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The Robo: Semi-Autonomous Robot that Detects Objects and has Speech Capabilities

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***Abstract*—The goal of this project is to design a semi-autonomous robotic greeter. It can detect an obstacle, such as a wall or a person and when it encounters any such object, it will then stop and wait for two seconds before producing a greeting. During the two second waiting period, any command from the remote will prevent the robot from issuing a greeting. The operations that can be controlled by the infrared remote control are starting the robot, stopping it, and making it turn left or right. The distance sensor will allow the robot to detect walls or a person that is objects approximately 20cm to 80cm away from it. The servo motor will be used as a motor for the robot. An audio breakout board connected to a speaker is used to emit sound from the robot. The micro-SD card is used to store the sound files.**

Keywords – robot, Semi-autonomous, microcontroller

I. INTRODUCTION (*Robots and Human Interaction)*

This project provides users with real robotic interaction in their everyday life. The robot presents the user with a greeting that will welcome them to the University of Hartford. The robot implements three things: obstacle avoidance, obstacle detection, and playing a greeting. Robotics is a fascinating area of study that has had many technological advances in the last decade. The project takes advantage of these new improvements by incorporating these technologies into our design. The design was inspired by many of the literary works that we have come across in our research. Aubrey Shick is a Carnegie Mellon University researcher. Shick is currently developing a robot, named Romibo, which will be used therapeutically to aid patients with dementia and autism [9]. The hopes are that the robot will have human like behaviors, which will help exercise the memory of patients with dementia and teach kids with autism pick up on human social cues. According to Ken Teh, there is a restaurant called Dalu Robot. This restaurant has become a hit among its customers because of the robots that have replaced the waiters. There are about 12 robots that help to operate the restaurant as one of the following: entertainers, servers, greeters, or receptionists. The robots have motion sensors that allow them to move around the restaurant and stop when they have reached a person or table. One of the customers was quoted saying, "They have a better service attitude than humans." The Arduino microcontroller is among the most preferred because it is open source and has a large supportive Arduino community that shares information and findings that they have had. The Arduino can be used for all types of projects and its simplicity allows for people of all backgrounds and skill to quickly learn how to use it. [5] Robotics and other technology are revolutionizing everyday tasks.

II. MATERIALS

In order for the project to come to life, the first purchased consisted of the following items: Arduino Mega, 2 Distance sensors, 2 Servo Motors, Breakout sound board, Infrared detector and source, 2GByte micro-SD card. After completing the preliminary stage the following items were purchased: Chassis, Connector, expansion board, wheels, 9.6V battery, 4 AA battery holder, 4 AA batteries, project enclosure, 4 buttons, SPDT switch, dc power plug, prototype shield, battery clips and small speakers. The Arduino mega microcontroller is important because it is the basis of the project. Component selection was the key to this project. One of the main operations of this robot is obstacle detection. The Infrared Proximity Long Range Sensor has a position sensitive detector, infrared emitting diode and a signal processing circuit all built in.

Fig. 1. Infrared Proximity Sensor Long Range. (*detect objects*)

This particular sensor sends out a particular voltage at a specific detection distance. It has an analog output and can measure from 20cm to 150cm. Obstacle detection is one of

three main operations. Obstacle avoidance is needed to make sure that the robot does not go into walls and other inanimate objects. To accomplish this a infrared remote and receiver was used.

Fig. 2 Infared Remote

Fig 3. Infared Receiver

The final operation the robot performs is voice generation, which is accomplished by the audio sound breakout. This breakout has a built in chip that called WTV020SD. This chip is a small IC for embedding audio–playback. The audio can be recorded on a computer and then converted to an ad4 file format and placed on a micro-SD card and then inserted into the chip. It has multiple modes included that can play the audio recording. Depending on whether a microntroller is involved will determine what mode is use. Four wire serial bus or Serial Peripheral Interface is the key to making the Audio Sound Breakout's two line serial mode work.

Fig 4. Audio Sound Breakout (voice generation)

To make all of these components work in unison there was the need of a microntrollor. The arduino microntroller was used to program the audio sound breakout , the distance sensor and the remote.

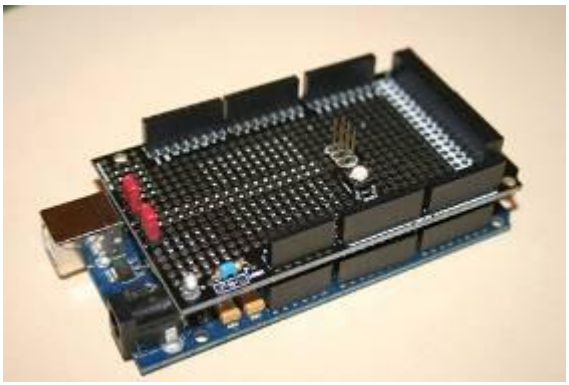
Fig 5. Arduino Mega 2560

To attach the sound chip to the robot the need of a prototype shield was necessary. The parts had to directly connect to the micontroller.

III. METHOD

After the components were collected the next step was to build the robot. The prototype shield had to have pins solder to it so it can be place on the microcontroller and the breakout board could be attached to the shield.

Fig. 6.Arduino Mega 2560 Prototype Shield



The prototype shield allows each component to be connected to the same ground and power. Once the robot was fully built the Arduino Mega 2560 Microcontroller was programed to detect obstacles based on distance sensor readings. And data was sent and received from the audio sound breakout using SPI. SPI uses a master and slave connection to send and receive data. This requires a four wire connection which in this case is the data in, clock, reset and the output which is called busy on the breakout board. Normally if you are using SPI with an Arduino microcontroller you would have to use the SPI library that is built in to the Arduino. But using this particular breakout board it essentially uses the concept of SPI. The breakout board can only send and receive bits using the serial port which essentially SPI. The audio sound breakout uses it's built in serial mode to communicate with the microcontroller. The methods are play, mute, unmute, volume

(which can turn the volume up or down depending on the number that the user enters), and reset.

When the volume is changed the microcontroller is actually sending a certain set of bits (FFFO-FFF7). Depending on which 16 bit hexadecimal number is sent is how the breakout board knows how loud to make the voice. When each method is called, the breakout board is receiving a certain set of bits through the serial connection. Note that to set up this connection in the code, there needs to be pins assigned to reset, output, clock and data in. Those assigned pins are then connected to the corresponding pins on the audio sound breakout board.

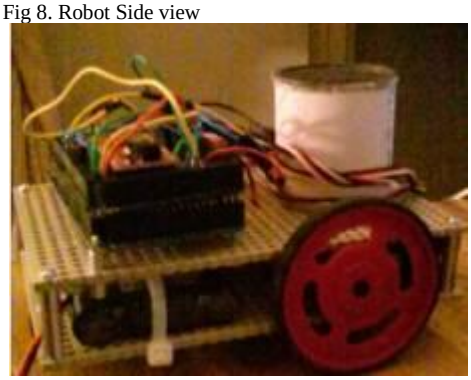
IV. Results

The distance sensor and the speaker is attached to the front of the robot. The two servomotors were attached on the side, towards the front of the robot.

Fig 7. Robot front view

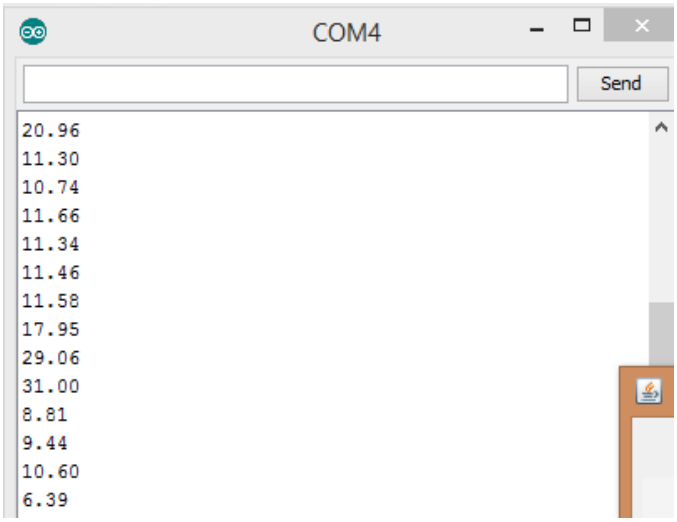
The robot has the microcontroller along with the connctions made from the distance sensor and the speaker. On the lower level level of the robot is a NiMh 9.6 volt battery and the actual servo motors.

Fig 8. Robot Side view



The distance sensor sends out a series of numbers that is read with the arduino.

Fig 9. Serial Port Readings from Arduino Microcontroller



Once it reaches a certain numeric value it will generate the greeting. The libraries for the servo motors and the chip on the breakout had to be included for the servo and the chip to react to the readings.

Fig 10. The setup code for main program

```
#include <Servo.h>
#include <WTV20SDBreakout.h>

Servo servoLeft;          // Define left servo
Servo servoRight;         // Define right servo
unsigned long duration;
int distancePin = 0;
int resetPin = 2;  // The pin number of the reset pin.
int clockPin = 3;  // The pin number of the clock pin.
int dataPin = 4;  // The pin number of the data pin.
int busyPin = 5;  // The pin number of the busy pin.

WTV20SDBreakout breakout(resetPin, clockPin, dataPin, busyPin);

void setup(){
  servoLeft.attach(31);  // Set left servo to digital pin 31
  servoRight.attach(33);  // Set right servo to digital pin 33
 servoRight.write(90);
 servoLeft.write(90);
  Serial.begin(9600);    //set the baud rate to 9600
 breakout.reset();
  breakout.volume(7);
    breakout.playVoice(1);
    delay(50);
    breakout.stopVoice();
    delay(50);
 forward();
```

The setup code connects the servos, the distance sensor and the audio sound breakout to pins on the microcontroller. The next step is to estimate a numeric value which will determine how close the robot gets to the object before taking action. A series of test were run to find a value of how close the robot needed to be. To make this estimate easier the voltage output from the sensor was converted to be as close to smaller

numbers. Once a specific range was chosen the sound would only play in that specific range.

Fig 11. Main Code

```
void loop(){
  float volts = analogRead(distancePin)*0.00322265624;
   float distance = 12.21*pow(volts, -1.15);
  Serial.println(distance);


    if (distance < 8){
    breakout.volume(7);
    breakout.playVoice(0);
    delay(50);
    breakout.stopVoice();
    delay(50);
    stopRobot();
    delay(1000);
    turnLeft();
    delay(1000);
    forward();
  }

}
```

V. Conclusion

The goal of this project was to build a robotic greeter that detects objects and produces a sound or recording. This goal was reached successfully. The sound generation is consistent whether the audio breakout board is playing one or multiple sounds. The robot always detects the object at the given numeric range and has a battery that can last for three hours.

VI. Future Work

The size of the robot is pretty small but it has adequate sound to make up for height. Making the robot a bigger robot will make the interaction between man and machine more convenient for the people. The increase in size will allow the general public to notice it more on a college campus. The robot as it stands now is only semi-autonomous, but the ultimate goal is to make it fully autonomous. When it is fully autonomous there will be no further use for the remote control unless for an emergency stop. To reach this goal, the robot needs to be able to distinguish a wall from a person. To accomplish person detection a thermal sensor will be added to the front of the robot. The thermal sensor will detect body heat, which is something that only living organisms can have. If the thermal sensor does not detect body heat but the distance sensor detects an object, it will perform one of three things; back up, turn left or turn right, all of which is part of the obstacle avoidance feature to the robot, but if the thermal sensor detects body heat and the distance sensor detects an object, then it will play the greeting or sound. Adding the thermal sensor will make the robot more effective.

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