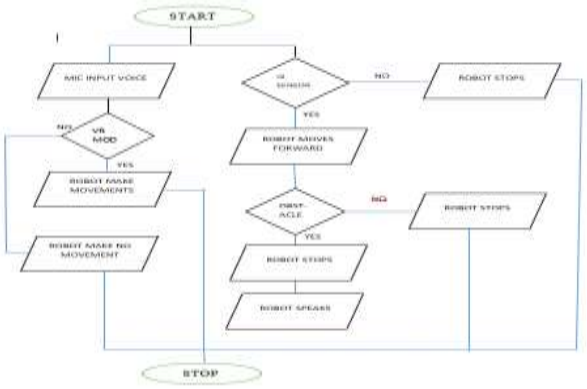

Fig.2. Flow chart of the speech recognition and obstacle detector

c)Main components of the system are as follows:-

1) Infrared sensor:

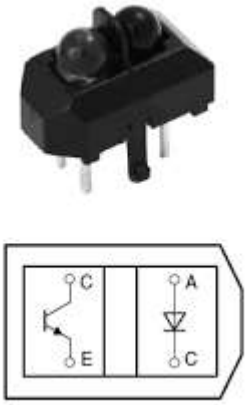

Fig.3. Infrared Sensor

It is an IR Emitter and an IR PhotoTransistor packaged together in a leaded package which blocks visible light. The package includes two mounting clips. The principle working behind this sensor is based on light reflections. A dark object reflects less light than a bright object, or we can also say, a dark object absorbs more light than a bright object, this is the only fundamental logic behind a line sensing robot. So, in a line sensing robot, we use this sensor that detects the difference between bright object and a dark object, or say, distinguishes a white line from a black surface.

2) Ultrasonic sensor

Fig.4. HC SR04 Ultrasonic Sensor

The ultrasonic sensor is used for obstacle detection. Ultrasonic sensor transmits the ultrasonic waves from its sensor head and again receives the ultrasonic waves reflected from an object. When an electrical pulse of high voltage is applied to the ultrasonic transducer it vibrates across a specific spectrum of frequencies and generates a burst of sound waves. Whenever any obstacle comes ahead of the ultrasonic sensor the sound waves will reflect back in the form of echo and generates an electric pulse. It calculates the time taken between sending sound waves and receiving echo. The echo patterns will be compared with the patterns of sound waves to determine detected signal's condition. The ultrasonic receiver shall detect signal from the ultrasonic transmitter while the transmit waves hit on the object. The combination of these two sensors will allow the robot to detect the object in its path. The ultrasonic sensor is attached in front of the robot and that sensor will also help the robot navigate through the hall of any building.

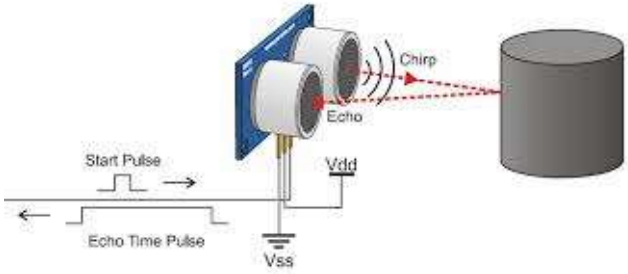

Fig.5. Ultrasonic Sensor operation

A.DESCRIPTION FOR THE OBSTACLE DETECTION PART

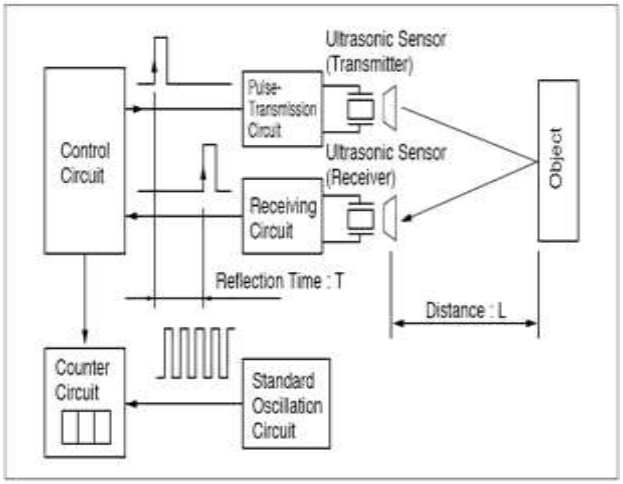

Fig.6. Sensor Detecting the Obstacle

After obstacle detection, the working of IR sensor for line follower was carried out .Then as a individual proceeding playback circuit implementation was done using APR9600 IC, which played the recorded voice as the output for the implemented circuit. All these individual stages were cascaded by interfacing it with the Arduino compatible Celestino board.

The output of the interfaced models was that the robot followed the black path on the white surface and if any obstacle on its way was found the robot will stop and would respond to the obstacle eg. get aside. The block diagram of line follower along with its circuit connection and the circuit diagram of APR9600 is as shown .

B.DESCRIPTION FOR THE LINE FOLLOWER PART

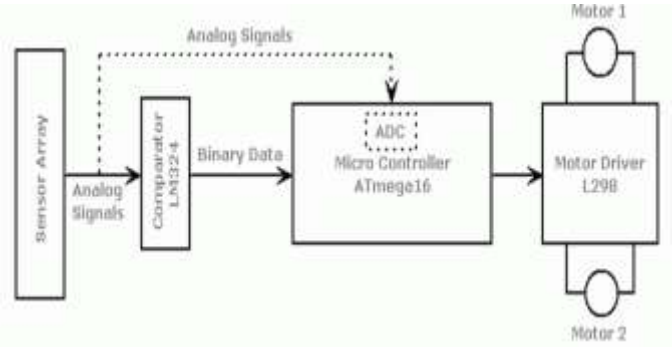

Fig.7. Interfacing the IR sensor to drive the Motors

The robot uses IR sensors to sense the line, an array of 8 IR LEDs (Tx) and sensors (Rx), facing the ground has been used in this setup. The output of the sensors is an analog signal which depends on the amount of light reflected back, this analog signal is given to the comparator to produce 0s and 1s which are then fed to the Arduino

L4	L3	L2	L1	R1	R2	R3	R4

Left Centre Right Sensor Array

Starting from the centre, the sensors on the left are named L1, L2, L3, L4 and those on the right are named R1, R2, R3, R4. Let us assume that when a sensor is on the line it reads 0 and when it is off the line it reads 1

The Arduino decides the next move according to the algorithm given below which tries to position the robot such that L1 and R1 both read 0 and the rest read 1.

L4	L3	L2	L1	R1	R2	R3	R4
1	1	1	0	0	1	1	1

Left Centre Right Desired State L1=R1=0, and Rest=1

Algorithm:

1. L= leftmost sensor which reads 0; R= rightmost sensor which reads 0. If no sensor on Left (or Right) is 0 then L (or R) equals 0; Ex:

L4	L3	L2	L1	R1	R2	R3	R4
1	0	0	1	1	1	1	1

Left Centre Right

Here L=3 R=0

L4	L3	L2	L1	R1	R2	R3	R4
1	1	0	0	0	0	0	0

Left Centre Right

Here L=2 R=4

2. If all sensors read 1 go to step 3, else, If L>R Move Left If L<R Move Right If L=R Stop and Goto step 1

3. Move Clockwise if line was last seen on Right,move Counter Clockwise if line was last seen on Left Repeat step 3 till line is found.

4. Go to step 1.

C. DESCRIPTION FOR THE PLAYBACK CIRCUIT PART

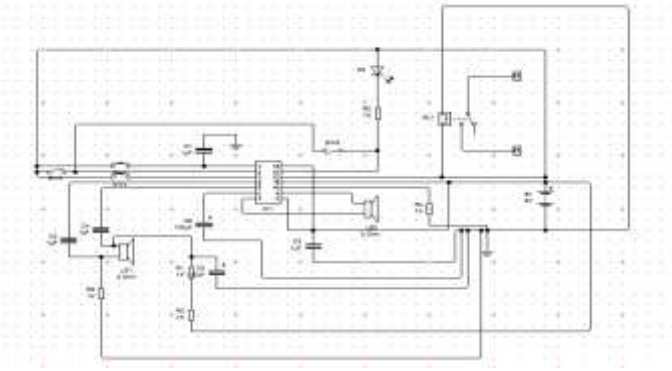

Fig.8.Circuit diagram playback IC APR9600 only for one message

For responding to the obstacle in the path the robot should be able to detect the obstacle first and then trigger a circuit which will alert the intruder or obstacle to move away. This we have used a record and playback IC APR9600 which basically has a non-volatile flash memory which does not require programming .It has a playback capability of 40-60 seconds. It samples incoming voice samples and stores the instantaneous voltage samples in non-volatile flash memory cells. Initially the LED glows when the IC records the voice obtained through the Mic. A single voice message upto 20 seconds can be recorded. The Ic remains in the recorded mode as long as the RecL is grounded. By changing the value of the OscR resistor R1 it is possible to increase the recording period.A.R1- 52K 20 sec

B.R1- 67K :24 sec

C.R1- 89K :30 sec

For playback , pin no.2 PLAYE should be triggered manually or externally to playback the recorded voice.

C. DESCRIPTION FOR THE VOICE RECOGNITION PART

Fig.9.Voice Recognition Module

The module could recognize your voice. It receives configuration commands or responds through serial port interface. With this module, we can control the car or other electrical devices by voice. This module can store up to 15 pieces of voice instruction. Those 15 pieces are divided into 3 groups, with 5 in each group. First we should train the module with voice instructions group by group. After that, we should import one group before it could recognize the 5 voice instructions within that group. If we need to implement instructions in other groups, we should import the group first. This module is speaker dependent. If you trained the module, other persons voice might not be able to make it work and prevent it from misusing.

IV. CONCLUSION

Our paper mainly focused on developing human friendly and effective robot which will mainly play a quintessential role in hospitals as well as in every medical aspect. Our entire model can be implemented on a single platform wherein all the subparts including the human voice could be transmitted to the module. Many of the projects are made on the idea of speech recognition through computers by a software application. But our project recognizes speech through not only software but also hardware. This human companion can be adopted by various paramedics and also in hospitals which can prove a life saver to the patients. Another field of implementation is to deploy these robots in the disaster relief and assistance programs taking into account insufficiency of man-power, inaccessibility in remote areas and time constraints.

V. FUTURE SCOPE

- Our design provides an excellent platform to have a wide variety of scope for the future.

- The voice commands can be sent over Bluetooth or radio frequencies to increase the range and reach of the robot.

- Different sensors such as temperature, gas can be used to make the robot more effective in hostile conditions.

- Smart playback and communicating devices with multiple commands could be implemented to convey multiple messages.

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