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Building an AT89C51-based Voice-Activated Programmable Multipurpose Robot

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Useful Links in this Article:

Datasheets, Tools and Technical Documents:
AT89RFD-01 MP3 Player Reference Design
AT89STK-05 Starter Kit is designed help developers using AT89C5131 USB Flash microcontroller.
http://www.atmel.com/dyn/general/advanced_search_results.asp?device=1&tools=1&faqs=1&datasheets=1&appNotes=1&userGuides=1&software=1&press=1&articles=1&flyers=1&checkAll=1&checkAllReference=1&target=AT89C51

Development Tools:
http://www.arrowdevtools.com

Compare and Buy Processors:
http://www.embedded-developer.com/corp/191/Atmel.htm

THE MAIN FEATURES OF THE ROBOT ARE :

1. It helps physically disabled persons by carrying some objects from place to place using the arm structure in the robot.

2. It guides the blind persons to reach a particular destination using the voice assistance feature.

3. It is used to guide visitors in an organization by providing information about the facilities available.

4. Because of the presence of the Real-time Clock (DS1307), time-based control of the robot is possible. For example, it is used in hospitals to inform patients to take the tablets at the right time.

5. It is used in hazardous places as it is controlled using a mobile communication device (DTMF technique).

6. The photo electric sensor in the robot will sense the obstacles and it will make decisions according to the obstacles it encounters.

All the aforementioned applications are implemented in the robot using the microcontroller AT89C51. The robot's motion is controlled by two stepper motors incorporated at the base. The driver circuits for these motors are controlled with an AT89C51.

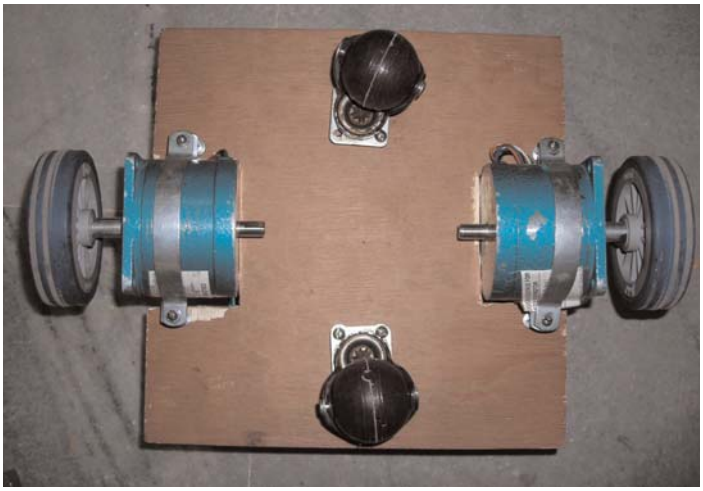
In the first two applications, the distance and direction of the destination is accepted as input through the user friendly keyboard, and multiplexed 7-segment display system. The arm structure is controlled by a relay circuit.

In the third application, the distance and direction are preprogrammed in the microcontroller AT89C51. We record all the information about the organization in the voice recorder APR9600 and are played back whenever voice assistance is needed.

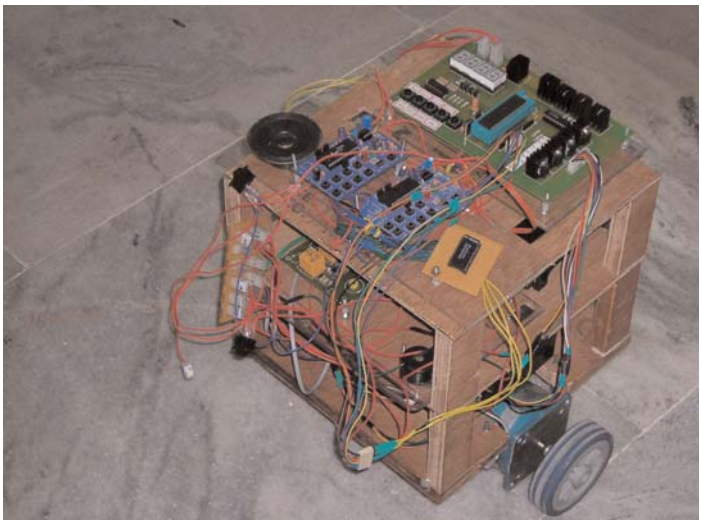
In the fourth application, a real-time clock counts seconds, minutes, hours, date of the month, month, day of the week, and year with leap year compensation valid up to 2100. We can set the time and we can program the robot in such a way that the robot can perform the work based on the real-time clock.

In the fifth application, the robot is controlled from a remote location using a dual tone multi-frequency decoding technique. If any obstacle comes in the pathway of the robot it is detected using the photo-electric sensors and appropriate decision is made. Because it is a general purpose robot with facilities like:
Pick and Place arm,
Voice assistance,
DTMF decoding techniques,
Real time clock,
Obstacle sensing, etc.

It can be programmed and used for variety of applications (a few of which were discussed earlier) .



Top Photo: View of the bottom of the robot, showing the stepper motors. Bottom Photo: Robot in motion.



Components Used in the Robot

1. Microcontroller (AT89C51)
2. Stepper motor
3. Batteries
4. Voltage regulator (7805)
5. FET (IRF540N)
6. Buffer (74HC244)
7. On-off Switch
8. Wheel
9. Free moving wheel
10. Photo electric sensor
11. Opto-coupler (MCT2E)
12. Buzzer
13. Push to on switch -
14. Seven segment display
15. BCD to seven segment decoder (4511)
16. Transistors (BC547)
17. Relay
18. Arm
19. Real-time clock (DS-1307)
20. Voice recorder IC (APR9600)
21. Speaker
22. Microphone
23. 4 X 16 Decoder (74154)
24. DTMF Decoder (CM8870)
25. Cell phones
26. Resistors
27. Capacitors
28. Diodes

EXPLANATION OF CIRCUIT DIAGRAM & OPERATION (SEE DIAGRAM, NEXT PAGE)

The clock is generated for the microcontroller using a crystal of frequency 11.0592MHz connected to pins XTAL1 and XTAL2. A 6V battery is connected to a 7805 voltage regulator. The regulated output is given as supply to the microcontroller and all the other IC'S used.

PORT0 of microcontroller AT89C51 is connected to input of buffer 74HC244. The buffer is used to isolate the microcontroller and the stepper motor. The output of buffer is given to IRF 540N, a FET to provide the necessary current to drive the stepper motor. The power supply for the stepper motor is from a 12V battery.

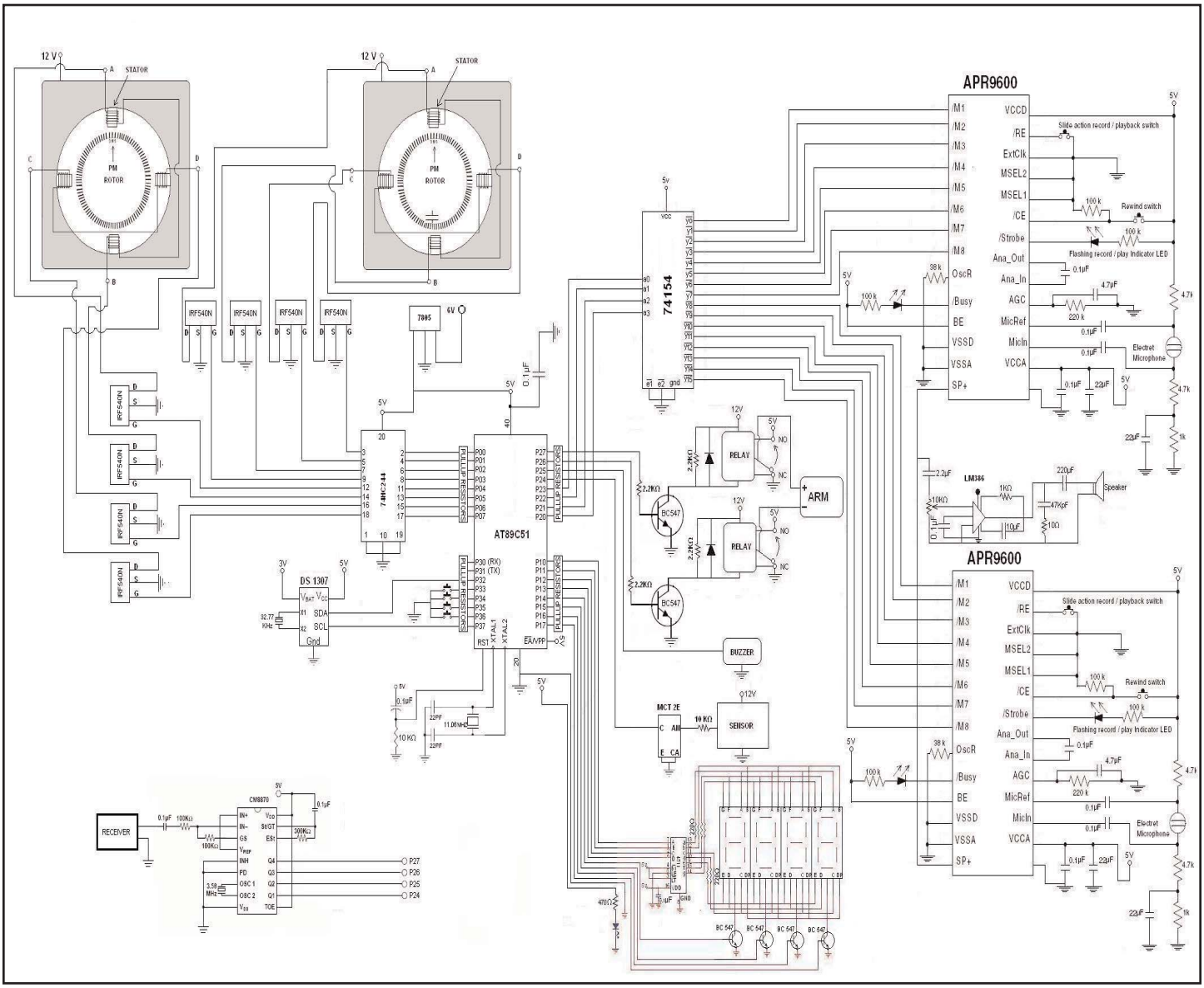
To rotate the motor in the clockwise direction the sequence is:

Step	Angle	A	B	C	D
0	1.8°	1	0	1	0
1	3.6°	0	1	1	0
2	5.4°	0	1	0	1
3	7.2°	1	0	0	1
4	9.0°	1	0	1	0

To rotate the motor in the anticlockwise direction the sequence is:

Step	Angle	A	B	C	D
0	1.8°	1	0	0	1
1	3.6°	0	1	0	1
2	5.4°	0	1	1	0
3	7.2°	1	0	1	0
4	9.0°	1	0	0	1

Circuit Diagram



References

1. Muhammad Ali Mazidi & Janice Gillispie Mazidi, the 8051 Microcontroller and Embedded Systems, Pearson Education.
2. David E. Simon, An Embedded Software Primer, Pearson Education Asia
3. Raj Kamal Embedded Systems: Architecture, Programming and Design, Tata McGraw-Hill Publishing Company Limited.

PORT1 of the AT89C51 is connected to a multiplexed seven segment display system. The seven segment displays used here are common anode displays. Each pin of upper nibble in PORT1 is connected to a transistor BC547 which selects one of the 7-segment displays. The lower nibble is connected to IC 4511 a common anode BCD to seven segment decoder which converts the BCD data to seven segment data and then give it to the seven segment displays. These displays are used for the user to set the time, distance to be traveled, display time, display distance to be traveled, etc.

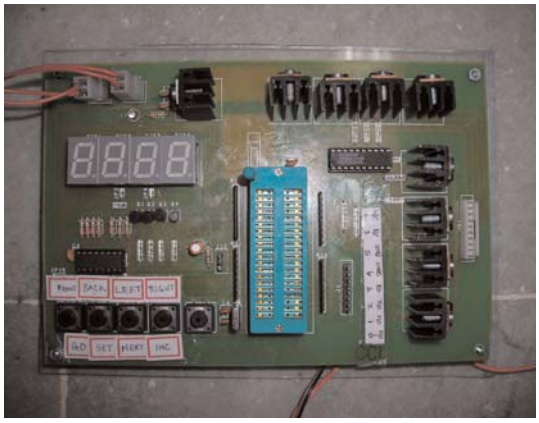
In PORT2 the lower nibble is connected to a 4 x16 decoder. The decoder outputs select which voice is to be played in APR9600's. The APR9600 device offers voice recording, non-volatile storage and playback capability. APR 9600 can store 8 voices because we use voice recorder IC's in random access mode. The duration of each voice is 7.5 seconds. We use these two voice recorder IC's in visitor guiding mode and patient guiding mode to play the voices stored.

In the upper nibble pin P2.4 is connected to a photoelectric sensor through an opto-coupler IC MCT2E which senses the obstacles in front of the robot. When the sensor senses the object it gives logic one to the controller. The pin P2.5 is connected to a buzzer. The pins P2.6 and P2.7 are connected to the base of transistor BC547. The collector of transistor BC547 is connected to the DC motor of the arm via relay which is used as a switching element for arm. When the microcontroller outs a 0V in the port pin P2.6 and +5V in the port pin P2.7 the arm comes out. When the microcontroller outs a +5V in the port pin P2.6 and 0V in the port pin P2.7 the arm moves inside.

In PORT3 the pins P3.3-P3.6 are connected to push to on switches which are used for giving input such as directions, distance and time to the robot.

The port pins P3.2 and P3.7 are connected to the SDA and SCL pins of the real time clock IC DS1307 respectively. The microcontroller communicates with DS1307 through I2C logic. We read the time from the real time clock and we can set the time in the patient guiding mode.

The robot is controlled wirelessly using the IC CM8870 by dual tone multi frequency technique (DTMF). Two cell phones are used here one as transmitter and another as a receiver .The signal from the receiver cell phone headset is given to the IC CM8870 which decodes the dual tones and gives a binary data according to the key pressed in the transmitter cell phone. The receiver cell phone is kept in the robot. First a call is made from a transmitter cell phone. After the call gets activated in the receiver end we can control the robot through the transmitter cell phone.



uC Board

Sensor, Relay, RTC, and Buzzer Board

Voice Board