University of Florida

Department of Electrical and Computer Engineering

EEL 5666
Intelligent Machines Design Laboratory

Toolbot
Special Sensor Report

Final report
By
Jeno Nagy
December 10, 2002

Voice Recognition

Voice recognition is used on Toolbot to allow the user to select a particular size socket to be dispensed using only voice. Voice recognition is a difficult sensory project, but there are several manufactured sub-systems, which can accomplish this task. Toolbot uses the Sensory Voice Direct 364 (from Jameco) to recognize a spoken work and send a digital signal which represent the work said.

The Voice Direct Board is set up for strict, continuous listening mode, which allows the user to say one key work, followed by up to fifteen additional words. Once the works are trained, the system is ready to listen to commands. When the key word is recognized, the secondary word is listened to. If this is also recognized, certain pins will be toggled high for 1 second to indicate a match.

Two designs were tried, one on-board the robot with a miniature microphone, and second a remote, RF link, with a transmitter in a remote control box, and the receiver on-board Toolbot. The on-board idea did not work well, since voice tone and attenuation must be exact to the trained words, else a false or no recognition is made.

The RF link was a much improved idea. It employs the Voice Direct board, another small PIC 16F84 microcontroller, and the Rentron TWS-434 RF transmitter (from Reynolds Electronics) all enclosed in a small box, with a microphone headset. The digital data from the voice board is read by the PIC and is sent serially at 2400 baud to the receiver on Toolbot. The receiver is the matched pair RWS-434, which then serially transmits the data to the main controller on Toolbot. The range as tested indoors was effective up to 25 feet, but Reynolds claims distances of 400 feet. The circuit for the

transmitter and receiver are shown on the following page. The code for both are listed in the appendix.

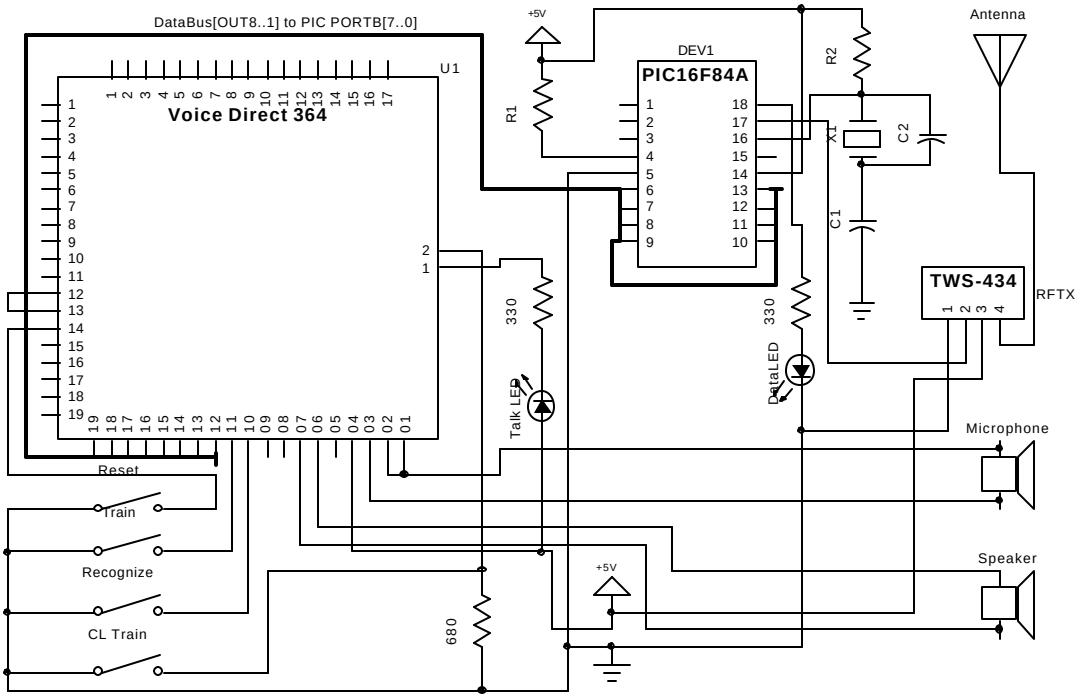


Figure 10. Voice Recognition RF transmitter headset

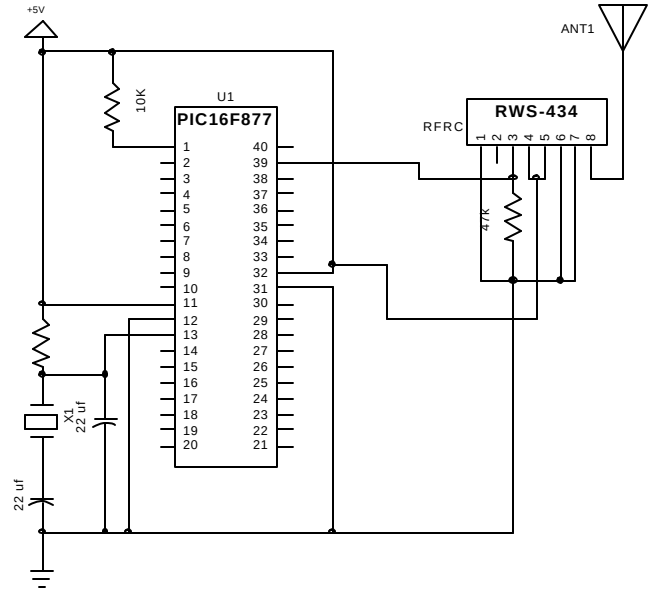


Figure 11. Voice recognition RF receiver

CMUcam Vision system

People following is implemented using the CMUcam serially connected to the main PIC controller. The CMUcam (From Seattle Robotics) is an integrated digital CMOS camera with an SX-28 microcontroller. Digital image information is extracted and serially transmitted. The theory of operation is that the camera can lock onto and track objects with bright colors. It does this by taking the RGB values of the tracked item, and following it on the screen. The camera then dumps serially image information, such as mass Y, mass X, and pixel information. This can be used to control the motion of Toolbot to keep the object centered in the camera's lens.

After many hours of terrible headaches and angry outburst of hatred, I got the camera to work and send serial data. (Despite having the wrong lens shipped form Seattle Robotics. NOTE: make sure you get the improved IR wide angle lens, its free if you ask). Initially the serial link was at 9600 and in pure bi-directional ASCII, but later improved to 38,400 baud with ASCII command transmission from PIC to camera, but raw stream data back form the camera to the PIC. This improved calculation time, since all values sent back were in standard 8-bit numerical format, as opposed to three 8-bit values representing the correct value ("2","5","1", for "251" for example).

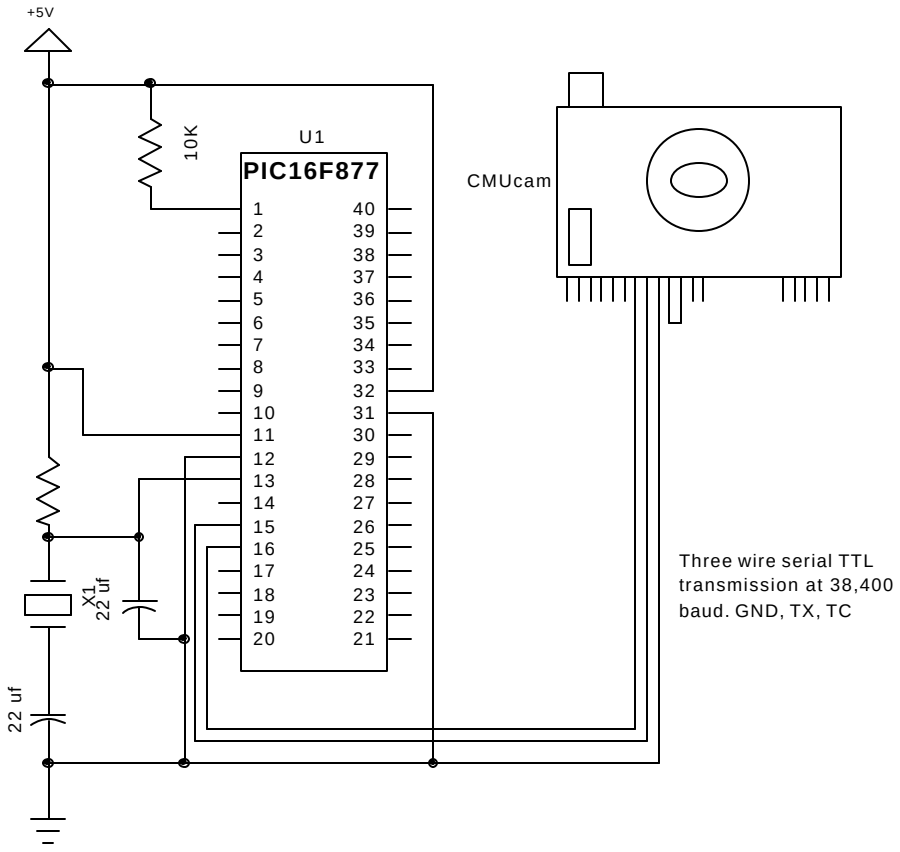
The camera is wired to a pair of input and output pins for receiving and transmitting. For various speed setting, jumpers must be set on the camera board. For 38,400, set jumper 2 only. Toolbot uses TTL logic level serial transmission, which the CMUcam offers as separate output pins on the board. These pins are also tied internally to a Max233 level shifter IC. This needs to be removed from its socket, otherwise the TTL logic pins do not work.

The CMUcam is initialized in a sequence of commands sent to the camera. The following shows how to lock on to a color on front of the camera and track its center of mass, its pixel count, and the camera's confidence level at seeing the object.

```
SerOut2    CMUcamTX,6,["rs",13]                'Camera reset
SerIn2     CMUcamRC,6,[WAIT(":")]
SerOut2   CMUcamTX,6,["PM 1",13]           'poll mode only
SerIn2     CMUcamRC,6,[WAIT(":")]
SerOut2    CMUcamTX,6,["MM 1",13]          'mass mode on
SerIn2     CMUcamRC,6,[WAIT(":")]
SerOut2              CMUcamTX,6,["CR 18 32 19 32",13] 'turn auto gain, white balace off
SerIn2    CMUcamRC,6,[WAIT(":")
SerOut2    CMUcamTX,6,["RM 3",13]
SerOut2    CMUCamTX,6,["TW",13]
SerIn2    CMUcamRC,6,[WAIT(":")]
LOOP
'SerOut2CMUcamTX,6,["TC",13]
SerIn2….DATA NEEDED
GOTO LOOP
```

The camera is reset on software, set to poll mode, mass mode is engaged and the image is adjusted by turning auto-gain and white balance off. Raw mode is turned on for raw transmission from camera to PIC. Then Track Window is called to lock in on object in the center part of the image. The RGB values of this object are tracked by calling the Track Color command. One frame of values is sent back each time. Toolbot checks to see if the center of mass in the X direction is close to the center. The screen size is 80 by 143, so the X center is at 40. If the mean is between 35 and 55, then move forward, else if les then 35 move left, or more that 55 move right. The pixel count indicated how many pixels the object takes up, hence the distance form it. If the pixel count > 208, then the object is close, so Toolbot stops. Confidence level indicates the camera's current lock on the color. If the confidence is low, the object is not in view.

The following figure shows the serial hook-up to the PIC. Complete Basic code for the camera is in the appendix.



CMUcam serial communication

Part Sources

Item	Seller	Cost
CMUcam	Seattle Robotics	$109
Voice Direct 364	Jameco	$59
RF pair	Reynolds Electronics	$38