Speaking Robot

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Abstract:
Speaking robot is a machine that speaks the data provided to it. The architecture of Robot consists of the following subsystems, namely Electronics subsystem and Software subsystem. Software subsystem gives a set of commands to the Electronics subsystem and generates control signals for the entire system. Software subsystem which is usually a computer provides easy to use interface for users which may be accepting commands like natural language sentences and translates it to low level commands which could be understood by machine (microcontroller or microprocessor). An IC which is usually used for recording voice is APR9600.

1. INTRODUCTION

Speaking Robot is a machine that can speak the data provided to it. The data can be provided in various forms – audio, text, etc. In this particular project, speech would be delivered by the robot using a digital voice recording IC APR9600 which is a single chip voice recorder and playback device from APLUS integrated circuits. The IC is controlled by PIC 16F877 microcontroller which is a 40 pin, 8-bit CMOS flash microcontroller from microchip. \(^{[1]}\) An embedded system is a combination of software and hardware to perform a dedicated task. Some of the main devices used in embedded products are Microprocessors and Microcontrollers. Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs, process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result. As everyone in this competitive world prefers to make the things easy and simple to handle, this project sets an example to some extent. Ninety-eight percent of all microprocessors are manufactured as components of embedded systems. Examples of properties of typically embedded computers when compared with general-purpose counterparts are low power consumption, small size, rugged operating ranges, and low per-unit cost. This comes at the price of limited processing resources, which make them significantly more difficult to program and to interact with. However, by building intelligence mechanisms on top of the hardware, taking advantage of possible existing sensors and the existence of a network of embedded units, one can both optimally manage available resources at the unit and network levels as well as provide augmented functions, well beyond those available. For example, intelligent techniques can be designed to manage power consumption of embedded systems. \(^{[2]}\)

A typical industrial microcontroller is quite unsophisticated compared to a typical enterprise desktop computer and generally depends on a simpler, less-memory-intensive program environment. The simplest devices run on bare metal and are programmed directly using the chip CPU’s machine code language. Often, however, embedded systems use operating systems or language platforms tailored to embed use, particularly where real-time operating environments must be served. At higher levels of chip capability, such as those found in SoCs, designers have increasingly decided that the systems are generally fast enough and tasks tolerant of slight variations in reaction time that "near-real-time" approaches are suitable. In these instances, stripped-down versions of the Linux operating system are commonly deployed, though there are also other operating systems that have been pared down to run on embedded systems, including Embedded Java and Windows IoT (formerly Windows Embedded).

2. SPEAKING ROBOT

The Speaking robot basically consists of three units – Input unit, Processing unit and Output unit. The block diagram is shown in

![Block diagram of robotic system](http://ijesc.org/)

Figure 1. Block diagram of robotic system
INPUT UNIT:
The input unit can be an IR sensor, a microphone, etc.

IR Sensor

Figure 2. IR Sensor

An Infrared (IR) sensor is used to detect obstacles in front of the robot or to differentiate between colors depending on the configuration of the sensor. With the power of the modern microcontrollers, like Arduino, to have a talking robot is one of the things that always everyone desired to do. You can build a talking robot in two ways:

- With the text-to-speech, writing a text that the robot says
- Recording some audio files with inside the voice already recorded that the robot repeats.

Using APR9600 - The APR9600 device offers true single-chip voice recording, non-volatile storage and playback capability for 40 to 60 seconds. Using text to speech IC, most circuits can be made to speak the words. Using a microcontroller: Arduino, we can add the speech converter chip and an amplifier to give our microcontroller speech. It has an infrared transmitter so that it can send commands from a distance to the Talking Module which will then play the speech. This is mainly a Picaxe project, but Arduino code is also included to allow an Arduino to talk.

Microphone

A microphone (mic) is a transducer that converts sound into an electrical signal. Microphones are used in many applications such as telephones, hearing aids, live and recorded audio, sound recording, two-way radios, radio and television broadcasting, and in computers for recording voice, speech recognition and for ultrasonic sensors. Several different types of microphones are used, which apply different methods to convert the air pressure variations of a sound wave to electrical signal. The most commonly used microphones are dynamic microphone, which uses a coil of wire suspended in a magnetic field; the condenser microphone, which uses the vibrating diaphragm as a capacitor plate, and the piezoelectric microphone, which uses a crystal of piezoelectric material.

The mic is used to record the voices to be played by the voice recording and playback IC (APR9600) whenever the IR sensor detects anything in front of it. The voices can be overwritten at any time.

PROCESSING UNIT:
The Processing unit consists of APR9600 IC and Text-to-speech IC.

APR9600

Figure D. shows a picture of APR9600 module.

Figure 4. APR9600 Module

Figure E. shows the block diagram of APR9600 module.

Figure 5. APR9600 Block Diagram

The APR9600 block diagram is included in order to give understanding of the APR9600 internal architecture. At the left-hand side of the diagram are the analog inputs. A differential microphone amplifier, including integrated AGC, is included on-chip for applications requiring its use. The amplified microphone signal is fed into the device by connecting the Ana_Out pin to the Ana_In pin through an external DC blocking capacitor. Recording can be fed directly into the Ana_In pin through a DC blocking capacitor, however, the connection between Ana_In and Ana_Out is still required for playback. The next block encountered by the input signal is the internal anti-aliasing filter. The filter automatically adjusts its response according to the sampling frequency selected so Shannon’s Sampling Theorem is satisfied. After anti-aliasing filtering is accomplished the signal is ready to be clocked into the memory array. This storage is accomplished through a
combination of the Sample and Hold circuit and the Analog Write/Read circuit. These circuits are clocked by either the Internal Oscillator or an external clock source. When playback is desired the previously stored recording is retrieved from memory, low pass filtered, and amplified as shown on the right-hand side of the diagram. The signal can be heard by connecting a speaker to the SP+ and SP- pins. Chip-wide management is accomplished through the device control block shown in the upper right hand corner. Message management is controlled through the message control block represented in the lower center of the block diagram.

TEXT-TO-SPEECH IC
We can use TTS256 IC for text to speech conversion. The TTS256 is an 8-bit microprocessor programmed with letter-to-sound rules. This built-in algorithm allows for the automatic real-time translation of English ASCII characters into allophone addresses compatible with the Magnevation SpeakJet Speech Synthesizer IC. Combine this with the SpeakJet to build a complete text-to-speech solution. The TTS256 is offered in a through-hole, 28-pin package. Supplied power should be +5V. Very few connections are required for operation. The TTS256 contains over 600 rules for pronouncing English text. While it does a pretty good job of the task, with a less than 5% error rate in most sentences, it will mispronounce some words. Often times, some creative spelling will help.

Table 1. TTS256 PIN CONNECTIONS

<table>
<thead>
<tr>
<th>Pin #</th>
<th>TTS256</th>
<th>Pin #</th>
<th>SpeakJet</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>TX</td>
<td>1</td>
<td>Vcc</td>
</tr>
<tr>
<td>1/4</td>
<td>Vcc</td>
<td>2/8</td>
<td>RX</td>
</tr>
<tr>
<td>18</td>
<td>RX</td>
<td>20</td>
<td>Ready</td>
</tr>
<tr>
<td>20</td>
<td>Ready</td>
<td>2/4</td>
<td>S1_TX</td>
</tr>
<tr>
<td>2/4</td>
<td>S1_TX</td>
<td>2/8</td>
<td>Buffer Half Full</td>
</tr>
<tr>
<td>2/8</td>
<td>Buffer Half Full</td>
<td>20</td>
<td>Ready</td>
</tr>
</tbody>
</table>

OUTPUT UNIT:
The Output unit consists of speaker, LED, etc.

SPEAKER

Connect the anode of the speak louder which is soldered well to the 220uF capacitor C13, and connect the cathode to the ground. And then plug into the GND of power supply line. And then plug into the other end of connecting line about the 0.1uF capacitor.

LED
A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small and integrated optical components may be used to shape the radiation pattern. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. Figure 6. shows a diagram of an LED.

Figure 6. SPEAKER

The LED glows whenever the robot speaks anything.

3. MESSAGE MANAGEMENT

Message Management General Description
Playback and record operations are managed by on chip circuitry. There are several available messaging modes depending upon desired operation. These message modes determine message management style, message length, and external parts count. Therefore, the designer must select the appropriate operating mode before beginning the design. The device supports three message management modes (defined by the MSEL1, MSEL2 and /M8_Option pins.

- Random access mode with 2, 4, or 8 fixed-duration messages
- Tape mode, with multiple variable-duration messages, provides two options:
  - Auto rewind
  - Normal

Modes cannot be mixed. Switching of modes after the device has recorded an initial message is not recommended. If modes are switched after an initial recording has been made some unpredictable message fragments from the previous mode may remain present, and be audible on playback, in the new mode. These fragments will disappear after a record operation in the newly selected mode. Table 1 defines the decoding necessary to choose the desired mode.
Table 2. MESSAGE MODE

<table>
<thead>
<tr>
<th>Mode</th>
<th>MSEL1</th>
<th>MSEL2</th>
<th>MB_OPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Access 2 fixed duration messages</td>
<td>0</td>
<td>1</td>
<td>Pull this pin to VCC through 10k resistor</td>
</tr>
<tr>
<td>Random Access 4 fixed duration messages</td>
<td>1</td>
<td>0</td>
<td>Pull this pin to VCC through 10k resistor</td>
</tr>
<tr>
<td>Random Access 8 fixed duration messages</td>
<td>1</td>
<td>1</td>
<td>The MB message trigger becomes input pin</td>
</tr>
<tr>
<td>Tape mode, Auto rewind operation</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tape mode, Normal operation</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

4. APPLICATIONS

- The talking module could be used to create a talking clock, talking thermometer, or even a talking voltmeter.
- It can be used to debug a microcontroller program by telling out loud what part of the program it is running while the program is being tested.
- It can speak for people who have temporarily or permanently lost their ability to speak.

5. FUTURE USE

- Mercedes Benz are planning to use talking robots for teaching autonomous cars how to talk.
- For the Japan 2020 Olympics, Toshiba has been creating robots for tourist information centres.
- The podcast for news, interviews.

6. HARDWARE USED

- IR SENSOR
- SPEAKER
- MICROPHONE
- BATTERY
- STEP-DOWN TRANSFORMER
- DIP SWITCHES
- APR9600 IC MODULE
- ARDUINO MICROCONTROLLER
- 3.3-VOLT REGULATOR
- CAPACITORS, RESISTORS, INDUCTORS, LEDs, WIRES, etc.

7. CONCLUSION

In this project, we have made a robot that speaks the data provided to it as input. We can provide the input in the form of speech or text. The robot starts speaking whenever the IR sensor detects anything in front of it. Moreover, for better interactions with the people, our robot rotates its head towards the person. Thus, our robot is a great asset for delivering information to outsiders about our college and its achievements.

8. ACKNOWLEDGEMENT

Every project big or small is successful largely due to the effort of a number of wonderful people who have always given their valuable advice or lent a helping hand. We sincerely appreciate the inspiration; support and guidance of all those people who have been instrumental in making this project a success. We would like to express special thanks of gratitude to our guide Dr. Radhika Khanna who gave us the golden opportunity to do this wonderful project on the topic “Speaking Robot”, which also helped us in doing a lot of Research and we came to know about so many new things. Last but not the least we place a deep sense of gratitude to our family members and friends who have been constant source of inspiration during the preparation of this project work.

9. REFERENCES


