Voice Controller

Back to the ME106 Homepage - Purpose - Component List - Introduction - Procedure - Conclusion

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Date: December 9, 1999

Purpose:

The main purpose of embarking on this project is to apply the theoretical and practical mechatronics design knowledge acquired during the course of this class to the conceptual design of a voice activated mechanism able to control the speed of a motor or turn on and off lights. The choice for this particular project originated from our knack for a project assignment that will demonstrate the applicability of basic electrical and electronic circuitry to the design of a control mechanism.

[Back to the top]

Component List:

- 1 VoiceDirect™ Voice Recognition Kit (Sensory Inc.)
- 2 OR Gates (74HCT32N)
- 2 Inverters (74HCT04N)
- 1 Set-Reset Latch (74279E)
- 4 MOSFET (IRL510)
- 1 Power Op-amp (LM675T)
- 3 Microswitches
- 5 Resistors (12 kW, 10kW, 7.1kW, 100W, 680W)
- 2 0.47micro-F Capacitors
- 1 LED
- 1 Motor
- 1 Microphone
- 1 Speaker

[Back to the top]

Introduction:

Incorporated in our design layout is the ability to effectively use voice to controlthe speed of a motor and the on/off function of lights. The VoiceDirect™ microchip recognizes a trained word and will give a logic high (+5 Volts) to the corresponding output pin. The output will only stay high for one second, so a latching circuit is needed.

The circuit for controlling the motor speed and the lighting will be turned on and off from the output of the voice chip. Four separate MOSFETS will be used as the switch (from on to off), a power op-amp will be used to control motor speed, and the light will go directly through the MOSFET.

It is worth noting the accuracy of the voice chip. The chip is highly sensitive to background noise. Here are a few things to do. First of all, keep background noise to a minimum. Second train the microchip in with the same background noise that it will be experiencing when in use. Last, try different microphones, microphone positions, and isolating of the microphone. Doing these three things should increase your accuracy.

[Back to the top]

Procedure:

Setting up the chip

The voice chip, made by Sensory Inc, comes configured in the VoiceDirect™ module. The

1. module needs connectors mounted to its input and output terminals. As shown in Table 1, solder connectors to all pins of JP-2 and pins 12, 13, and 14 of JP-3. We recommend using male headers (0.1" centers) for ease connection. The rest of JP-3 and JP-1 are used when the chip is configured to operate with a microcontroller.

JP-2	1	Mic (+)	9		JP-3	7	
	2	Mic (+)	10	Recognize		8	
	3	Mic (-)	11	Train		9	
	4	Vcc	12	Word 1		10	
	5	GND	13	Word 2		11	
	6	Speaker	14	Word 3		12	To 13
	7	Speaker	15	Word 4		13	To 13
	8		16	Word 5		14	Reset

Table 1. VoiceDirect™ Connections (Blank pins or pins not shown are unused.)

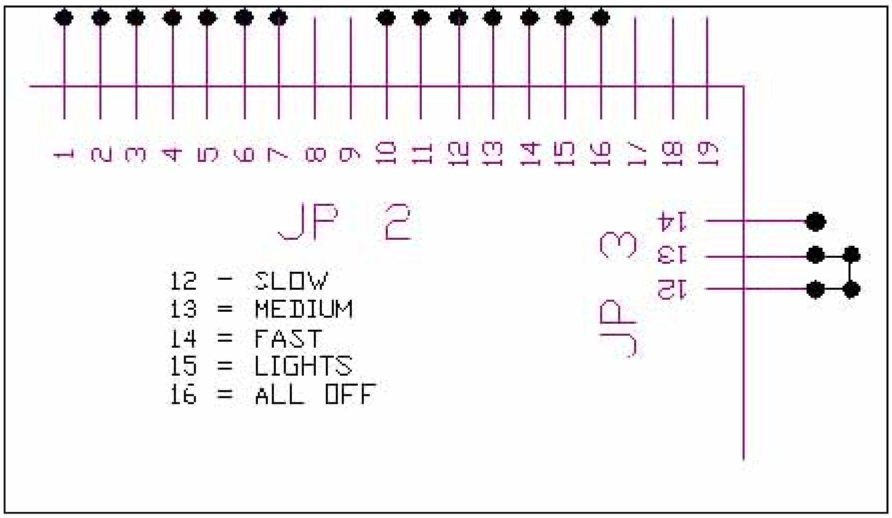


Figure1. VoiceDirect™ Pins

[Back to the top]

2. Wire the voice controller as shown in Figure 2.

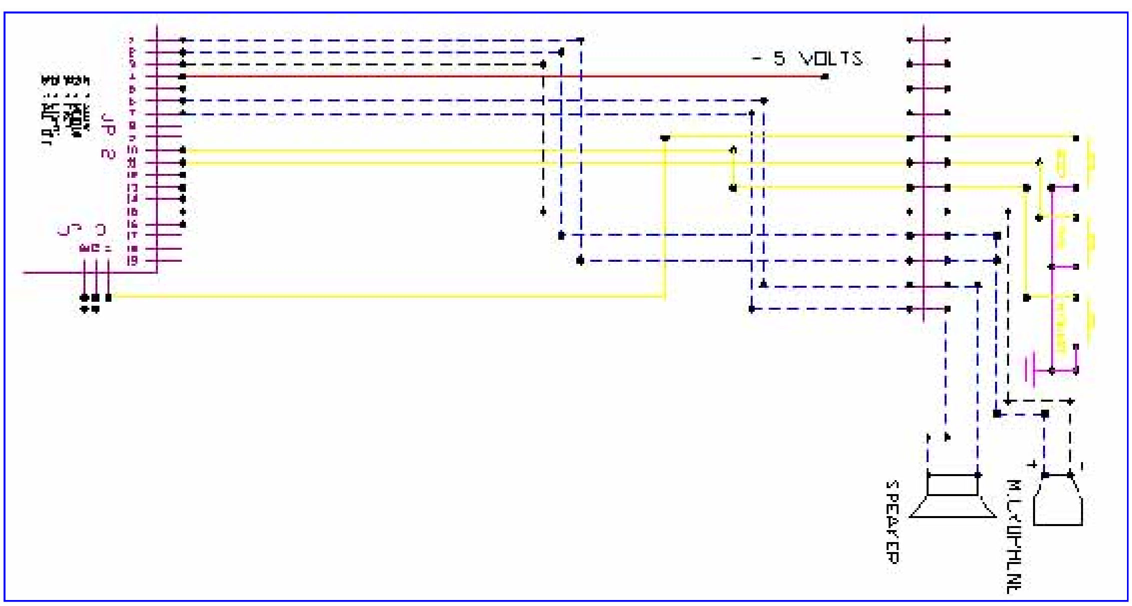


Figure 2. Initial Wiring of Voice Controller (Click to view full diagram)

[Back to the top]

3. When a voltage is applied as shown in Figure 2, the chip should "beep". Now we can train and test the voice chip. Pulling the train pin to ground momentarily and releasing it (or by using a micro-switch) will initiate the train process. The chip will ask for word one. After repeating it, the chip will either accept it or give an error asking for the word again. You can train up to fifteen words. When you have trained all the words you need, press the train button again will end the train session. You can continue to train from the last word you have trained by initiating the same sequence mentioned above. You cannot go back to the previous word, however you can erase all the words and start over by momentarily pressing both the train and the recognize buttons. Here is how we set up the chip for our design:

Word #	Word to be Recognized
Word 1	"slow"
Word 2	"medium"
Word 3	"fast"
Word 4	"lights"
Word 5	"off"

Table 2. Recognized Word Table

[Back to the top]

4. Once the chip is trained, you can test it by momentarily pressing the recognize button and waiting for the voice chip to prompt you to say a word. If the word you say is recognized it will say, "Word 1 (or corresponding number)," and send to a designated pin 5 volts for one second. Word one corresponds to pin 12 on JP-2. Word two corresponds to pin 13 on JP-3, and so on. There are only eight output pins available on the chip. The way to get fifteen separate outputs is as follows:

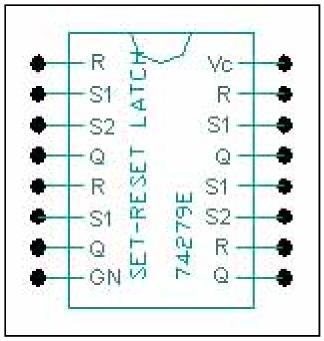
Word 1	Pin 12
Word 2	Pin 13
Word 3	Pin 14
Word 4	Pin 15
Word 5	Pin 16
Word 6	Pin 17
Word 7	Pin 18
Word 8	Pin 19
Word 9	Pin 12 & 19
Word 10	Pin 13 & 19
Word 11	Pin 14 & 19
Word 12	Pin 15 & 19
Word 13	Pin 16 & 19
Word 14	Pin 17 & 19
Word 15	Pin 18 & 19

Table 3. Word Output Pin Relationship

Latching Circuitry

[Back to the top]

1. Since the voice controller only remains high (5 volts) for one second, we need to create a latch circuit to keep it high for our needs. We will do this with the aid of a Set-Reset Latch. See Figure 3 for the truth table and latch pin configuration.



Input			Output
S1	S2	R	Q
L	L	L	N/A
L	x	H	H
x	L	H	H
H	H	L	L
H	H	H	No Change

Figure 3. Latch Truth Table and Pin Configuration

[Back to the top]

2. The latch we are using has the outputs we desire, but the inputs are the invert of what we need. We will solve this by inverting all inputs into the latch as shown in Figure 4. Pin 1 of the inverter is the first input. Pin 2 is its inverted output. The last pin on the left side, pin 7, is ground. The top pin on the right, pin 14, is Vcc.

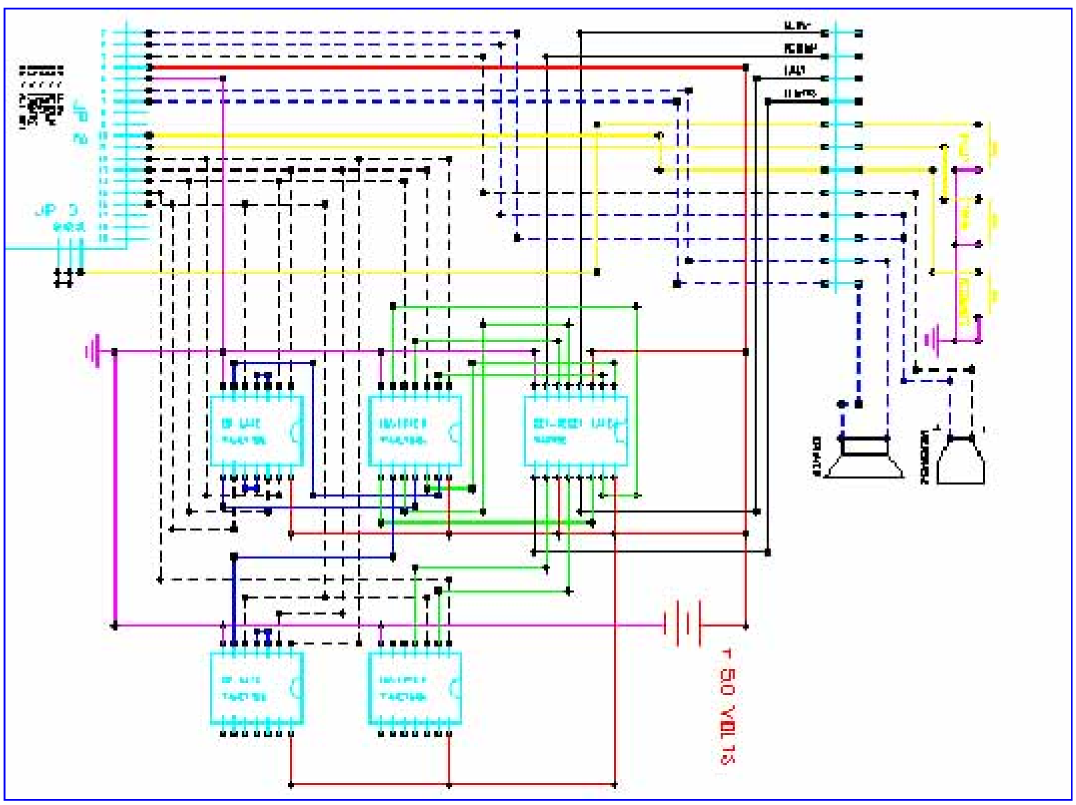


Figure 4. Latch, Inverter, and Or Gate (Click to view full diagram)

Logic Circuitry

[Back to the top]

1. Also shown in Figure 4 are the necessary logic gates. Since we want the circuit to turn off when off is spoken; logic OR gates are used to achieve this. When off is said, all functions are turned off. Similarly, the words slow, medium, and fast are going to be used to control a motor's speed. Since we only want one speed on at a time, when slow is said, medium and fast should turn off. The same goes for the other two combinations. The word lights is used to turn on a light and it is only turned off when the word off is spoken. Figure 5 shows the OR gate pin configuration. For the OR gate, pin 7 is ground and pin 14 is Vcc. Pin 1 or Pin

2 outputs to pin 3, pin 4 or pin 5 outputs to pin 6, pin 13 or pin 12 outputs to pin 11, and finally pin 10 or pin 9 outputs to pin 8.

Motor Speed and Light Control Circuitry

[Back to the top]

1. IRL510 MOSFETS are used to turn on and off our light and motor speed circuits. For the light circuit connect the output from the latch corresponding to lights to the gate of one MOSFET. To the drain will be a resistor in series with an LED. The source will go to ground. See Figure 5 for a diagram.

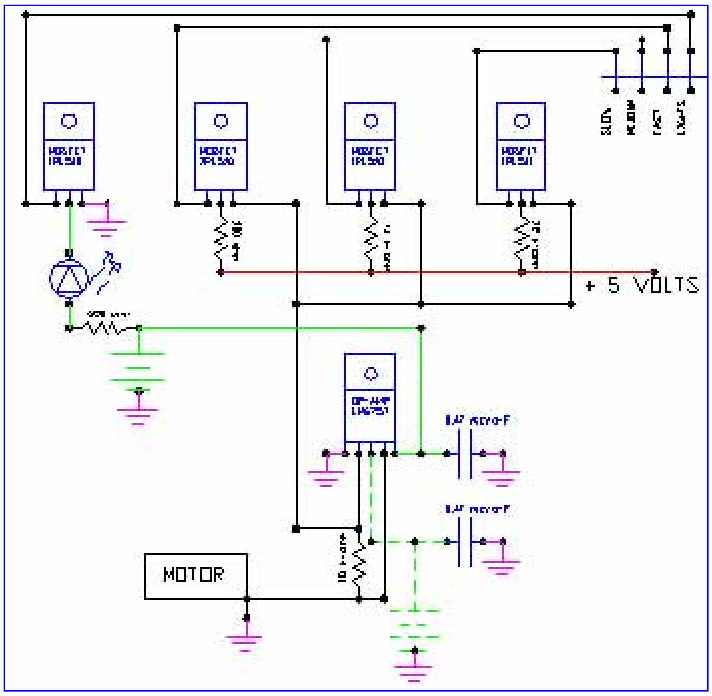


Figure 5. Light and Motor Speed Control Circuit (Click to view full diagram)

[Back to the top]

2. As shown above wire the corresponding outputs of the latch (for the speed control) to individual MOSFETS. Note the three different resistance values going to the drains of the MOSFETS. This variable will control the speed. Wire the source of all three MOSFETS to the inverting terminal of the LM675T Power Op-amp. Wire the remainder of the circuit according to the diagram.

Completed Circuit

[Back to the top]

1. Here is the diagram of the completed circuit:

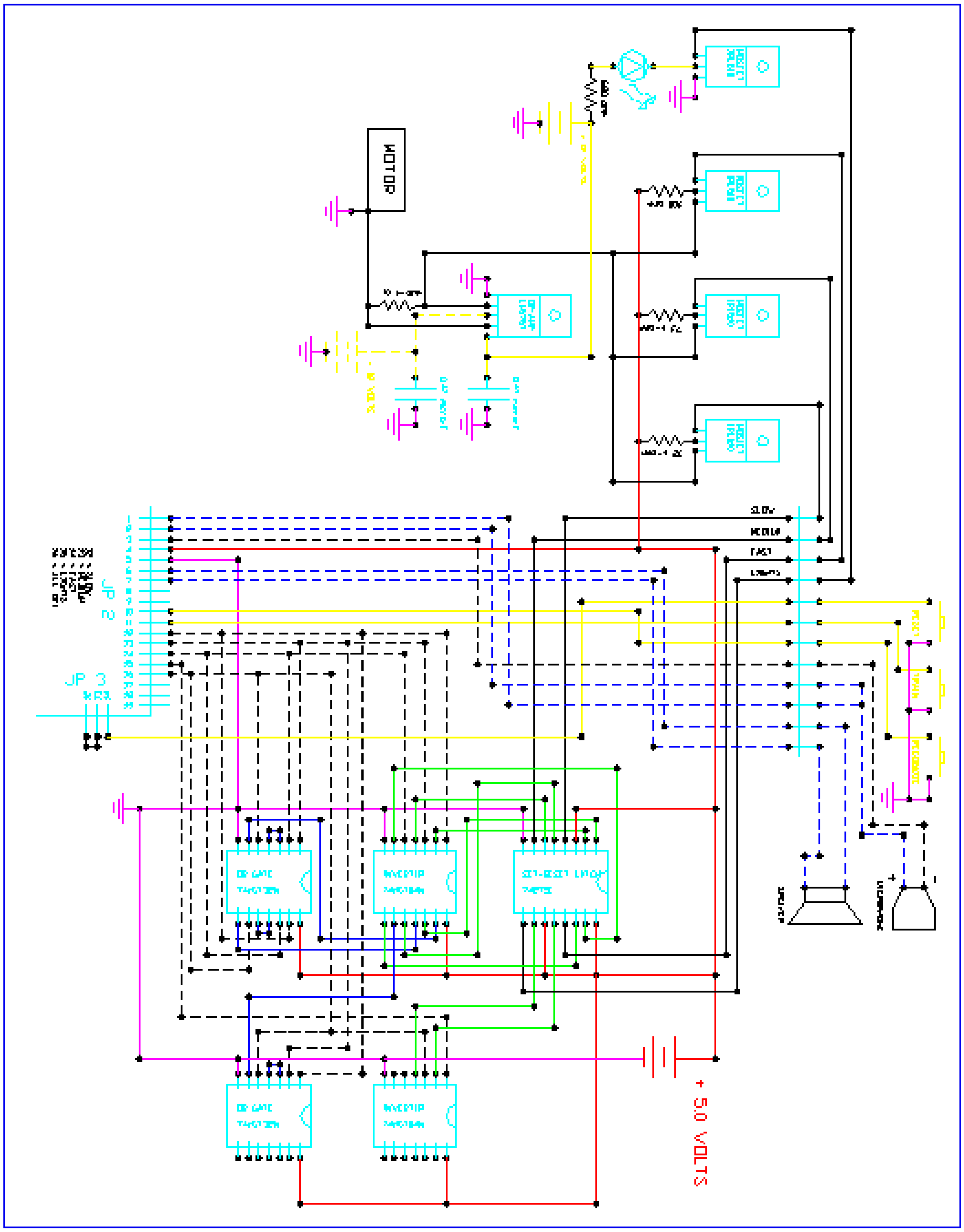


Figure 6. Complete Circuit (Click to view full diagram)

[Back to the top]

Conclusion:

In conclusion, we would like to say that the project design turned out a complete success. Though the voice chip used in the design of the project had some shortcomings, it basically did what we wanted it to. That was, recognize voice commands as inputs and send out digital signals as outputs. One noticeable set back of the chip was in its' inability to clearly distinguish between the background noise and the actual word commands. Its accuracy varied from 50% - 75% depending on the intensity of the background noise. In curbing this setback, we isolated the microphone from much of the background noise and this increased the accuracy of the voice chip to between 90% and 100%. The major setback of the chip, however, was that it did not have continuous recognition. By continuous recognition is meant the ability of the chip to reset itself and recognize sound continuously while sending out required outputs without any human interference. This was a major setback because that is exactly how we wanted the voice chip to operate. Interestingly, however a little late for our project, the manufacturer of the voice chip is going to add a continuous recognition function too next years VoiceDirect™ model. A second limitation of the chip was that it was a speaker dependent chip. This means it will only recognize the voice of the trainer. We would have liked to have a speaker independent chip that would recognize anyone's voice, unfortunately, do to financial constraints we were unable to purchase this advanced chip. However, within our cost limits, and also that of laboratory and human errors, our project design turned out great.

[Back to the top]