Omnibot 2000

IMDL: Summer 1999

by

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Integrated System

Omnibot 2000 is an autonomous mobile agent (robot) built for the Intelligent Machines Design Laboratory during the summer of 1999. The robot resembles the upper torso of a human. It has two arms and a head, and sits on a mobile base. Each arm has five degrees of freedom, including a gripper as an end effector. The robot also has two degrees of freedom for the head, allowing it to pan and tilt. Additionally, the base contains six drive wheels. The robot has a total of 12 degrees of freedom; each actuated by a servo. The wheeled base also has two drive motors, each rotating a pair of wheels on each side of the robot.

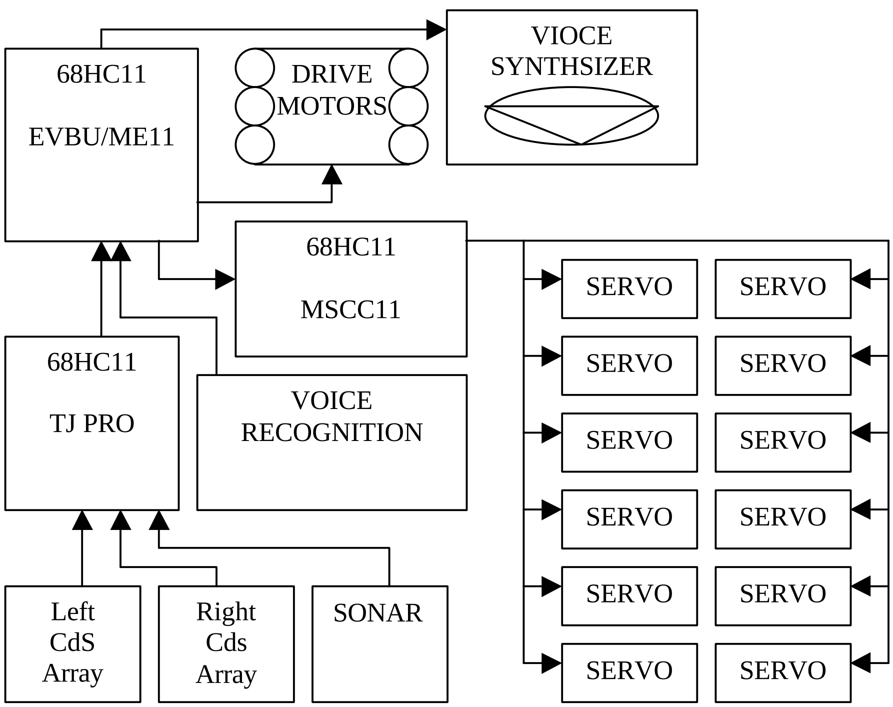
The robot also contains three Motorola 68HC11 microcontrollers. One is operating in single chip mode on a Mekatronix MSCC11 circuit board. The other two are operating in expanded multiplexed mode with 32K of SRAM. One is on a Mekatronix TJ Pro circuit board and the other is on a Motorola EVBU board. The robot also has a voice synthesizer module, voice recognition, low-resolution vision, 12 infrared emitters and detectors, and four bump sensors.

The robot was designed to aid the elderly, the disabled, or those who are in need of assistance. It can perform simple functions, such as grabbing or carrying small objects. The operator issues commands to the robot, and the robot then responds by performing the requested task. The functions are low level, such as, "Gripper left plus [amount]" or, "Body forward." In addition to this "slave" behavior, the robot can entertain audiences by singing and dancing to <u>YMCA</u>. The robot also introduces itself and explains many of its features. Finally, the robot was also programmed to give my oral presentation.

The block diagram of the robot is shown in Figure 1. The 68HC11 on the EVBU board execute the main program, and takes in data from the sensors. It also sends commands to the MSCC11 via the SCI port to control the servos.

The structure of the robot was designed with the end user in mind. People who may need assistance will find that the robot is easy to use. The robot resembles a human; there are two arms and a head, so there are similarities between the way a person move and the way the robot moves. Therefore, when assistance is required, the user intuitively knows how to instruct the robot to move.

FIGURE 1:



Mobile Platform

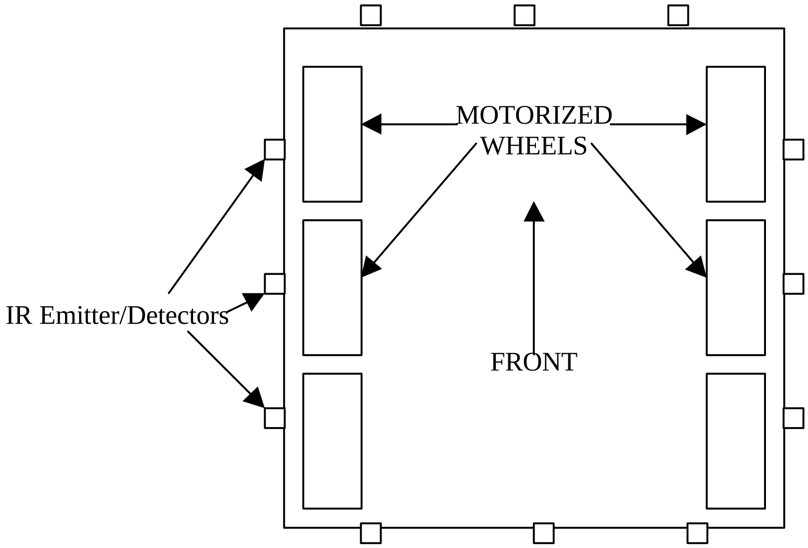
The platform is a Tomy Omnibot 2000, a robotic toy manufactured in the early 1980's. It is 30 inches tall, 24 inches wide and 15 inches deep. It has a head with two eye sockets, two arms with grippers, and sits on a wheeled base. It originally contained control electronics, a cassette tape player, a liquid crystal display, and small DC motors for actuation of some of the joints. I removed all of the stock electronics, except for the two drive motors.

Although the robot was designed as a child's toy, many improvements were made to the mechanical structure. First, seven more degrees of freedom were added, and the five existing ones were modified. Each arm has five, including the pitch and yaw of the shoulder, the pitch of the elbow, the rotation of the wrist, and the opening and closing of the gripper. The head can also pan and tilt. Therefore, the robot now has 12 degrees of freedom.

The entire platform is mobile. There are two drive motors in the base, each rotating two drive wheels. There are also two more wheels that are not motorized for added stability. The configuration is shown in Figure 2:

FIGURE 2:

Top View



Actuation and Output Devices

The goal of Omnibot 2000 is to help and entertain people. Help is provided by means of the robotic arms; they can grasp objects, move the objects to a new location and then release the objects. For example, the arms can grab a can of soda, then lift the can, rotate the wrist to pour the soda into a glass, and then return the can to its original position. As for entertainment, the robot uses the arms to form the letters “Y”, “M”, “C”, and “A” while singing and dancing to YMCA.

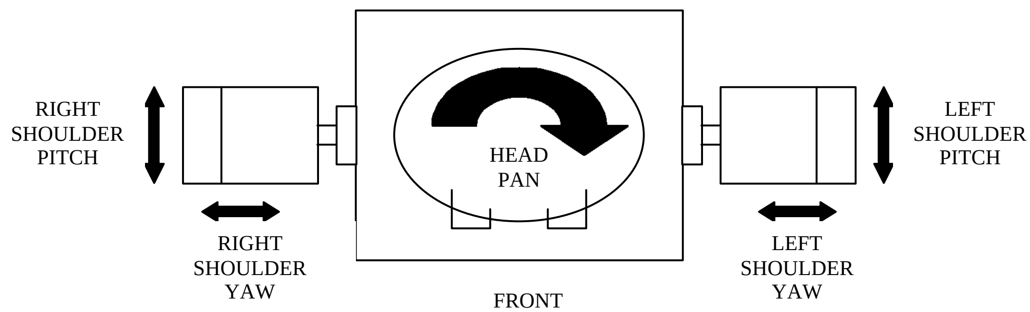
The original robot had small DC motors in the right arm providing movement to the shoulder pitch, the rotation of the wrist, and the actuation of the gripper. However, these motors did not have enough torque for the desired application. Seven more degrees of freedom were added, and the same control algorithms were needed for all of the joints. Therefore, the motors that came with the robot were removed and replaced by servos.

To accomplish the specified goals, Omnibot 2000 needed servos that can supply enough torque to move all of the joints. The servo torque must also provide strength for the arms to lift objects in the grippers. The grippers also need high torque servos to grasp objects without slipping. Due to these requirements, Omnibot 2000 uses precision Cirrus Hobbies servos.

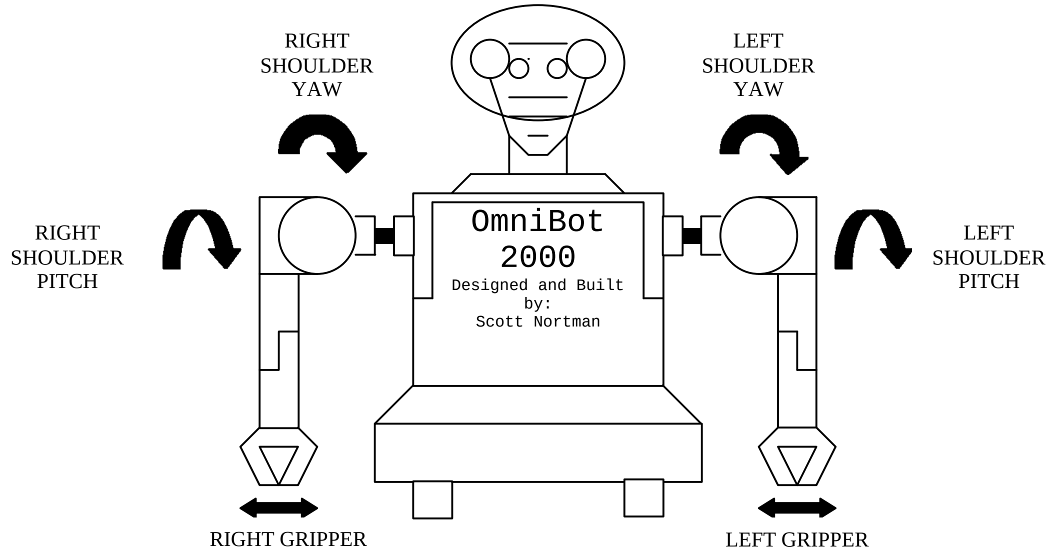
The shoulder joints have two degrees of freedom along the pitch axis and yaw axis. They may be moved independently, each using a CS-600 servo. The servos provide 333 oz-in. of torque, which allow the arms to rotate about each axis and lift objects. The pitch axis of each elbow uses a CS-400 servo, which provides 180 oz.-in. of torque. Each wrist rotates about its roll axis, and uses a CS-50 servo with 45 oz.-in. of torque. Finally, each gripper uses a CS-80MG servo with 130 oz.-in. of torque allowing the gripper to open and close. Figure 3 shows the movements for Omnibot 2000.

FIGURE 3:

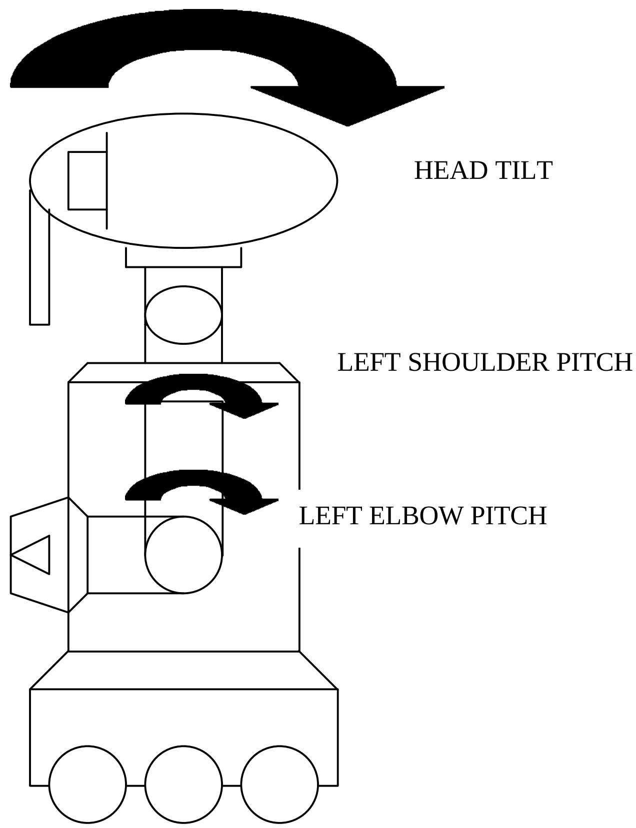
Top View



Front View:



Left View:



The servos are controlled by a Motorola 68HC11 microcontroller on a Mekatronix MSCC11 circuit board, operating in single chip mode. This microcontroller generates the pulse width modulation (PWM) signals needed by the servos. The signal is a TTL level pulse, with a period of 20 milliseconds. The duty cycle varies between zero and ten percent. A zero percent duty cycle causes the servo to position the output shaft at zero degrees, while a ten percent duty cycle positions the output shaft at 180 degrees.

The single chip microcontroller receives data from another 68HC11 microcontroller through the asynchronous serial port (SCI). The transferred data frame contains three bytes for each action performed by the servo. The first byte is a zero, indicating the beginning of a frame. The second byte contains a number between zero and 15, determining which servo should be moved. The third and final byte of the frame is a number from zero to 128, indicating the position the selected servo should move to. The code may be found in the appendix.

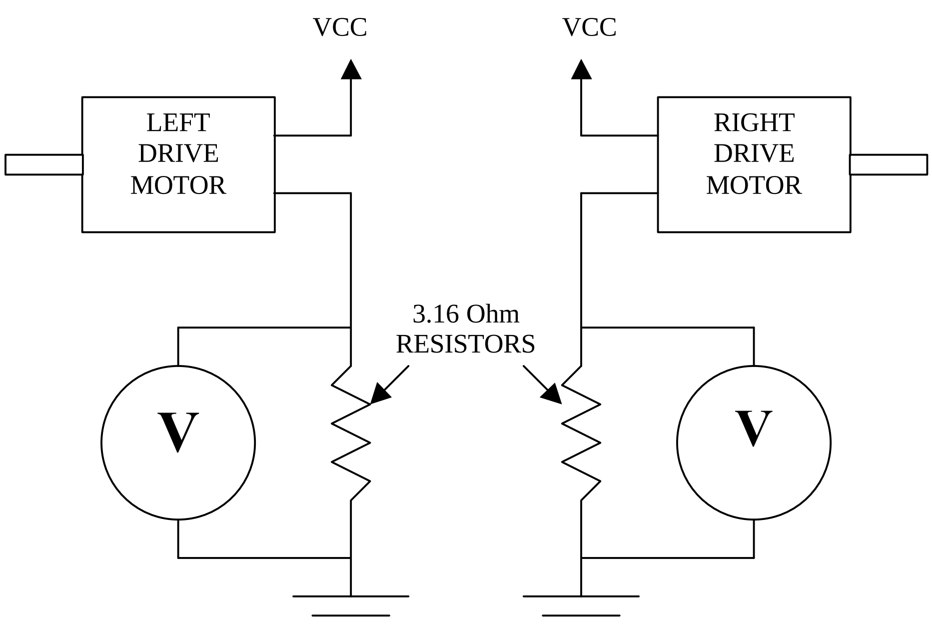
Although the above method of control is easy to implement, there are some disadvantages to using the SCI port. First, because the frame of data is transferred with the SCI port, a terminal may not be used to troubleshoot the robot during debugging or during use. Second, when any code is downloaded to the main microcontroller, the SCI lines must be disconnected from the main microcontroller because the data will also be transferred to the single chip controller, causing the servos to move to undesired positions. An alternate to disconnecting the SCI lines is to add a separate power switch to the single chip microcontroller so the PWM signals can not be generated.

For Omnibot 2000 to move around, drive motors are used. The base contains two drive motors from the original design. They are housed in a gearbox in between the sets of wheels. The motors are gear-reduced to increase their output torque and reduce their speed. There is a transmission feature in the gearbox, allowing the output of the gearbox to have a “high speed” and a “low speed” selection. This feature was not used for the current design, and the transmission was left in the “high speed” position. The drive motors and gearbox do have some limitations. They were not designed to carry the weight of the modified Omnibot 2000 robot. Because of the added weight, they are slow, loud, and do not allow the robot to turn well.

The stall current of the motors was determined experimentally, as shown in Figure 4. The stall current was found to average 1.27 Amps. The low current requirements of the drive motors permitted the use of a single chip motor driver. The chip is a Texas Instruments L293D Quadruple Half H Driver. The chip can provide enough current, however a heat sink was needed because the chip is designed to handle 1200 mA per coil and the stall current is 1270 mA for each coil.

The control signals are provided by another Motorola 68HC11 microcontroller, operating in expanded multiplexed mode. This controller is on an EVBU board, with a Mekatronix ME11 daughter board containing 32k of SRAM, a 74HC390 clock divider chip, and a memory mapped output port. Each of the drive motors requires two control signals from the microcontroller, the first for direction and the second for speed. The direction control lines used are port D bits 4 and 5. The speed control lines are from port, bits 5 and 6.

FIGURE 4:



Sensors

Onmibot 2000 has four different sensor suites. The first uses eight infrared (IR) emitters and detectors, arranged around the base, to determine the proximity of objects from the base. The second suite consists of four bump sensors. Two of the bump sensors are in the front of the base, and the other two are in the back. Next is the “special” sensor: voice recognition. This sensor is actually located in a separate, wearable module. The final sensor is low-resolution vision. However, due to time constraints, this last system is not functioning.

There are 12 IR emitter/ detector pairs are arranged around the bottom of the base as shown in Figure 2. Although there are 12 emitters and detectors, the center pairs on each side are not connected, and only eight are currently in use. They emit IR light modulated at 40kHz. The emitters are connected to a memory mapped output latch. Writing a 1 to the corresponding bit at address 0x7000 turns them on. The detectors are modified Sharp GP1U58Y IR sensors. They have been modified so they output an analog voltage in response to detected IR light. Therefore, the returned voltage is in proportion to the proximity of objects. The eight detectors are connected to port E of the 68HC11 operating in expanded multiplexed mode. Port E connects them to the internal analog to digital (AD) converter. Hopefully the IR sensors will prevent the robot from contacting any objects. However, if the robot does hit an object, the bump sensor will indicate a collision. The robot will then say, “Ouch!” and either back up or turn away or speed up, depending on which bump sensor(s) was contacted. If both front and back sensors are pressed at the same time, the robot will shut off the motors to prevent the motor driver from overheating.

The “special” sensor is voice recognition. Voice recognition was chosen because speech is a natural way to communicate. Software that performs speech recognition is currently available for personal computers. These programs operate simultaneously with the computer operating system. However, the disadvantages include the requirement of a compatible sound card, and the necessity of a computer. While these speech programs are impressive, they can not be inexpensively incorporated into an autonomous mobile robot. Fortunately, another option is available.

Another more viable voice sensor approach is with hardware that does not require a computer. The use of this sensor on an autonomous mobile robot is made possible by an HM2007 IC chip. The chip provides the options of recognizing either 40 words .96 second long or 20 words 1.92 seconds long. The circuit I am using selects the .96 second word length enabling the chip to recognize 40 independent words.

Although only 40 words may be recognized, these words control all of the functions of my robot. The words that may be understood are shown in Figure 5. The words may be used to change behaviors. Accordingly, if I say, “Slave,” the robot will stop its current behavior and respond to my spoken commands only, as opposed to its other sensor readings. If I say, “Avoid,” the robot will avoid obstacles. Additionally, these words may be used in combination so simple phrases may be understood. For example, the phrase, “Rotate left shoulder forward nine zero degrees,” will be understood by the robot and it will then rotate its left shoulder forward 90 degrees.

FIGURE 5

WORD NUMBER	WORD	WORD NUMBER	WORD
1	ONE	21	ROTATE
2	TWO	22	GRIPPER
3	THREE	23	WRIST
4	FOUR	24	SHOULDER
5	FIVE	25	ELBOW
6	SIX	26	HEAD
7	SEVEN	27	NECK
8	EIGHT	28	DANCE
9	NINE	29	AVOID
10	ZERO	30	SLAVE
11	FORWARD	31	FOLLOW
12	BACKWARD	32	PITCH
13	LEFT	33	YAW
14	RIGHT	34	MINUS
15	BODY	35	PLUS
16	BEGIN	36	CLEAR
17	STOP	37	INTRO
18	MOVE	38	SHOW
19	OPEN	39	*EXTRA*
20	CLOSE	40	*EXTRA*

Since the recognition is dependent upon the proximity of the speaker to the microphone, the microphone could not be mounted on the mobile robot. This would cause inconsistencies in recognizing the words. Due to these inconsistencies, the sensor is positioned in a separate module. This module is self-contained and wearable. It contains the HM2007 IC and additional circuitry required for transmitting the data to the robot via a RF signal. The module has a 12-button keypad, with buttons for 0-9, train, and clear. It also has two seven segment displays that indicate which word, if any was recognized. There is also a microphone/antenna jack, an on/off switch, and a status indicator LED.

The voice recognition module may be trained by entering in the number of the word that is to be trained, then pressing the “train” button, and finally saying the word. The status LED blinks after the word is trained, and the seven segment displays show the number of the trained word. The process is then repeated for all of the words. To clear a word, the number of the word that the user wishes to clear is entered, and then the “clear” button is pressed.

The HM2007 is a digital signal microprocessor. It receives input from the microphone and samples the signal and a fixed frequency. The data collected during the sampling is stored in the NVSRAM. When a new word is heard by the HM2007, it collects the data and stores it to a temporary location. It then compares the results of the new data to the data of known words stored in memory. If the stored data matches within an allowable range (accounting for allowable error), the processor indicates a match by placing the data on the data bus and asserting a data enable signal. This causes the data to be latched and displayed on the two seven segment displays.

This data must also be sent to the robot. This is accomplished by using a Holtek 640 encoder, a Holtek 648L decoder, a Linx Technologies TXM transmitter, and a Linx Technologies RXM receiver. The encoder receives the data from the data bus, and upon receiving the enable signal converts and encodes the data into a serial format which can be transmitted via the RF modules and then decoded be the Holtek IC. The data is then latched to the microprocessor in the robot with a memory-mapped input/output port. The block diagram is shown in Figure 6 and the schematic is shown in Figure 7.

FIGURE 6:

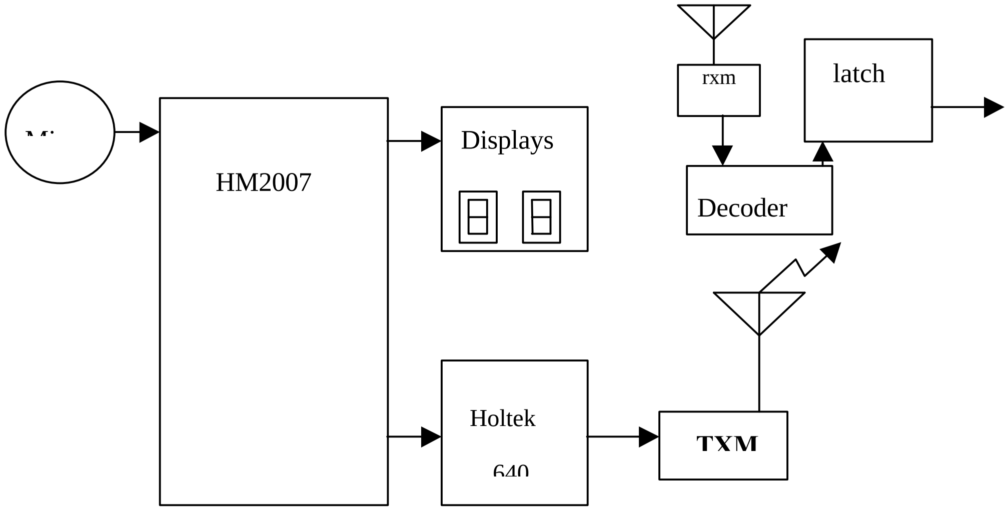
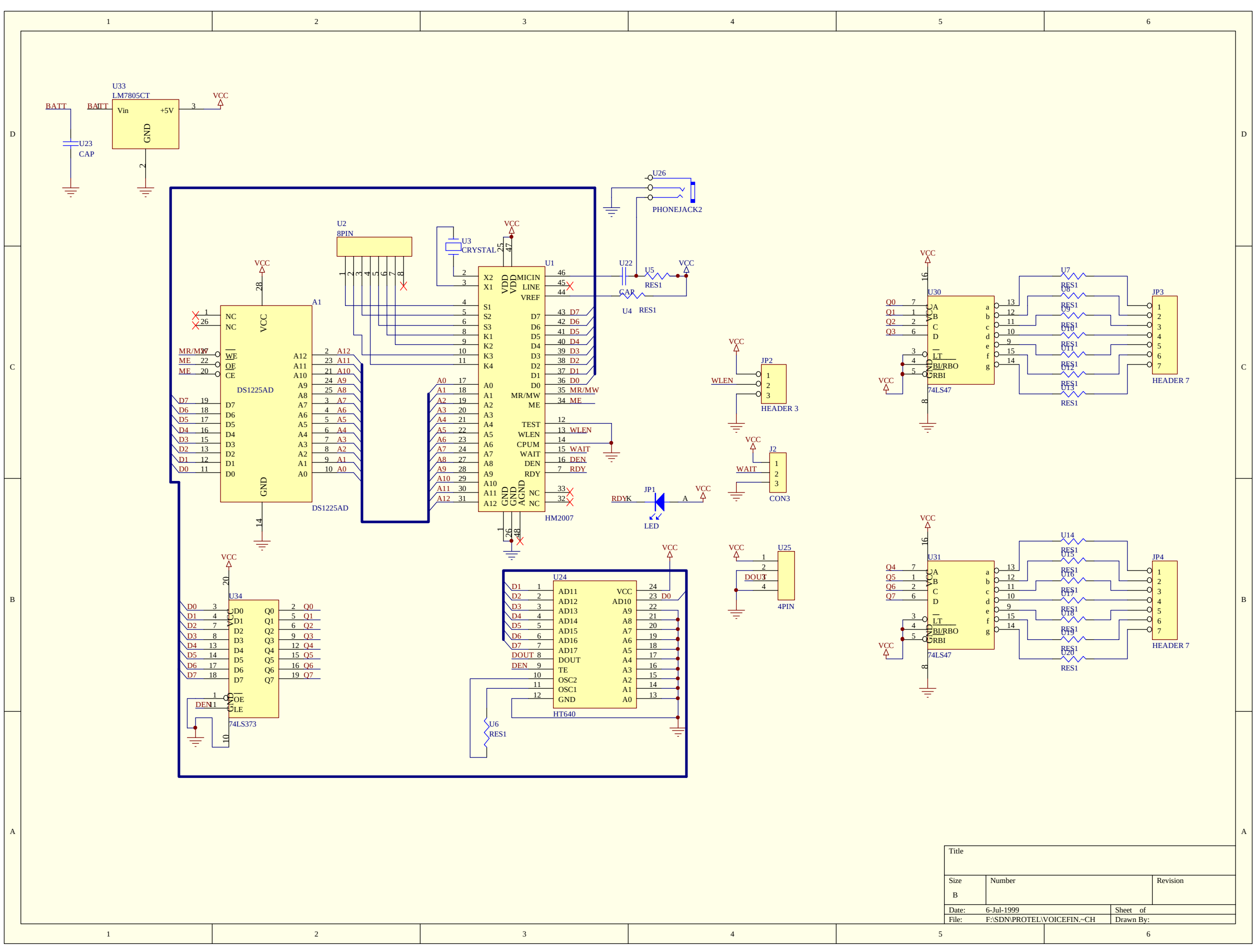


Figure 7:



The performance of the voice recognition module was determined experimentally. All of the different keywords were programmed into the module, and then the list was repeated five times. The mis-recognized words were re-programmed into the module after each trial (the incorrect selection is shown in parenthesis). The results of each trial are shown in Figure 8, and plotted in Figure 9 (Note: experiments were performed before final word changes were made). In addition to the single words being repeated, phrases were also tested. Two different phrases were repeated five times. The first phrase was, "Open left gripper." The second phrase was, "Rotate left shoulder forward nine zero degrees." They were repeated three times. The results are shown in Figure 10 and plotted in Figure 11. The module is shown in Figure 12.

FIGURE 8:

WORD NUMBER	WORD	TRIAL 1 CORRECT?	TRIAL 2 CORRECT?	TRIAL3 CORRECT?	TRIAL 4 CORRECT?	TRIAL 5 CORRECT?
1	ONE	Y	Y	Y	Y	Y
2	TWO	Y	Y	Y	Y	Y
3	THREE	N(08)	N(28)	Y	Y	N(32)
4	FOUR	Y	Y	Y	Y	Y
5	FIVE	N(13)	Y	Y	N(23)	Y
6	SIX	Y	Y	Y	Y	Y
7	SEVEN	Y	Y	N(33)	Y	Y
8	EIGHT	N(3)	Y	Y	N(21)	N(27)
9	NINE	N(14)	N(14)	Y	Y	Y
10	ZERO	Y	Y	Y	Y	Y
11	FORWARD	Y	Y	Y	Y	Y
12	BACKWARD	Y	Y	Y	Y	Y
13	UP	N(28)	Y	Y	Y	Y
14	DOWN	Y	N(27)	Y	Y	Y
15	LEFT	Y	Y	Y	Y	Y
16	RIGHT	Y	Y	Y	Y	Y
17	STOP	Y	Y	Y	Y	Y
18	MOVE	Y	Y	Y	Y	Y
19	OPEN	Y	Y	Y	Y	Y

20	CLOSE	Y	Y	Y	Y	Y
21	ROTATE	Y	Y	Y	Y	Y
22	SET	Y	Y	N(13)	Y	Y
23	TIME	Y	Y	Y	Y	Y
24	GRIPPER	Y	Y	Y	Y	Y
25	WRIST	Y	Y	Y	Y	Y
26	SHOULDER	Y	Y	Y	Y	Y
27	ELBOW	Y	Y	Y	Y	Y
28	HEAD	Y	N(31)	Y	Y	Y
29	NECK	Y	Y	N(28)	Y	Y
30	DANCE	Y	Y	Y	Y	Y
31	AVOID	N(28)	Y	Y	Y	Y
32	DEGREES	Y	Y	Y	Y	Y
33	SLAVE	Y	Y	Y	Y	Y
34	*EXTRA*					
35	*EXTRA*					
36	*EXTRA*					
37	*EXTRA*					
38	*EXTRA*					
39	*EXTRA*					
40	*EXTRA*					

FIGURE 9:

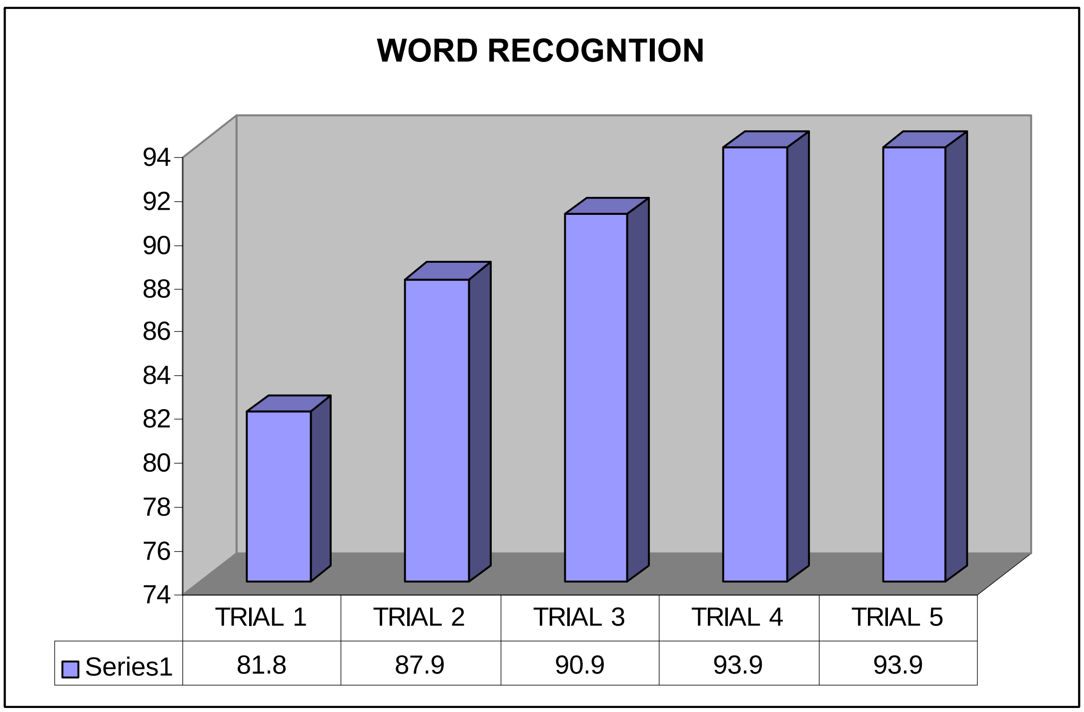


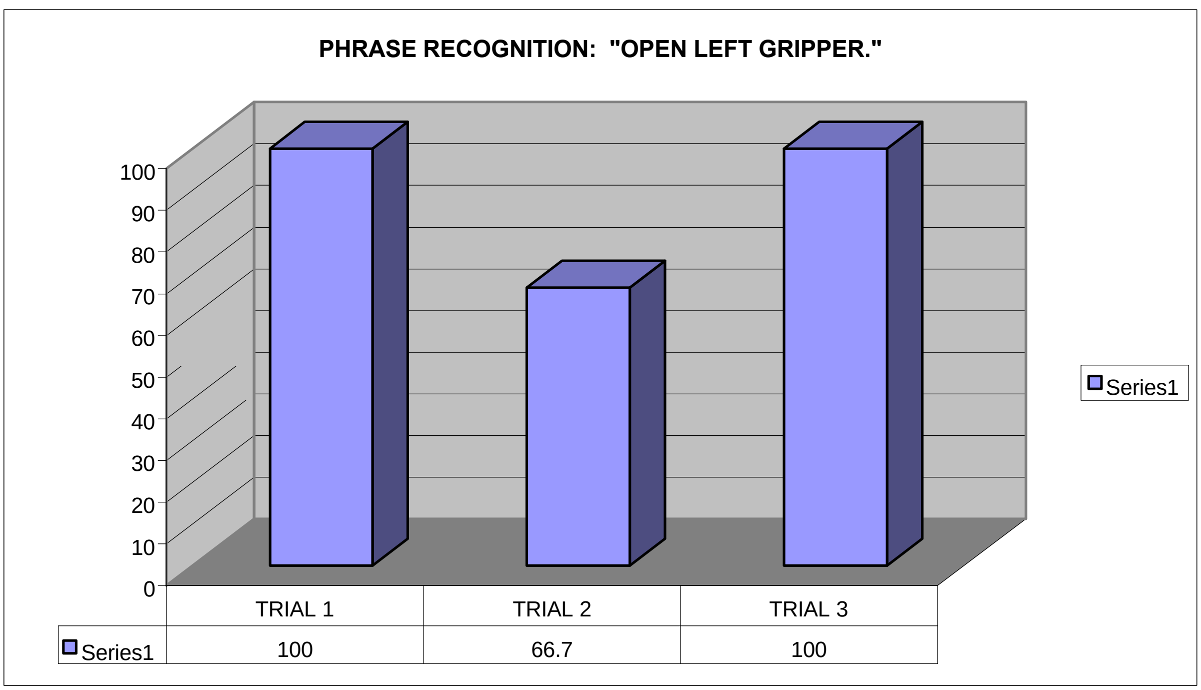
FIGURE 10:

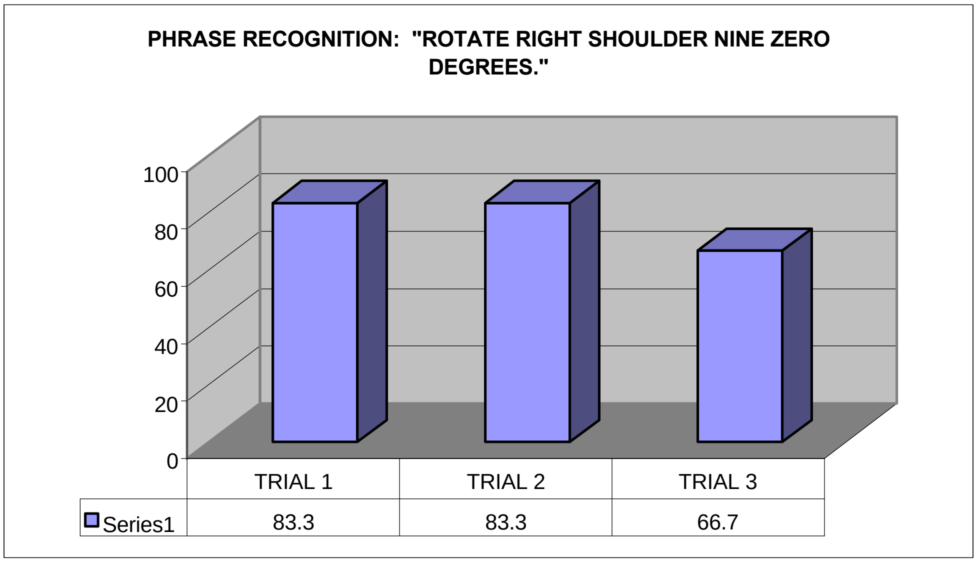
	TRIAL 1	TRIAL 2	TRIAL3
WORD			

NUMBER				
19	OPEN	Y	Y	Y
15	LEFT	Y	N(19)	Y
24	GRIPPER	Y	Y	Y

		TRIAL 1	**TRIAL 2**	**TRIAL3**
WORD NUMBER				
21	ROTATE	Y	Y	Y
16	RIGHT	Y	Y	Y
26	SHOULDER	Y	Y	N(21)
9	NINE	N(77)	N(16)	N(16)
10	ZERO	Y	Y	Y
32	DEGREES	Y	Y	Y

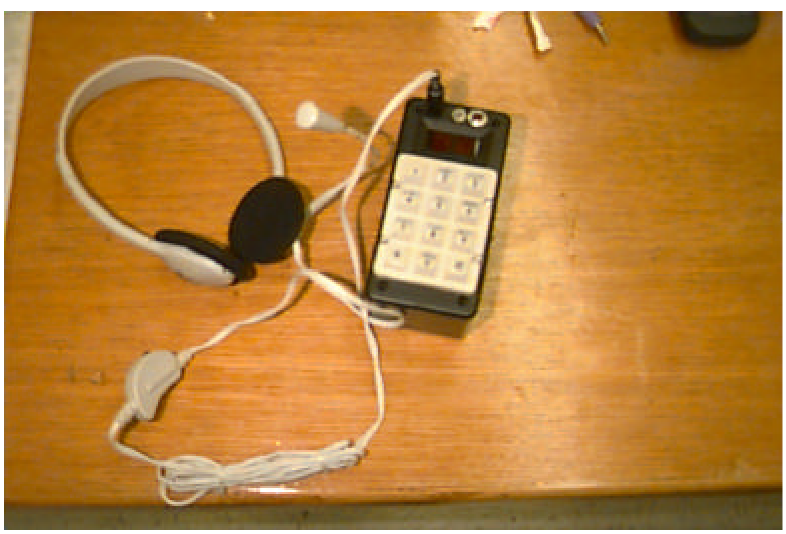
FIGURE 11:





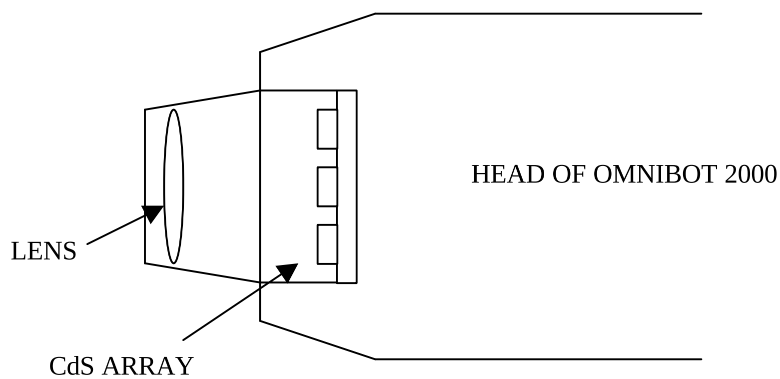
As indicated from the above data, the device works best when simple phrases are used. This may be attributed to the fact that individual words may have been over-emphasized when spoken individually, but not when they were part of a phrase. Another user may have a more consistent voice, thereby improve the accuracy of the module. Although the results could be improved, there is sufficient evidence indicating that the voice recognition module is a useful tool for humans to verbally communicate with robots.

Figure 12:



The fourth and final sensor suite is a low-resolution vision system. This suite contains 50 CdS cells, seven analog multiplexers, a sonar emitter circuit, a sonar receiver circuit, and a Mekatronix TJ pro board with a Motorola 68HC11 microcontroller operating in expanded multiplexed mode with 32k of SRAM. In addition to the electronics, each eye contains a 50 mm lens, focusing images on each of the two CdS arrays, as shown in Figure 13. Although all of the hardware is present, the low-resolution vision system is currently not functioning due to lack of time.

FIGURE 13:



Behaviors

Omnibot 2000 is currently capable of four behaviors. These include obstacle avoidance, wall following, obeying commands, entertaining. The behaviors are selected by issuing voice commands to the robot. By saying, “Begin avoid” the robot will start its avoidance behavior. The other behaviors are started in a similar fashion. The robot repeats the words that it hears, so the user will know if the robot has understood the command correctly. Once a complete command is understood, the robot will then say a phrase indicating that it has understood the commands, and then executes the instructions.

The first three behaviors use the sensors to determine the actions of the robot, while the last two are simply “shows.” The avoidance behavior uses four IR emitters and detectors. Two are in the front of the robot, and two are in the rear. The sensors return a value between 88 and 120. There are no objects being detected when 88 is returned, and when 128 is returned the sensors are saturated. There is an avoidance threshold set at 100, and when the sensors return a value higher than that, the robot turns away from the corresponding high sensor direction. Additionally, if the sensors in the rear return a value higher than the avoidance threshold, the robot speeds up to get away from the object. This is obstacle avoidance behavior.

The wall following behavior uses the other four IR emitters and detectors. Two are on the left side, and two are on the right side. The values returned by the detectors on a side are compared to the threshold, and when the forward detector is above it and the rear detector is below it, the robot starts to turn away, and vice-versa. This situation is the same for the left and right sides.

The next behavior is obeying commands, is “slave” mode. The robot will listen to spoken instructions, and then do as it is told. The words are used in combinations to make up phrases. The phrases that Omnibot 2000 will understand are:

1. ROTATE(21) LEFT(13) SHOULDER(24) PITCH(32) MINUS(34) <AMOUNT>
2. ROTATE(21) LEFT(13) SHOULDER(24) PITCH(32) PLUS(35) <AMOUNT>
3. ROTATE(21) LEFT(13) SHOULDER(24) YAW(33) MINUS(34) <AMOUNT>
4. ROTATE(21) LEFT(13) SHOULDER(24) YAW(33) PLUS(35) <AMOUNT>
5. ROTATE(21) LEFT(13) ELBOW(25) MINUS(34) <AMOUNT>
6. ROTATE(21) LEFT(13) ELBOW(25) PLUS(35) <AMOUNT>

7. ROTATE(21) LEFT(13) WRIST(23) MINUS(34) <AMOUNT>
8. ROTATE(21) LEFT(13) WRIST(23) PLUS(35) <AMOUNT>
9. ROTATE(21) RIGHT(14) SHOULDER(24) PITCH(32) MINUS(34) <AMOUNT>
10. ROTATE(21) RIGHT(14) SHOULDER(24) PITCH(32) PLUS(35) <AMOUNT>
11. ROTATE(21) RIGHT(14) SHOULDER(24) YAW(33) MINUS(34) <AMOUNT>
12. ROTATE(21) RIGHT(14) SHOULDER(24) YAW(33) PLUS(35) <AMOUNT>
13. ROTATE(21) RIGHT(14) ELBOW(25) MINUS(34) <AMOUNT>
14. ROTATE(21) RIGHT(14) ELBOW(25) PLUS(35) <AMOUNT>
15. ROTATE(21) RIGHT(14) WRIST(23) MINUS(34) <AMOUNT>
16. ROTATE(21) RIGHT(14) WRIST(23) PLUS(35) <AMOUNT>
17. ROTATE(21) HEAD(26) MINUS(34) <AMOUNT>
18. ROTATE(21) HEAD(26) PLUS(35) <AMOUNT>
19. ROTATE(21) NECK(27) MINUS(34) <AMOUNT>
20. ROTATE(21) NECK(27) PLUS(35) <AMOUNT>
21. BODY(15) LEFT(13) <AMOUNT>
22. BODY(15) RIGHT(14) <AMOUNT>
23. BODY(15) FORWARD(11) <AMOUNT>
24. BODY(15) BACKWARD(12) <AMOUNT>

35. GRIPPER(22) LEFT(13) MINUS(34) <AMOUNT>

36. GRIPPER(22) LEFT(13) PLUS(35) <AMOUNT>

37. GRIPPER(22) RIGHT(14) MINUS(34) <AMOUNT>

38. GRIPPER(22) RIGHT(14) PLUS(35) <AMOUNT>

<AMOUNT> indicates that the user is to say two digits, each zero through nine, indicating the position the servo is to move to. However, when issuing any commands that start with the command word, “BODY” <AMOUNT> indicates the amount of time the robot is to move in the specified direction in tenths of a second. For example, if the user wanted the robot to look straight ahead (head_pan servo equal to 0 degrees), the command would be, “ROTATE HEAD MINUS ZERO ZERO.” If the user wanted the robot to move forward for half a second, the command would be, “BODY FORWARD ZERO FIVE.” By using these commands, the user can have Omnibot 2000 perform basic assistive tasks.

The final behavior was developed to make Omnibot capable of giving a PowerPoint presentation, or sing and dance to a song. The user programs in the spoken text, in combination with body movements, and Omnibot 2000 will give a presentation or sing and dance. There is a function in the code, mouse_click(), that causes Omnibot to press the mouse button. However, Omnibot can not hold the mouse on its own; a rubber band is needed to secure it in place. To start this behavior, the user states the command words, “BEGIN SHOW.” Additionally, this behavior gives Omnibot the capability to dance. The lyrics to the song YMCA were programmed into Omnibot, along with the body gestures. When the correct command words are spoken, Omnibot 2000 will sing and dance to YMCA.

Conclusion

Omnibot 2000 was a great learning experience. I learned about mechanical design, electrical design, and software design. I also learned how to integrate everything and what problems may arise from combining different systems together to create a robot.

Omnibot 2000 is capable of intelligent, autonomous behavior. It can avoid bumping into objects, and if it does hit something, it then back up, turns, and continues on. It can also follow walls in combination with obstacle avoidance, so it can follow the walls of a room and still avoid bumping into things. Additionally, Omnibot 2000 is great for entertainment. People are fascinated when they watch it, so it attracts a large audience, and it fits the stereotypical image of a robot.

Although it is great for entertaining, it does not work well enough to help people. The control methods are too complex, the voice recognition can not perform consistently, and the mechanical structure has faults. The robot is a “proof of concept.” It proves that all of these ideas can be integrated into an autonomous working robot. It also exposes faults in the ideas and some of the original theory behind its conception.

If I were going to built Omnibot again, some things that can be improved include the mechanical design, electrical design, and overall control methodologies. A more robust mechanical structure, with more degrees of freedom, better end effectors, and a better locomotion system would satisfy the mechanical problems. The new structure, combined with a faster processor, more memory, and better sensors would be good enough for a new platform. The control system should be improved; higher level commands would simplify controlling Omnibot. This also includes better voice recognition, because the current system is not consistent enough for a reliable robot.

In spite of the downfalls, Omnibot 2000 is a great robot. Many ideas were implemented in the design, and some were successful, some were not. At times of failure, I would question all of the hard work and effort I was putting into the building of this robot. Luckily, the accomplishments outweigh all of the failures I had. I would like to build another robot similar to Omnibot 2000, and I can say that I have learned from my mistakes and the next robot will show this.

ABSTRACT

Omnibot 2000 is the name of the robot I built for EEL 5666, Intelligent Machines Design Laboratory, during the summer of 1999. The robot is designed to be a personal assistant, capable of helping the elderly or disabled. Additionally, Omnibot 2000 can entertain and perform. Its behaviors include obstacle avoidance, wall following, obeying commands, and performing. The user, using voice recognition determines the behaviors. The user issues commands to the robot, and the robot responds by repeating the words, and then performing the specified behavior. The robot contains four different sensor suits, including infrared emitters and detectors, bump switches, voice recognition, and low-resolution vision. During wall following behavior, Omnibot will turn away from objects in its path. When it is doing wall following, it will follow the walls of a room, and it will also avoid bumping into obstacles. When the robot is in its obeying commands behavior, the user can instruct the robot to move its arms, grippers, head, and body. The robot is a slave, performing any tasks the user requests. When it is told to dance, it will start singing and dancing to YMCA, or any other song programmed. Additionally, the robot was programmed to give my oral presentation.

Executive Summary

Omnibot 2000 was an old toy manufactured about 10 years ago by a toy company named Tomy. It was designed to be a toy, controlled by a hand held transmitter. The original design was not autonomous, the user had to control the actions of the robot by pushing buttons on the controller. The robot now has four different behaviors: obstacle avoidance, wall following, obeying commands, and entertaining. It also had only five degrees of freedom: the head could pan, the left shoulder pitch could rotate, the left gripper could open and close, and the wrist could rotate. I modified the original design by adding seven more degrees of freedom, for a total of 12. The head can now pan and tilt, each shoulder can now rotate about its pitch and yaw axis, both elbows can rotate about their pitch axis, both grippers can open and close, and both wrists can rotate. After redesigning the mechanical structure, I removed all of the stock electronics and added three Motorola 68HC11 microcontrollers. Two operate in expanded multiplexed mode, while the third operates in single chip mode. One of the expanded mode processors is used for the low-resolution vision system, while the other is used as the main controller of the robot. The single chip controller generates the signals required to control the servos. I also added a voice synthesizer module, voice recognition, infrared (IR) emitters and detectors, and bump sensors. The voice recognition is used to control the behaviors, as well as issue commands to the robot while it is in "slave" mode. The IR emitters and detectors are used for obstacle avoidance and wall following. The entertaining behavior does not any of the sensors. Omnibot 2000 is a successful performer, but the poor performance of the voice recognition limits the effectiveness of the robot when it is obeying commands. Fortunately, it does a great job at giving PowerPoint presentations.

Omnibot 2000

Final Report

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Introduction

Many people who are sick or elderly require special care or assistance when trying to perform certain tasks. Maybe someone who is sick can not grab an item that was dropped or are immobile and con not get it himself or herself. That is what Onmibot 2000 is designed to do: help people. Because the mechanical structure resembles a human, controlling the robot is intuitive and easy for people to learn. Additionally, because the robot is controlled by voice command, it is easy to use for people who are in need.

The goal of Onmibot 2000 was to design an intelligent autonomous agent that could move around, not bump into things, and help people. The robot would be capable of providing assistance, with an easy to use interface. As an added feature, the robot would also be able to entertain by singing and dancing.

These features are all available on Omnibot 2000. The following paper discusses the ideas and goals for the project. It then talks about the problems encountered, as well as the improvements made over the original design. Finally, the paper ends by talking about the accomplished goals and ideas for the future.