University of Florida
Department of Electrical and Computer Engineering
EEL 5666
Intelligent Machines Design Laboratory

"Lil' Homie"
Final Report

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Abstract

The goal of this project is to make an autonomous robot that can take pictures at parties of people (and/or animals). Lil' Homie does this by using a suite of sensors for obstacle avoidance and people detection. A Motorola 68HC812 microcontroller was used in controlling actuation and getting readings from the sensor suite. An onboard Pocket PC was used to process the sensors readings, send commands to all of the connected devices (motors, servos, LEDs, and camera), house any additional data, and to provide the user with an intuitive graphical user interface. The Pocket PC also provided the user with an extra level of interactivity.

Executive Summary

Lil' Homie is an autonomous party picture taking robot with a personality. Designed for use at parties or social gatherings, Lil' Homie roams around a room while avoiding obstacles for a random amount of time. After that random amount, the robot stops and waits for 10 seconds for a person to jump in front of the camera. During that wait time, Lil' Homie randomly plays one of about 10 predefined messages to call a subject over to get their picture taken. If someone comes over, there picture is taken and a praise message is played. If no one comes over, no picture is taken and a message of disapproval is played. The process begins over again until the routine is stopped.

Lil' Homie uses two Sharp GP2D12 IR Sensors and two PVC plastic whiskers for obstacle detection. A HVW Technologies PIR Motion Sensor is used to detect people. Also, an Aiptek Mini Pencam 1.3 digital camera is used to capture the photos. Finally, a Technological Arts 68HC812 powered development board relays signals to/from motors, servos, and sensors to/from an onboard Compaq iPaq 3650 Pocket PC where the signals are processed.

The Compaq iPaq 3650 Pocket PC provides a suite of utilities to calibrate, troubleshoot, and power Lil' Homie. The device has a 206 MHz Intel StrongArm microprocessor and 32 MB of ram which gives Lil' Homie a tremendous amount of processing power and storage space. Also, the device gives the operator a nice user interface to work with.

Introduction

Imagine, you are in Gainesville and the Gators' football team just won the biggest game of the season. To celebrate, you and your friends throw a 4 keg party at your place. The next morning you wake up confused on the lawn of you apartment complex, thinking to yourself, "What happened last night?" With Lil' Homie, it's possible to know exactly what happened last night. Also, with Lil'Homie, you can collect bribe pictures of other people doing stupid things or even get a digital guestbook of every person that walks through the door. This report describes the design process, sensor suite, and software of the robot in detail. It will also discuss pitfalls I found during the implementation of Lil' Homie.

Integrated Systems

The complete block diagram of how Lil' Homie's systems are connected is illustrated in Figure 1. A Technological Arts Adapt812 developing board is at the heart of the bot. Every device is connected to this developing board. The microcontroller relays sensor readings to an onboard Compaq iPaq 3650 Pocket PC where all of these signals are processed and decisions are made. These decisions are sent back to the Adapt812 µP where the appropriate signals are generated for the servos, motors, and other devices. The Adapt812 only serves as a forwarding device between the Pocket PC and the connected devices; all processing and decision making is done on the Pocket PC.

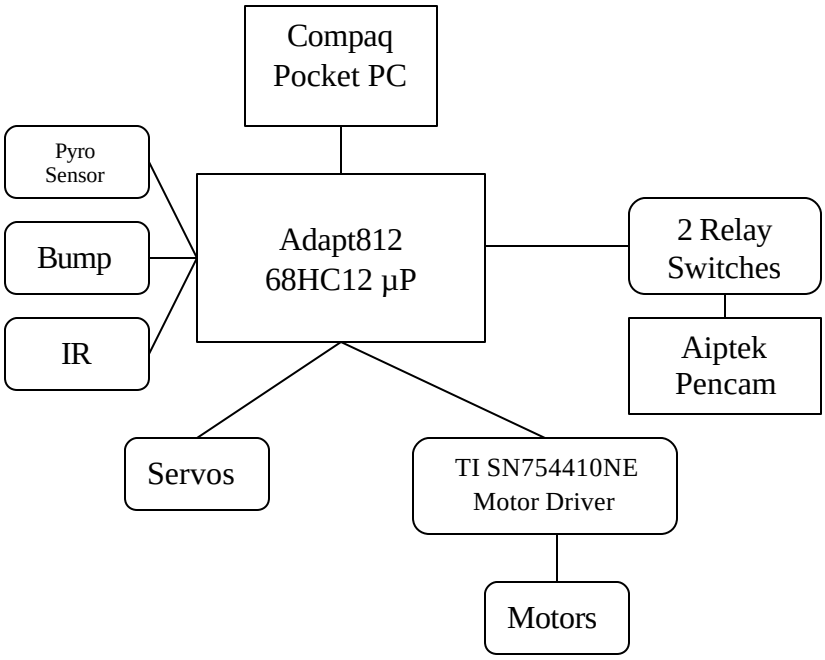


Figure 1 – Block Diagram of Robot's Integrated Systems

Technological Arts Adapt812 Developing Board

The Adapt812 Developing Board has many key features that made it, in my opinion, ideal for my robot. They are:

- *Small (2.25" x 3.25") package*
- *90 I/O lines, all programmable as input or output, many with input capture, output compare, and "key wake-up" interrupt capability*

- *8-channel, 8-bit analog-to-digital converter*
- *Provided plenty of space (4K EEPROM and 1K RAM on-chip) to run robot's slave program*
- *2 SCI UART systems*

The way the ports on Lil' Homie is configured is shown in Table 1.

Connection	Function	Port	Connector	Pin
Servo 1	Pan left/right movement	PT3/OC3	H1	10
Servo 2	Tilt up/down movement	PT2/OC2	H1	11
PWM1	Left Motor Speed Control Signal	PT0/OC0	H1	13
PWM2	Right Motor Speed Control Signal	PT1/OC1	H1	12
1A	Motor Direction Control	PJ3/KWJ3	H1	18
2A	Motor Direction Control	PJ2/KWJ2	H1	19
3A	Motor Direction Control	PJ1/KWJ1	H1	20
4A	Motor Direction Control	PJ0/KWJ0	H1	21
Left Front IR	Left IR Readings	PAD0/AN0	H1	22
Right Front IR	Right IR Readings	PAD1/AN1	H1	23
Left Bump	Left Bump Whisker	ADDR17/PG1	H2	37
Right Bump	Right Bump Whisker	ADDR16/PG0	H2	36
Camera Mode Relay	Mode	ADDR9/PA1	H2	32
Camera Shutter Relay	Shutter	ADDR8/PA0	H2	33

Table 1 – Connections made on Adapt812

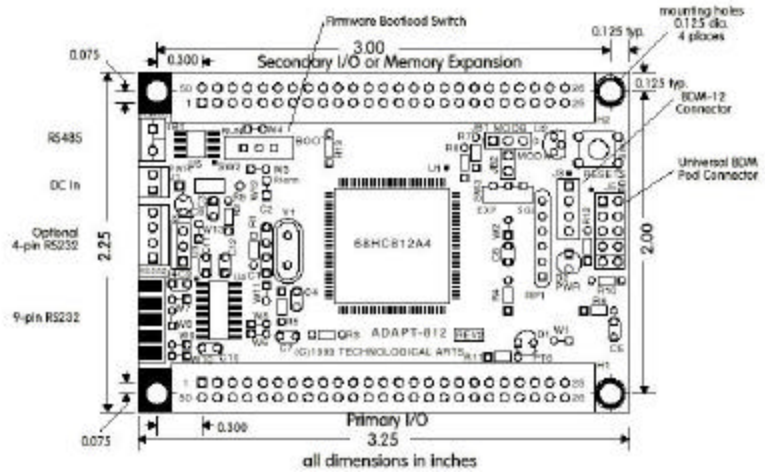
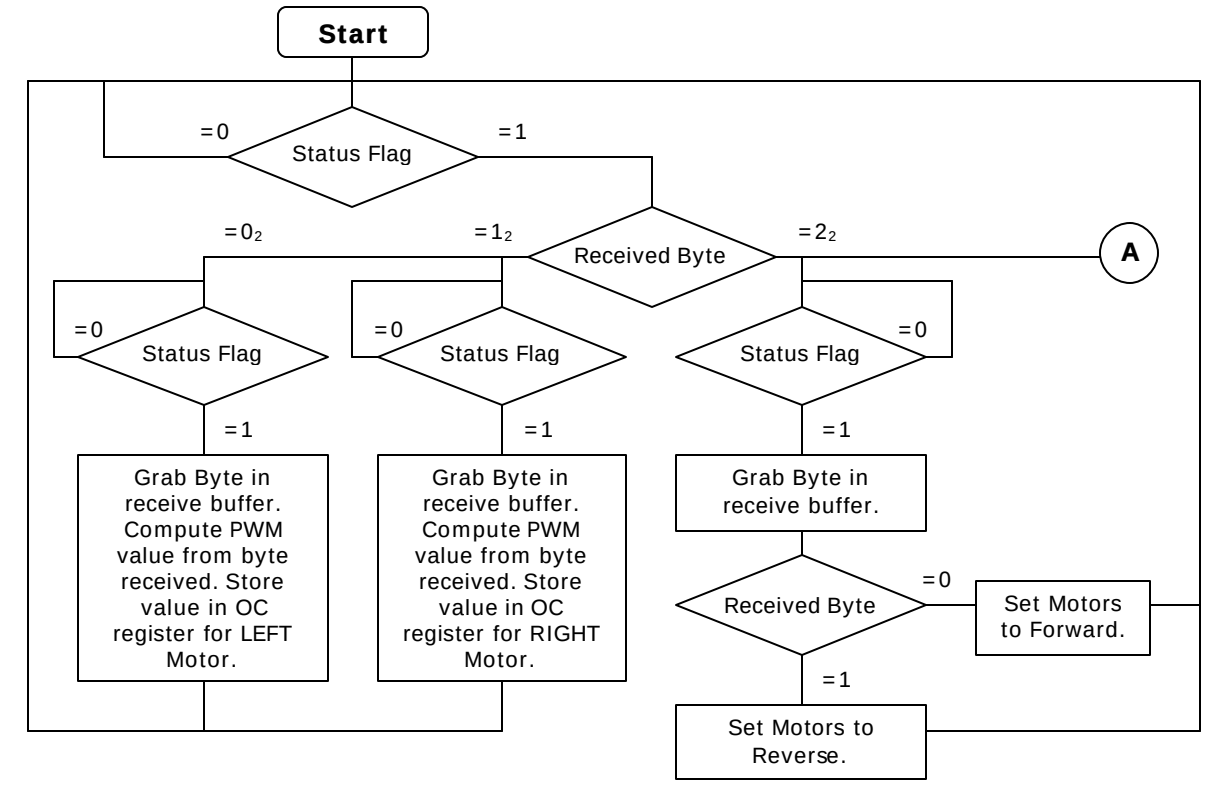
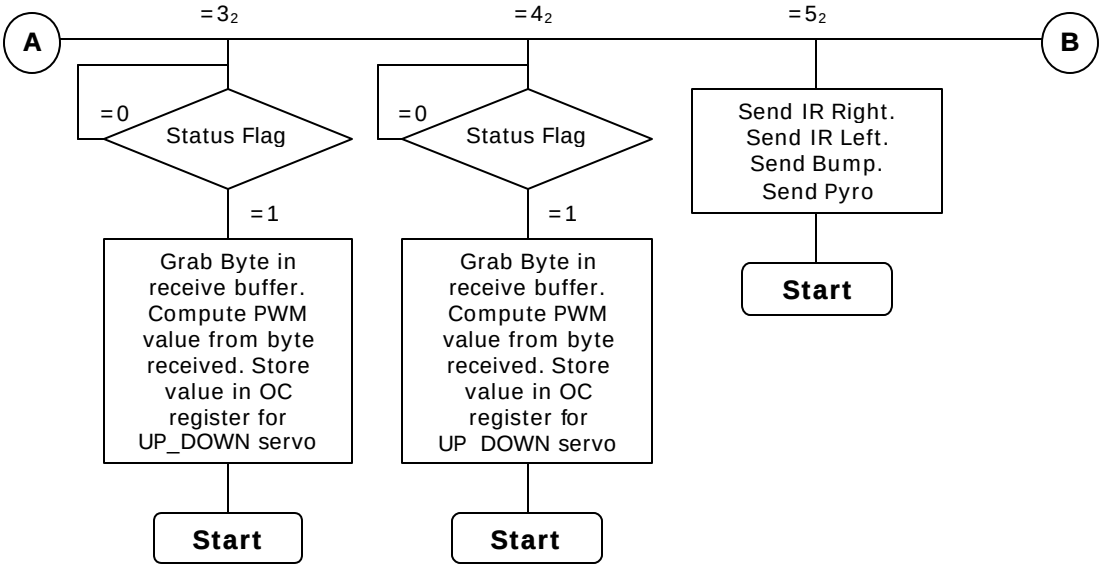


Figure 2 – Adapt812 Schematic

The protocol created for the Pocket PC and the microcontroller to communicate with each other is quite simple. The communication algorithm is illustrated in the flow chart in Figure 3. Basically, the microcontroller constantly polls to see if any new data has been received. Once data is received, a comparison is made to the byte that is stored in the receive buffer. If the byte is equal to 0_2, then the following byte is the value of the speed for the left motor. If the byte is equal to 1_2, then the following byte is the value of the speed for the right motor. The protocol pretty much follows this same routine to control the pan-and-tilt servos, turn camera on, take picture, and change direction of the motors (see flow chart). However, when the byte in the receive buffer is equal to 5_2, the microcontroller sends all of the sensor readings to the Pocket PC which triggers an interrupt on the Pocket PC so it can handle the data.


Start
=0
Status Flag
=1
=0₂
=1₂
Received Byte
=2₂
A
=0
Status Flag
=0
Status Flag
=0
Status Flag
=1
=1
=1
Grab Byte in receive buffer. Compute PWM value from byte received. Store value in OC register for LEFT Motor.
Grab Byte in receive buffer. Compute PWM value from byte received. Store value in OC register for RIGHT Motor.
Grab Byte in receive buffer.
Received Byte
=0
Set Motors to Forward.
=1
Set Motors to Reverse.


A
=3₂
=4₂
=5₂
B
=0
Status Flag
=0
Status Flag
Send IR Right.
Send IR Left.
Send Bump.
Send Pyro
=1
=1
Grab Byte in receive buffer. Compute PWM value from byte received. Store value in OC register for UP_DOWN servo
Grab Byte in receive buffer. Compute PWM value from byte received. Store value in OC register for UP DOWN servo
Start
Start
Start

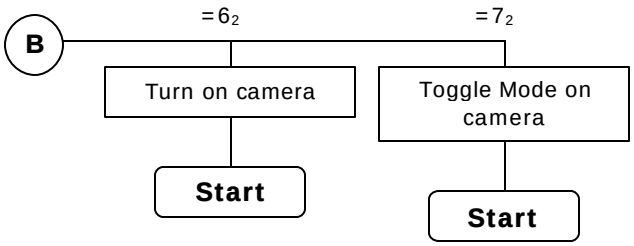


Figure 3 – Complete Flow Chart of uP and PPC Protocol

Compaq iPaq 3650 Pocket PC

An onboard Compaq iPaq 3650 Pocket PC is used for processing all of the data received from all of the sensors, providing the user with an intuitive user interface, and executing Lil' Homie's behaviors. Having the Pocket PC implemented is good for many reasons:

- *Makes Lil' Homie's platform completely universal; that is, many applications can be created and stored on the Pocket PC for the robot to run.*
- *Monster processing power is available. Normally, having a large amount of processing power is only available by transmitting video or data to a distant laptop or workstation. With the new generation of Pocket PCs, up to 400 MHz is available in a small package. Lil' Homie's Pocket PC's clock rate is at 206 MHz.*
- *Lots of storage for program code and data. Normally today's Pocket PCs have about 64MB of ram with the option to have up to 1 GB of CompactFlash storage space. Lil' Homie has 32 MB ram which seems to be plenty for most applications.*
- *Intuitive User Interface. There are many applications for robots that could help with a person's busy life. Since Pocket PCs have an easy to use Windows environment (with the option to have Linux instead if desired), the complexity of operating a robot is eliminated.*

The PPC software suite for Lil' Homie includes a Main Menu that links many utilities for troubleshooting and calibration of the bot. You can also execute Lil' Homie's main behavior from this Main Menu. Lil' Homie's Main Menu is pictured in Figure 3.

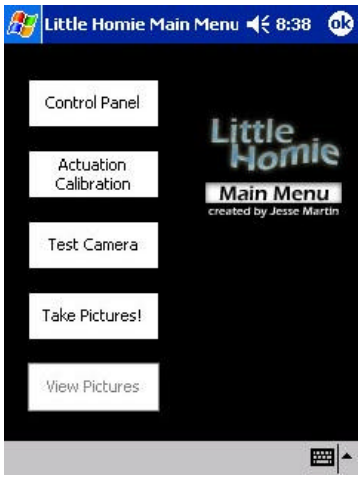


Figure 4 – Lil' Homie's Main Menu Screen

There are four functions currently implemented for Lil' Homie—the Control Panel, Actuation Calibration, Test Camera, and Take Pictures.

Control Panel

The control panel is a where you can easily see potential problems with Lil' Homie's sensor and actuator suite. From the main menu, you can see the value readings for each sensor, manually control each motor, run an Obstacle Avoidence behavior program, and manually control each servo. You also see exactly what values are stored in the servos' output compare registers to generate the appropriate waveform for the servos' position.

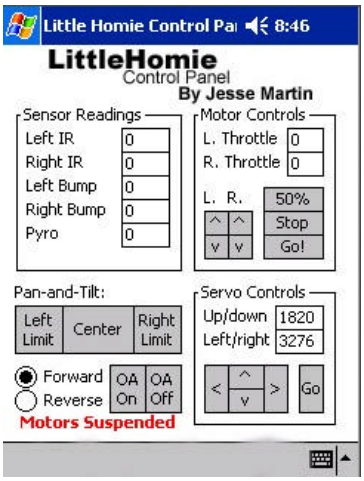


Figure 5 – Lil' Homie's Control Panel

Actuation Calibration

In testing motors, I found that Lil' Homie moves differently depending on what surface it travels on. In the actuation calibration menu, the user can alter what values the motors get for the platform to travel straight or to turn on different surfaces.

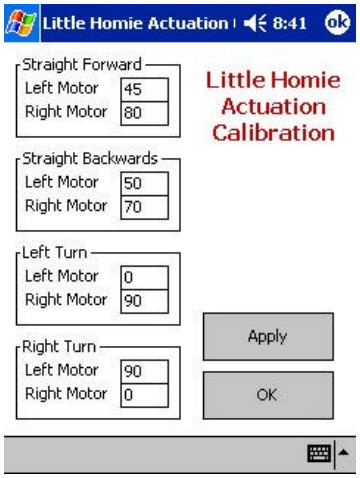


Figure 6 – Lil' Homie's Actuation Calibration Menu

Test Camera

In the test camera menu, it is possible to turn on the Aiptek digital camera, take a picture, and erase the contents of the camera.

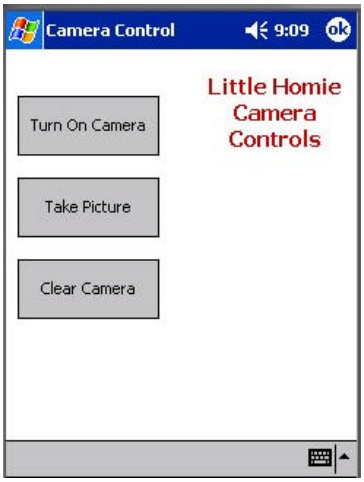


Figure 7 – Lil' Homies Camera Control Panel

Take Pictures!

The take pictures function is the main function of the bot. This is the area to execute the Take Pictures program. When the robot is ready to start the routine, the "Start Taking Picture" button

becomes enabled. Whenever an important event occurs, a message is written in the messages text box.

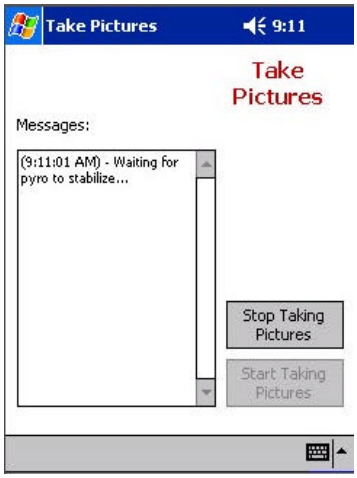


Figure 8 – Lil' Homie's Main Program

Mobile Platform

One of the things that I would most like to redesign is Lil' Homie's platform. As shown in figure 9, the platform is mostly rectangle with two DC motors used for actuation. A rear ball caster is used to hold the back end off the ground. An acrylic box was constructed to house all of the electronics and to serve as a platform for the pan-and-tilt "head" and PPC. On the underbelly, 12 AA batteries supply power to the motors and electronics.

The main reason why I would like to redesign the platform is that it is too small. After adding the microcontroller board, breadboard, pan-and-tilt, and PPC, there is no room left to add other devices.

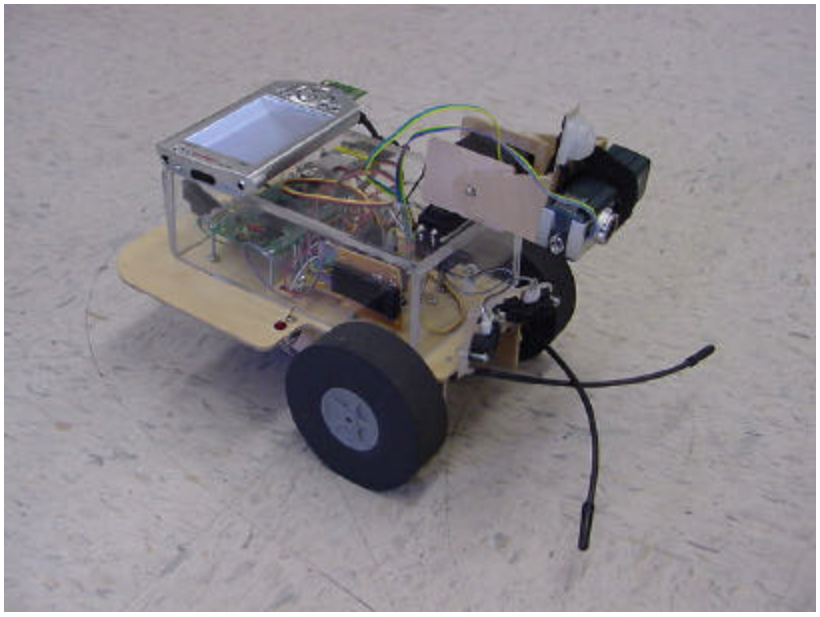


Figure 9 – Lil' Homie

Actuation

Two Tamiya High Power Gearbox kits were used for actuation of the platform. They are set to a gear aspect ratio of 68.4:1 to get a torque of 1040 g-cm. At 4.5V, they run at about 160 RPM. When the motors are stalled, they pull a little over 1A (more like 1.15A) each. One TI SN754410 motor driver controls the motors. The wiring diagram is shown in Figure 10. The motor driver's logic table is shown in Table 2.

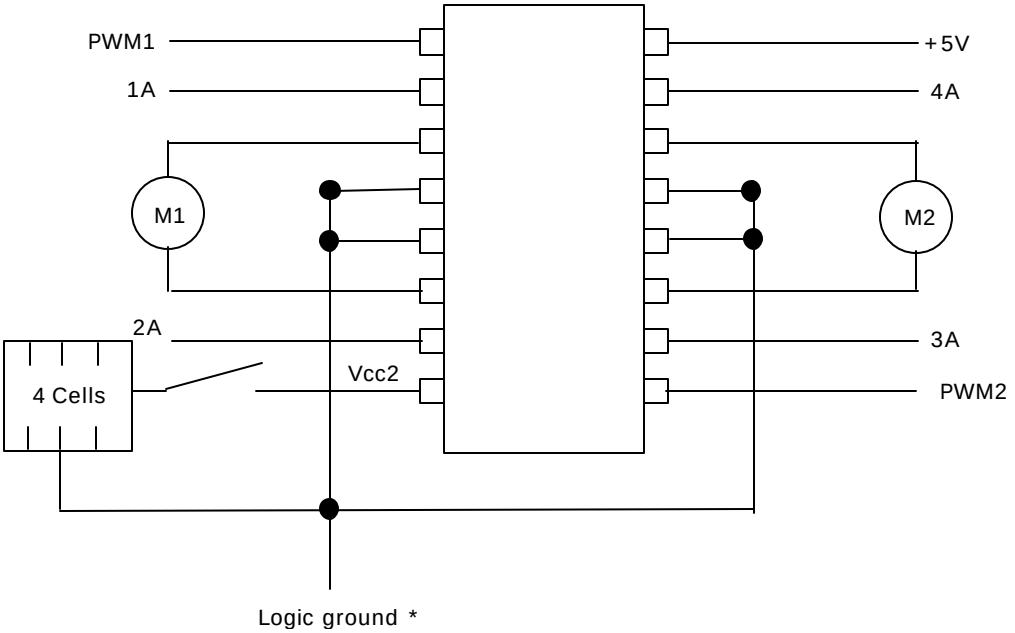


Figure 10 – Wiring diagram of Lil' Homie's motor driver

PWM1	1A	2A	Motor Function
0	-	-	Coast
1	0	0	Dynamic Braking
1	1	1	Dynamic Braking
1	1	0	Motor Forward
1	0	1	Motor Reverse

Table 2 – Example logic table for M1

In addition to the two DC motors, there are two Hitec 300 servos controlling the pan-and-tilt mechanism for the camera.

Sensors

Lil' Homie has two Sharp GP2D12 IR Sensors and two PVC whisker bump switches in the front for obstacle avoidance, a HVW Technologies PIR Motion Detector for detecting people, and an Aiptek Mini Pencam 1.3 digital camera to capture pictures with.

Sharp GP2D12 IR Sensors

The Sharp IR Sensors give analog readings from 1 – 255, where 1 means there is no object detected and 255 means there is an object very close. The sensors were mounted on Lil' Homie as shown in Figure 2.

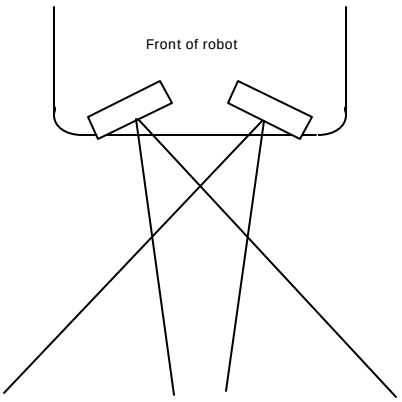


Figure 2 – IR arrangement

HVW Tech PIR Motion Detector

The HVW Tech PIR Motion Detector is a simple and cheap pyroelectric sensor that detects the movement of the inferred radiation signature of humans and animals. The detector has a simple three line setup as shown figure 3. It takes about 1 min, once Lil' Homie is first powered on, for the pyroelectric sensor to stabilize and get readings.

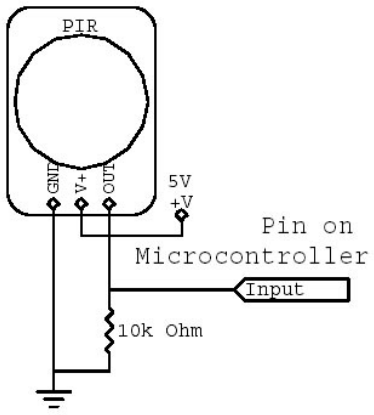


Figure 3 – Pyroelectric wiring diagram

One very important thing I noticed is that if the platform that the detector sits on moves, the PIR sensor generates unreliable readings. As shown in Figure 4, the readings from the sensor bounces from +5V to 0V many times before it settles down to give accurate readings. It seems that the pyro sensor takes no more than 5 seconds to settle once the platform stops moving. To overcome this, Lil' Homie has to wait for those 5 seconds before polling to see if a person is detected.

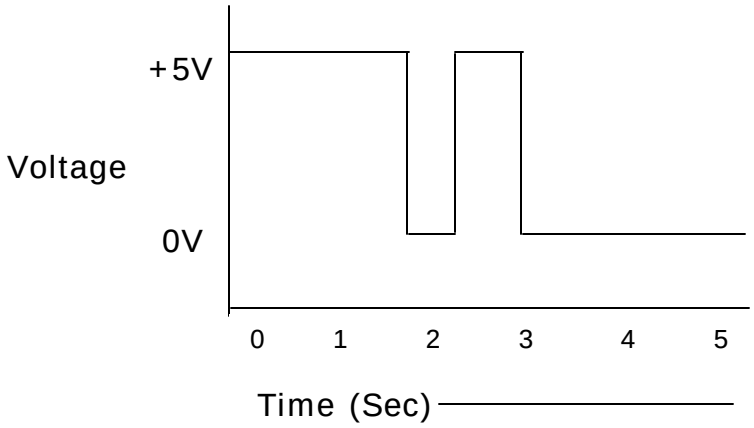


Figure 4 – Example Timing Diagram on PIR when platform moves

Aiptek Mini Pencam 1.3

Originally, the CMUcam was going to be used to capture the photos. The photos then would have been sent to the Pocket PC where they would be stored. Unfortunately, the CMUcam doesn't take

acceptable pictures for this application; instead, the CMUcam should be only used for applications in computer vision.

To get around the problem, I hacked into a cheap ~$50 Aiptek Mini Pencam 1.3 digital camera. The key features of this camera are:

- *Small 1" x 1" x 3 ½" package*
- *32 MB flash can store 140 images at maximum*
- *USB interface*
- *Low Powered – runs off only two AAA batteries which can take about 140 pictures on*
- *1.3 MPixel CMOS Sensor takes images at 1248 x 960 pixels*
- *Can take video*
- *Simple two button operation consists of a Mode and Shutter button*

To hack it, wires had to be soldered from the Mode and Shutter buttons to two separate relay switches that the microcontroller could control. Figures 5 and 6 show how the wires are soldered on. Figure 7 shows the circuit that constructed to get the microcontroller to control the Mode and Shutter features.

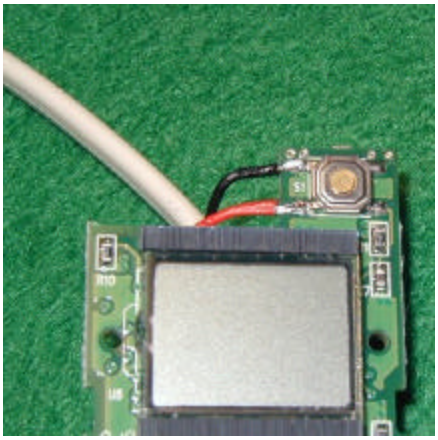


Figure 5 – Mode Button on Pencam

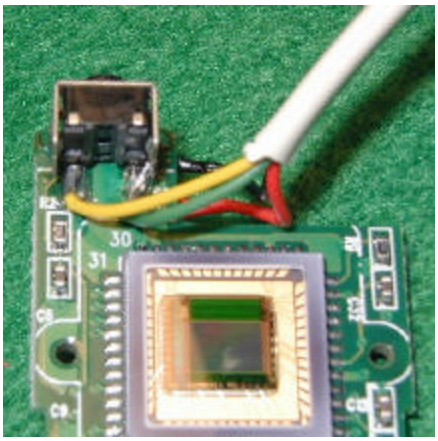


Figure 6 – Shutter Button on Pencam

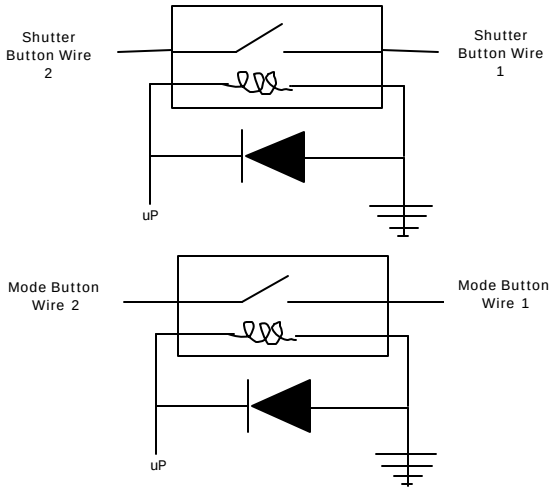


Figure 7 – Wiring to from Pencam to relay

Behaviors

Lil' Homie has four behaviors—that is, obstacle avoid, call a person over, wait for person, and take a picture. For a random amount of time between 5 to 30 seconds, Lil' Homie roams around a room while avoiding obstacles. Once that time has elapsed, Lil' Homie plays a 5 second message to call a person over. While the message plays, the pyro sensor stabilizes its readings. Next, Lil' Homie waits another 5 seconds for a person to come within the view of the camera. If a person is detected, a picture is taken and a praise message is played. If a person is not detected, Lil' Homie tells everybody that they are no fun. Finally, the process begins all over again with Lil' Homie obstacle avoiding until the routine is stopped.

Conclusion

In summary, Lil' Homie was somewhat of a success. The robot actually does take good pictures of people at parties. Interfacing the Pocket PC proved to be very beneficial in troubleshooting problems found in the connected devices. It also became a great tool for conducting experiments.

The next plan for Lil' Homie is to interface the PPC to the camera in such a way that the pictures taken can be viewed on the PPC. This will be an extremely hard thing to achieve because of 1) connectivity issues and 2) driver issues. Although this is true, I believe that it is achievable.

In building Lil' Homie, I learned more things than I've ever learned while attending UF. IMDL proved to be an expensive but the most rewarding experience I've ever encountered. I've now grown to have an extreme interest in robotics.

References

[1] Jones, Flynn, Seiger. “Mobile Robots: Inspiration to Implementation.” 2nd Edition. A.K. Peters Publishers. Natick, MA. 1998.

[2] “Hacking a Cheap PIR Motion Sensor”. http:// www.seattlerobotics.org/encoder/ nov98/pirhack.htmlW. October 29, 2002

[3] “Microsoft eVB COMM Control on your Pocket PC using eMbedded Visual Basic”. http://www.devbuzz.com/content/zinc_eVB_COMM_control_pg1.asp. December 9, 2002

[4] “AYUCR Camera Controller – Modifying a Pencam for External Control”. http://www.robnee.com/electronics/Articles/6/. December 9, 2002

Appendix A: Parts and Supplies

Sharp GP2D12 Distance Measuring Sensor
MarK III Robot Store
2889 Tolkien Lane
Lake Oswego, OR 97034
http://www.junun.org/MarkIII/
(503)638-8407

BMP-01 Bumper Switches
Lynxmotion, Inc.
PO Box 812
Pekin, IL 61554-0818
http://www.lynxmotion.com
(309)382-1816

PIR Motion Detector
HVW Technologies Inc.
218, 3907 – 3A St. N.E.
Calgary, Alberta T2E 6S7
CANADA
http://www.HVWTech.com
(403)730-8603

Tamiya 70144 Ball Caster Kit
Pololu Corporation
3335 Hauck St. #1023
Las Vegas, NV 89146
http://www.pololu.com
1-8777-7-POLOLU

Hitech 300 Servos
Tamiya High Powered Motor Kit
Mondo-Tronics
124 Paul Drive, Suite 12
San Rafael, CA 9493
http://www.robotstore.com
(415)491-4600

Aiptek Mega Pencam 1.3
Wal-Mart
3570 SW Archer Rd
Gainesville, FL 32608
(352) 371-3171

Appendix B – Motorola 68HC12 Assembly Code

```
/***********************************
 * Slave Code for Lil'Homie Robot
 * PROGRAMMER:  Jesse Martin
 * UPDATED: December 9, 2002
***********************************/



*  Operational Parameters


_100MS          equ     25
_250MS          equ     61
_500MS          equ     125
_1SECOND        equ     250
_2SECONDS       equ     500
_3SECONDS       equ     750
_5SECONDS       equ     1250
_10SECONDS      equ     2500
_25SECONDS      equ     6250
_60SECONDS      equ     15000
_2MIN           equ     30000

RAM             equ     $0800           ;68HC812A4 internal RAM
STACK           equ     $0bff           ;Stack at top of internal ram
rbase           equ     $0000           ;68HC812A4 register block
EEPROM          equ     $f000           ;68HC812A4 internal EEPROM
CONSTANTS       equ     $fe00           ;CONSTANTS STORED IN EEPROM

* Operational Constants

TRUE            equ     $FF
FALSE           equ     $00
CR              equ     $D
LF              equ     $A
SPACE           equ     $20

;RTI Variables
clrmask         equ     %11000000       ;mask for clearing timer flags
rtimask1        equ     %10000001       ;M=8Mhz, 1.024 msec interrupt with 16 MHz
xtal
rtimask2        equ     %10000010       ;M=8Mhz, 2.048 msec interrupt with 16 MHz
xtal
rtimask3        equ     %10000011       ;M=8Mhz, 4.096 msec interrupt with 16 MHz
xtal
rtimask4        equ     %10000100       ;M=8Mhz, 8.196 msec interrupt with 16 MHz
xtal
rtimask5        equ     %10000101       ;M=8Mhz, 16.384 msec interrupt with 16 MHz
xtal
rtimask6        equ     %10000110       ;M=8Mhz, 32.768 msec interrupt with 16 MHz
xtal
rtimask7        equ     %10000111       ;M=8Mhz, 65.536 msec interrupt with 16 MHz
xtal
```

```
rtiflag         equ     %10000000

;SCI Variables
scimask         equ     %00101100       ;RIE - SCI Interrupt enable
                                        ;RE - Receiver Enable
RDRFflag        equ     %00100000       ;RDRF - Receive Data Register Full flag
TDREflag        equ     %10000000       ;TDRE - Transmit Data Register Empty flag

;Baud rate definitions
;MCLK=8Mzh
BAUD110         equ     4545    ;(baud) 110 baud with 16 Mhz crystal
BAUD300         equ     1667    ;(baud) 300 baud with 16 Mhz crystal
BAUD600         equ     833     ;(baud) 600 baud with 16 Mhz crystal
BAUD1200        equ     417     ;(baud) 1200 baud with 16 Mhz crystal
BAUD2400        equ     208     ;(baud) 2400 baud with 16 Mhz crystal
BAUD4800        equ     104     ;(baud) 4800 baud with 16 Mhz crystal
BAUD9600        equ     52      ;(baud) 9600 baud with 16 Mhz crystal
BAUD14400       equ     35      ;(baud) 14400 baud with 16 Mhz crystal
BAUD19200       equ     26      ;(baud) 19200 baud with 16 Mhz crystal
BAUD38400       equ     13      ;(baud) 38400 baud with 16 Mhz crystal


* Registers
REG     EQU     $0000

PORTA   EQU     $0000           ;PORTA
PORTB   EQU     $0001           ;PORTB
DDRA    EQU     $0002           ;PORTA - DATA DIRECTION REGISTER
DDRB    EQU     $0003           ;PORTB - DATA DIRECTION REGISTER
PORTC   EQU     $0004           ;PORTC
PORTD   EQU     $0005           ;PORTD
DDRC    EQU     $0006           ;PORTC - DATA DIRECTION REGISTER
DDRD    EQU     $0007           ;PORTD - DATA DIRECTION REGISTER
PORTE   EQU     $0008           ;PORTE
DDRE    EQU     $0009           ;PORTE - DATA DIRECTION REGISTER
PEAR    EQU     $000A           ;PEAR - PORTE ASSIGNMENT REGISTER
MODE    EQU     $000B           ;MODE - MODE REGISTER
PUCR    EQU     $000C           ;PUCR - PULL UP CONTROL REGISTER
RDRIV   EQU     $000D           ;RDRIV - REDUCED DRIVE OF I/O LINES


INITRM  EQU     $0010           ;INITRM - INITIALIZATION OF INTERNAL RAM POSITION
REGISTER
INITRG  EQU     $0011           ;INITRG - INITIALIZATION OF INTERNAL REGISTER
POSITION REGISTER
INITEE  EQU     $0012           ;INITEE - INITIALIZATION OF INTERNAL EEPROM
POSITION REGISTER
MISC    EQU     $0013           ;MISC - MISCELLANEOUS MAPPING CONTROL REGISTER
RTICTL  EQU     $0014           ;RTICTL - REAL TIME INTERRUPT CONTROL REGISTER
RTIFLG  EQU     $0015           ;RTIFLG - REAL TIME INTERRUPT FLAG REGISTER
COPCTL  EQU     $0016           ;COPCTL - COP CONTROL REGISTER
COPRST  EQU     $0017           ;COPRST - ARM/RESET COP TIMER REGISTER
ITST0   EQU     $0018           ;ITST0
ITST1   EQU     $0019           ;ITST1
ITST2   EQU     $001A           ;ITST2
ITST3   EQU     $001B           ;ITST3
```

```
INTCR   EQU     $001E           ;INTCR - INTERRUPT CONTROL REGISTER
HPRIO   EQU     $001F           ;HPRIO - HIGHEST PRIORITY I INTERRRUPT
KWIED   EQU     $0020           ;KWIED - KEY WAKEUP PORTD INTERRUPT ENABLE REGISTER
KWIFD   EQU     $0021           ;KWIFD - KEY WAKEUP PORTD FLAG REGISTER

PORTH   EQU     $0024           ;PORTH
DDRH    EQU     $0025           ;DDRH - DATA DIRECTION REGISTER
KWIEH   EQU     $0026           ;KWIEH - KEY WAKEUP PORTH INTERRUPT ENABLE REGISTER
KWIFH   EQU     $0027           ;KWIFH - KEY WAKEUP PORTH FLAG REGISTER
PORTJ   EQU     $0028           ;PORTJ
DDRJ    EQU     $0029           ;DDRJ DATA DIRECTION REGISTER
KWIEJ   EQU     $002A           ;KWIEJ - KEY WAKEUP PORTJ INTERRUPT ENABLE REGISTER
KWIFJ   EQU     $002B           ;KWIFJ - KEY WAKEUP PORTJ FLAG REGISTER
KPOLJ   EQU     $002C           ;KPOLJ - KEY WAKEUP PORTJ POLARITY REGISTER
PUPSJ   EQU     $002D           ;PUPSJ - KEY WAKEUP PORTJ PULL-UP/PULLDOWN SELECT
REGISTER
PULEJ   EQU     $002E           ;PULEJ - KEY WAKEUP PORTJ PULL-UP/PULLDOWN ENABLE
REGISTER

PORTF   EQU     $0030           ;PORTF
PORTG   EQU     $0031           ;PORTG
DDRF    EQU     $0032           ;DDRF - DATA DIRECTION REGISTER
DDRG    EQU     $0033           ;DDRG - DATA DIRECTION REGISTER
DPAGE   EQU     $0034           ;DPAGE - DATA PAGE REGISTER
PPAGE   EQU     $0035           ;PPAGE - PROGRAM PAGE REGISTER
EPAGE   EQU     $0036           ;EPAGE - EXTRA PAGE REGISTER
WINDEF  EQU     $0037           ;WINDEF - WINDOW DEFINATION REGISTER
MXAR    EQU     $0038           ;MXAR - MEMORY EXPANSION ASSGNMENT REGISTER

CSCTL0  EQU     $003C           ;CSCTL0 - CHIP SELECT CONTROL REGISTER 0
CSCTL1  EQU     $003D           ;CSCTL1 - CHIP SELECT CONTROL REGISTER 1
CSSTR0  EQU     $003E           ;CSSTR0 - CHIP SELECT STRETCH REGISTER 0
CSSTR1  EQU     $003F           ;CSSTR1 - CHIP SELECT STRETCH REGISTER 1
LDVH    EQU     $0040           ;LDV - LOOP DIVIDER HIGH REGISTER
LDVL    EQU     $0041           ;LDV - LOW REGISTER
RDVH    EQU     $0042           ;RDV - REFERENCE DIVIDER HIGH REGISTER
RDVL    EQU     $0043           ;RDV - LOW REGISTER

CLKCTL  EQU     $0047           ;CLKCTL - CLOCK CONTROL REGISTER

ATDCTL0 EQU     $0060           ;ATDCTL0 - RESERVED
ATDCTL1 EQU     $0061           ;ATDCTL1 - RESERVED
ATDCTL2 EQU     $0062           ;ATDCTL2 - ATD CONTROL REGISTER
ATDCTL3 EQU     $0063           ;ATDCTL3 - ATD CONTROL REGISTER
ATDCTL4 EQU     $0064           ;ATDCTL4 - ATD CONTROL REGISTER
ATDCTL5 EQU     $0065           ;ATDCTL5 - ATD CONTROL REGISTER

ATDSTAT         EQU     $0066
ATDSTATH        EQU     $0066   ;ATDSTAT - ATD STATUS HIGH REGISTER
ATDSTATL        EQU     $0067   ;ATDSTAT - LOW REGISTER

STDTEST         EQU     $0068
ATDTESTH        EQU     $0068   ;ATDTEST - ATD TEST HIGH REGISTER
ATDTESTL        EQU     $0069   ;ATDTEST - LOW REGISTER
```

```
PORTAD  EQU     $006F           ;PORTAD - PORT AD DATA INPUT REGISTER
ADR0H   EQU     $0070           ;ADR0H
ADR1H   EQU     $0072           ;ADR1H
ADR2H   EQU     $0074           ;ADR2H
ADR3H   EQU     $0076           ;ADR3H
ADR4H   EQU     $0078           ;ADR4H
ADR5H   EQU     $007A           ;ADR5H
ADR6H   EQU     $007C           ;ADR6H
ADR7H   EQU     $007E           ;ADR7H

TIOS    EQU     $0080           ;TIOS - TIMER INPUT CAPTURE/OUTPUT COMPARE SELECT
CFORC   EQU     $0081           ;CFORC - TIMER COMPARE FORCE REGISTER
OC7M    EQU     $0082           ;OC7M - OUTPUT COMPARE 7 MASK REGISTER
OC7D    EQU     $0083           ;OC7D - OUTPUT COMPARE 7 DATA REGISTER

TCNT    EQU     $0084
TCNTH   EQU     $0084           ;TCNT - TIMER COUNT HIGH REGISTER
TCNTL   EQU     $0085           ;TCNT - HIGH REGISTER

TSCR    EQU     $0086           ;TSCR - TIMER SYSTEM CONTROL REGISTER
TQCR    EQU     $0087           ;TQCR - RESERVED
TCTL1   EQU     $0088           ;TCTL1 - TIMER CONTROL REGISTER 1
TCTL2   EQU     $0089           ;TCTL2 - TIMER CONTROL REGISTER 2
TCTL3   EQU     $008A           ;TCTL3 - TIMER CONTROL REGISTER 3
TCTL4   EQU     $008B           ;TCTL4 - TIMER CONTROL REGISTER 4
TMSK1   EQU     $008C           ;TMSK1 - TIMER INTERRUPT MASK 1
TMSK2   EQU     $008D           ;TMSK2 - TIMER INTERRUPT MASK 2
TFLG1   EQU     $008E           ;TFLG1 - TIMER INTERRUPT FLAG 1
TFLG2   EQU     $008F           ;TFLG2 - TIMER INTERRUPT FLAG2

TC0     EQU     $0090
TC0H    EQU     $0090           ;TC0 - TIMER INPUT/CAPTURE COMPARE HIGH REGISTER0
TC0L    EQU     $0091           ;TC0 - LOW REGISTER

TC1     EQU     $0092
TC1H    EQU     $0092           ;TC1 - HIGH REGISTER
TC1L    EQU     $0093           ;TC1 - LOW REGISTER

TC2     EQU     $0094
TC2H    EQU     $0094           ;TC2 - HIGH REGISTER
TC2L    EQU     $0095           ;TC2 - LOW REGISTER

TC3     EQU     $0096
TC3H    EQU     $0096           ;TC3 - HIGH REGISTER
TC3L    EQU     $0097           ;TC3 - LOW REGISTER

TC4     EQU     $0098
TC4H    EQU     $0098           ;TC4 - HIGH REGISTER
TC4L    EQU     $0099           ;TC4 - LOW REGISTER

TC5     EQU     $009A
TC5H    EQU     $009A           ;TC5 - HIGH REGISTER
TC5L    EQU     $009B           ;TC5 - LOW REGISTER

TC6     EQU     $009C
TC6H    EQU     $009C           ;TC6 - HIGH REGISTER
```

```
TC6L    EQU     $009D           ;TC6 - LOW REGISTER

TC7     EQU     $009E
TC7H    EQU     $009E           ;TC7 - HIGH REGISTER
TC7L    EQU     $009F           ;TC7 - LOW REGISTER

PACTL   EQU     $00A0           ;PATCL - PULSE ACCUMULATOR CONTROL REGISTER
PAFLG   EQU     $00A1           ;PAFLG - PULSE ACCUMULATOR FLAG REGISTER

PACNT   EQU     $00A2
PACNTH  EQU     $00A2           ;PACNT - 16 BIT PULSE ACCUMULATOR COUNT HIGH
REGISTER
PACNTL  EQU     $00A3           ;PACNT - LOW REGISTER

TIMTST  EQU     $00AD           ;TIMTST - TIMER TEST REGISTER
PORTT   EQU     $00AE           ;PORTT
 DDRT    EQU     $00AF           ;PORTT - DATA DIRECTION REGISTER

SC0BDH  EQU     $00C0           ;SC0BDH - SCI BAUD RATE CONTROL REGISTER
SC0BDL  EQU     $00C1           ;SC0BDL - SCI BAUD RATE CONTROL REGISTER
SC0CR1  EQU     $00C2           ;SC0CR1 - SCI CONTROL REGISTER
SC0CR2  EQU     $00C3           ;SC0CR2 - SCI CONTROL REGISTER
SC0SR1  EQU     $00C4           ;SC0SR1 - SCI STATUS REGISTER
SC0SR2  EQU     $00C5           ;SC0SR2 - SCI STATUS REGISTER
SC0DRH  EQU     $00C6           ;SC0DRH - SCI DATA REGISTER
SC0DRL  EQU     $00C7           ;SC0DRL - SCI DATA REGISTER
SC1BDH  EQU     $00C8           ;SC1BDH - SCI BAUD RATE CONTROL REGISTER
SC1BDL  EQU     $00C9           ;SC1BDL - SCI BAUD RATE CONTROL REGISTER
SC1CR1  EQU     $00CA           ;SC1CR1 - SCI BAUD CONTROL REGISTER
SC1CR2  EQU     $00CB           ;SC1CR2 - SCI CONTROL REGISTER
SC1SR1  EQU     $00CC           ;SC1SR1 - SCI STATUS REGISTER
SC1SR2  EQU     $00CD           ;SC1SR2 - SCI STATUS REGISTER
SC1DRH  EQU     $00CE           ;SC1DRH - SCI DATA REGISTER
SC1DRL  EQU     $00CF           ;SC1DRL - SCI DATA REGISTER
SP0CR1  EQU     $00D0           ;SP0CR1 - SPI CONTROL REGISTER
SP0CR2  EQU     $00D1           ;SP0CR2 - SPI CONTROL REGISTER
SP0BR   EQU     $00D2           ;SP0BR - SPI BAUD RATE REGISTER
SP0SR   EQU     $00D3           ;SP0SR - SPI STATUS REGISTER

SP0DR   EQU     $00D5           ;SP0DR - SPI DATA REGISTER
PORTS   EQU     $00D6           ;PORTS
DDRS    EQU     $00D7           ;PORTS - DATA DIRECTION REGISTER

EEMCR   EQU     $00F0           ;EEMCR - EEPROM MODULE CONFIGURATION
EEPROT  EQU     $00F1           ;EEPROT - EEPROM BLOCK PROTECT
EETST   EQU     $00F2           ;EETST - EEPROM TEST
EEPROG  EQU     $00F3           ;EEPROG - EEPROM CONTROL

*MASKS
BIT0            EQU     %00000001
BIT1            EQU     %00000010
BIT5            EQU     %00100000
BIT7            EQU     %10000000
BIT76           EQU     %11000000
BIT41           EQU     %00010010
BIT32           EQU     %00001100
```

```
;               ORG     CONSTANTS
;MENU           DC.B    "SELECT AN OPTION:", LF, "1)TURN SERVO LEFT", LF, "2)TURN
SERVO RIGHT", LF, "3)CENTER SERVO", 0


*************************************************
*  MAIN PROGRAM
*************************************************

                ORG     EEPROM

                LDS     #STACK

                JSR     INIT_SCI        ;INIT SCI SYSTEM
                JSR     INIT_MOTOR      ;INIT MOTORS
                JSR     INIT_SERVOS     ;INIT SERVOS
                JSR     INIT_AD         ;INIT AD SYSTEM
                CLI

;Initialize PORTT - LED on board
                movb    #%01100000, DDRT         ;Bit 6,5 of PORTT are Output
                bclr    PORTT, %01100000

;Initialize PORTA
                movb    #%00000011, DDRA         ;Bit 0,1 of PORTA are Output
                bclr    PORTT, %00000011

;Motors foward
                movb    #%00000101, PORTJ


LOOP            LDAA    SC0SR1          ; check status reg (RDRF in bit 5)
                ANDA    #%00100000      ; check if receive buffer full
                BEQ     LOOP            ; wait until data present

                LDAB    SC0DRL
                CMPB    #0      ; first byte = 0 means following byte is for left
motor
                BEQ     LEFT_MOTOR

                CMPB    #1      ; first byte = 1 means following byte is for right
motor
                BEQ     RIGHT_MOTOR

                CMPB    #2      ; first byte = 2 means following byte is direction
                BEQ     DIRECTION

                CMPB    #3      ; first byte = 3 means following byte is for
up/down servo
                BEQ     UP_DOWN

                CMPB    #4      ; first byte = 4 means following byte is for
left/right servo
                BEQ     LEFT_RIGHT
```

```
                CMPB    #5      ; first byte = 5 means send sensor readings
                LBEQ    GET_READINGS

                CMPB    #6      ;Turn on camera or toggle Mode on camera
                LBEQ    TURN_ONCAM

                CMPB    #7
                LBEQ    CAPTURE_PIC

                BRA     LOOP

LEFT_MOTOR      LDAA    SC0SR1          ; check status reg (RDRF in bit 5)
                ANDA    #%00100000      ; check if receive buffer full
                BEQ     LEFT_MOTOR      ; wait until data present

                LDAB    SC0DRL
                LDAA    #0
                LDY     #400
                EMUL                    ;multiply command by 400 and add 1
                ADDD    #1
                STD     TC0

                BRA     LOOP

RIGHT_MOTOR     LDAA    SC0SR1          ; check status reg (RDRF in bit 5)
                ANDA    #%00100000      ; check if receive buffer full
                BEQ     RIGHT_MOTOR     ; wait until data present

                LDAB    SC0DRL
                LDAA    #0
                LDY     #400
                EMUL
                ADDD    #1
                STD     TC1

                BRA     LOOP

DIRECTION       LDAA    SC0SR1          ; check status reg (RDRF in bit 5)
                ANDA    #%00100000      ; check if receive buffer full
                BEQ     DIRECTION       ; wait until data present

                LDAB    SC0DRL
                BEQ     FORWARD

                movb    #%00001010, PORTJ
                BRA     LOOP

FORWARD         movb    #%00000101, PORTJ
                LBRA    LOOP


UP_DOWN         LDAA    SC0SR1          ; check status reg (RDRF in bit 5)
                ANDA    #%00100000      ; check if receive buffer full
                BEQ     UP_DOWN         ; wait until data present
```

```
                LDAB    SC0DRL
                LDAA    #0
                LDY     #14             ; multiply by constant
                EMUL
                ADDD    #1400
                STD     TC2

                LBRA    LOOP

LEFT_RIGHT      LDAA    SC0SR1          ; check status reg (RDRF in bit 5)
                ANDA    #%00100000      ; check if receive buffer full
                BEQ     LEFT_RIGHT      ; wait until data present

                LDAB    SC0DRL
                LDAA    #0
                LDY     #14             ; multiply by constant
                EMUL
                ADDD    #1400
                STD     TC3

                LBRA    LOOP

GET_READINGS    LDAA    ADR0H           ; send IR right
                JSR     SEND_BYTE
                LDAA    ADR1H           ; send IR left
                JSR     SEND_BYTE
                LDAA    PORTG           ; send bump sensors
                JSR     SEND_BYTE
                LDAA    PORTJ           ; send pyro
                JSR     SEND_BYTE

                LBRA    LOOP

TURN_ONCAM      movb    #%00000010, PORTA
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
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                JSR     WAIT_HALF
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                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                movb    #%00000000, PORTA
```

```
                LBRA    LOOP

CAPTURE_PIC     movb    #%00000001, PORTA
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
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                JSR     WAIT_HALF
                JSR     WAIT_HALF
                JSR     WAIT_HALF
                movb    #%00000000, PORTA


                LBRA    LOOP

*-----------------------------------------------
*  SUBROUTINES
*-----------------------------------------------

*-------------------------------------------------------------
**  Send whatever is in accumulator A out the serial port
**     when it becomes available.
*-------------------------------------------------------------

SEND_BYTE       BRCLR   SC0SR1, %10000000, SEND_BYTE
                STAA    SC0DRL
                RTS


*********************************************
*  Prints out to SCI until EOF (0) is reached by  *     where X is pointing
*********************************************

PRINT_SCI       BRCLR   SC0SR1, BIT7, PRINT_SCI         ; Wait for TDR to be empty
                MOVB    1, X+, SC0DRL                   ; Send out char and inc X
                TST     0, X
                BNE     PRINT_SCI                       ; If not end of string,
continue
                RTS                                     ; Otherwise, end subroutine

*********************************************
*  Prints single char in REG B to SCI
```

```
*********************************************
PRINT_CHAR      TST     SC0SR1                  ;wait for transmit data register
empty (TDRE)
                BPL     PRINT_CHAR              ; Wait for TDR to be empty
                STAB    SC0DRL                          ; Send Out
                RTS                                     ; End subroutine

*********************************************
**  DELAY ROUTINE
**      REGISTERS: Y Reg
**      5ms = 12(0.5us) + 6(0.5us)Y - 2(0.5us)
*********************************************

DELAY           PSHY                    ;Y REG IS USED, SO SAVING FIRST
                LDY     #200            ;LOADING Y WITH TIME DELAY
IN_DELAY        NOP
                NOP
                DEY                     BNE     IN_DELAY
                PULY                    ;PULLING Y TO WHAT IT WAS ORIGNIALLY
                RTS


*-----------------------------------------------------------
**  DELAY ROUTINE
**      REGISTERS: Y Reg
**      500us = 12(0.125us) + 6(0.125us)Y - 2(0.125us)
*-----------------------------------------------------------

WAIT_HALF       PSHY                    ;Y REG IS USED, SO SAVING FIRST
                LDY     #$FFFF          ;LOADING Y WITH TIME DELAY
IN_HALF         NOP
                NOP
                DEY
                BNE     IN_HALF
                PULY                    ;PULLING Y TO WHAT IT WAS ORIGNIALLY
                RTS


*-----------------------------------------------------------
**  DELAY ROUTINE
**      REGISTERS: Y Reg
**      100us = 12(0.125us) + 6(0.125us)Y - 2(0.125us)
*-----------------------------------------------------------

WAIT_AD         PSHY                    ;Y REG IS USED, SO SAVING FIRST
                LDY     #132            ;LOADING Y WITH TIME DELAY
IN_WAIT_AD      NOP
                NOP
                DEY
                BNE     IN_WAIT_AD
                PULY                    ;PULLING Y TO WHAT IT WAS ORIGNIALLY
                RTS

*********************************************
*  INITIALIZATION ROUTINES
*********************************************
```

```
*-------------------------------------------------
*   INIT SCI SYSTEM
*-------------------------------------------------

INIT_SCI        movb    #0,SC0CR2         ;disable SCI 0 rcvr. & xmtr. & rx int
                movb    #0,SC0CR1
                movb    #BAUD9600, SC0BDL        ;Set baud rate to 9600

                LDAA    #%00001100      ; Enable Tx and Rx;
                STAA    SC0CR2          ;   all interrupts diabled

                ldaa    SC0SR1                  ;read register to clear flag RDRF
                ldaa    SC0DRL                  ;dummy read to flush receive buffer

******************End SCI Init******************


*-------------------------------------------------
*   INIT MOTORS (only on OCO and OC1)
*-------------------------------------------------



INIT_MOTOR      BSET    tios,%10000011  ; Setup channels 0,1, and 7 to be TOC
channels.

; Set channels 0 and 1 to clear their output pins when the compare happens

                BSET    tctl2, %00001010

; Set the prescalar to roll over on 32ms periods

                BSET    tmsk2,%00110010

; Setup TOC7 to handle the start of the pulses by setting the value to 1
; when the TCNT is zero

                BSET    oc7m, %00000011
                BSET    oc7d, %00000011
                LDX     #$9C40
                STX     TC7
                BSET    tmsk2, %00001000
; Turn on the timer
                BSET    tscr, %10000000

;Initialize PORTJ
                movb    #%00001111,DDRJ         ;Bits 0 - 3 of PORTJ are Output
                MOVW    #1, tc0
                MOVW    #1, tc1
                RTS             ;END SERVICE ROUTINE

******************End Motor Init******************

*-------------------------------------------------
*   INIT SERVOS (only on OC2 and OC3)
```

```
*-------------------------------------------------


INIT_SERVOS     BSET    tios,%10001100  ; Setup channels 2,3 and 7 to be TOC
channels.

; Set channels 2 and 3 to clear their output pins when the compare happens

                BSET    tctl2, %10100000

; Set the prescalar to roll over on 32ms periods

                BSET    tmsk2,%00110010

; Setup TOC7 to handle the start of the pulses by setting the value to 1
; when the TCNT is zero

                BSET    oc7m, %00001100
                BSET    oc7d, %00001100
                LDX     #$9C40
                STX     TC7
                BSET    tmsk2, %00001000
; Turn on the timer
                BSET    tscr, %10000000

                MOVW    #1820, tc2
                MOVW    #3276, tc3

                RTS             ;END SERVICE ROUTINE

******************End Servo Init*******************

*-------------------------------------------------------------
**  Initialize Analog to Digital converter
*-------------------------------------------------------------

INIT_AD         movb    #%10000000, ATDCTL2
                jsr     WAIT_AD                 ;wait 100us for AD to be ready
                movb    #%00110000, ATDCTL5
                RTS                             ;end subroutine

******************End AD Init******************

*MC68HC812A4 VECTOR INTERRUPTS

VECTOR  EQU     $FFCE
        ORG     VECTOR

        FDB     EEPROM          ;KEY WAKEUP H
        FDB     EEPROM          ;KEY WAKEUP J
        FDB     EEPROM          ;ANALOG TO DIGITAL
        FDB     EEPROM          ;SERIAL COMMUNICATION 1
        FDB     EEPROM          ;SERIAL COMMUNICATION 0
        FDB     EEPROM          ;SPI SERIAL TRANSFER COMPLETE
        FDB     EEPROM          ;PULSE ACCUMULATOR INPUT EDGE
```

```
FDB     EEPROM          ;PULSE ACCUMULATOR OVERFLOW
FDB     EEPROM          ;TIMER OVERFLOW
FDB     EEPROM          ;TIMER CHANNEL 7
FDB     EEPROM          ;TIMER CHANNEL 6
FDB     EEPROM          ;TIMER CHANNEL 5
FDB     EEPROM          ;TIMER CHANNEL 4
FDB     EEPROM          ;TIMER CHANNEL 3
FDB     EEPROM          ;TIMER CHANNEL 2
FDB     EEPROM          ;TIMER CHANNEL 1
FDB     EEPROM          ;TIMER CHANNEL 0
FDB     EEPROM          ;REAL TIME INTERRUPT
FDB     EEPROM          ;IRQ OR KEY WAKE UP D
FDB     EEPROM          ;XIRQ
FDB     EEPROM          ;SWI
FDB     EEPROM          ;RESERVED
FDB     EEPROM          ;COP FAILURE RESET
FDB     EEPROM          ;COP CLOCK MONITOR FAIL RESET
FDB     EEPROM          ;RESET
```

Appendix C – Pocket PC Code

MAIN MENU CODE

```
Option Explicit

'GLOABAL VARIABLES
'All forms can access these while program is running

Public leftMotor As Integer
Public rightMotor As Integer
Public Go As Boolean
Public up_down As Integer
Public left_right As Integer
Public IR_right As Integer
Public IR_left As Integer
Public Bump_left As Integer
Public Bump_right As Integer
Public Pyro As Integer
Public Left_Forward As Integer
Public Right_Forward As Integer
Public Left_Reverse As Integer
Public Right_Reverse As Integer
Public leftMotorLeftTurn As Integer
Public rightMotorLeftTurn As Integer
Public leftMotorRightTurn As Integer
Public rightMotorRightTurn As Integer
Public goingInReverse As Boolean



Private Sub ActCalibration_Click()
    Calibration.Show
End Sub


Private Sub ControlPanel_Click()
    Controlpan.Show
End Sub

Private Sub Form_OKClick()
    App.End
End Sub

'Event executed when form loads

Private Sub Form_Load()

  leftMotor = 0    'Initialize all gloabal variables
  rightMotor = 0
  Go = False
```

```
  up_down = 30      'Servo values are already set when uP boots up
  left_right = 134

  Left_Forward = 45     'Preset values for motors to make bot go foward
  Right_Forward = 80    '     and backwards straight
  Left_Reverse = 50
  Right_Reverse = 70

  leftMotorLeftTurn = 0
  rightMotorLeftTurn = 90
  leftMotorRightTurn = 90
  rightMotorRightTurn = 0

  goingInReverse = False



End Sub

Private Sub TakePics_Click()
    Capture.Show
End Sub

Private Sub TestCam_Click()
    Camera.Show
End Sub
```

CONTROL PANEL CODE

```
' Desc:  Control program for Little Homie robot
' Date: 11/6/02
' Programer: Jesse Martin

Option Explicit

'Form VARIABLES

Public IncomingStr As String
Public outputBuffer As String
Public OA_on As Boolean


'Event executed when form loads

Private Sub Form_Load()
    Timer1.Enabled = True   'Turn on timer event that gets
                    'sensor readings every .3 sec
    OA_on = False
    Splash.goingInReverse = False
    Comm1.PortOpen = True  'Open Com 1
```

```
End Sub

Private Sub Form_OKClick()
    Timer1.Enabled = False
    Comm1.PortOpen = False
    Controlpan.Hide    'Close Form
End Sub

Private Sub Comm1_OnComm()
  Select Case Comm1.CommEvent
  Case comEvReceive
     IncomingStr = Comm1.Input
     Process_data (IncomingStr)  'Process data when data is recieved
     Case comEvSend
     ' do nothing here
  End Select
End Sub

Private Sub Process_data(temp As String)
    Dim Size As Integer
    Size = Len(temp)
    If Size = 4 Then    'Only process data when data is 3 bytes long
        IR_rightText.text = CByte(Asc(Mid(temp, 1, 1)))
        Splash.IR_right = CInt(Asc(Mid(temp, 1, 1)))
        IR_leftText.text = CByte(Asc(Mid(temp, 2, 1)))
        Splash.IR_left = CInt(Asc(Mid(temp, 2, 1)))
        Bump_rightText.text = CByte(Asc(Mid(temp, 3, 1))) And 1   'AND with 1 to get value of Bit0
        Splash.Bump_right = CInt(Asc(Mid(temp, 3, 1))) And 1
        If (CByte(Asc(Mid(temp, 3, 1))) And 2) = 2 Then     'AND with 2 to get value of Bit1
            Bump_leftText.text = 1
            Splash.Bump_left = 1
        Else
            Bump_leftText.text = 0
            Splash.Bump_left = 0
        End If
        If (CByte(Asc(Mid(temp, 4, 1))) And 128) = 128 Then      'AND with 128 to get value of Bit7
            Splash.Pyro = 1
            PyroText.text = 1
        Else
            Splash.Pyro = 0
            PyroText.text = 0
        End If
    End If
End Sub


Private Sub OA_off_Click()
    OA_on = False
    Suspend.Caption = "Motors Suspended"
    motorStop_Click
    Splash.leftMotor = 0
    Splash.rightMotor = 0
```

```
    motorLeftText.text = 0
    motorRightText.text = 0
    motorForward.Value = True
    motorForward_Click

End Sub

Private Sub OA_on_Click()
    OA_on = True
    Suspend.Caption = "OA running"
End Sub

'**********SERVO CONTROLS*************

Private Sub servocenter_Click()
    Splash.left_right = 134
    Text2.text = (Splash.left_right * 14) + 1400
    Splash.up_down = 30
    Text1.text = (Splash.up_down * 14) + 1400
    servogo_Click
End Sub

Private Sub servogo_Click()
    outputBuffer = Chr(4) + Chr(Splash.left_right)
    Comm1.Output = outputBuffer     'Output left/right commands to uP
    outputBuffer = Chr(3) + Chr(Splash.up_down)
    Comm1.Output = outputBuffer     'Output up/down commands to uP
End Sub

Private Sub servoleftlimit_Click()
    Splash.left_right = 255
    Text2.text = (Splash.left_right * 14) + 1400
    Splash.up_down = 11
    Text1.text = (Splash.up_down * 14) + 1400
    servogo_Click
End Sub

Private Sub servoright_Click()
    If (Not Splash.left_right = 255) Then
        Splash.left_right = Splash.left_right + 1
        Text2.text = (Splash.left_right * 14) + 1400
    End If
End Sub

Private Sub servoleft_Click()
    If (Not Splash.left_right = 0) Then
        Splash.left_right = Splash.left_right - 1
        Text2.text = (Splash.left_right * 14) + 1400
    End If
End Sub

Private Sub servorightlimit_Click()
```

```
    Splash.left_right = 23
    Text2.text = (Splash.left_right * 14) + 1400
    Splash.up_down = 129
    Text1.text = (Splash.up_down * 14) + 1400
    servogo_Click
End Sub

Private Sub servoup_Click()
    If (Not Splash.up_down = 255) Then
        Splash.up_down = Splash.up_down + 1
        Text1.text = (Splash.up_down * 14) + 1400
    End If
End Sub

Private Sub servodown_Click()
    If (Not Splash.up_down = 0) Then
        Splash.up_down = Splash.up_down - 1
        Text1.text = (Splash.up_down * 14) + 1400
    End If
End Sub
'**********END SERVO CONTROLS**********


'Timer event that sends command to get new
'readings from sensors every .3sec

Private Sub Timer1_Timer()
    outputBuffer = Chr(5)
    Comm1.Output = outputBuffer
    If OA_on = True Then
        Timer1.Enabled = False  'Must turn off timer until event is know
        If Splash.Bump_right = 0 Or Splash.Bump_left = 0 Then
            If Splash.goingInReverse = False Then
                motorStop_Click   'stop motors
                delay_halfsec
                motorReverse_Click   'set motors into reverse
                Splash.goingInReverse = True
            End If
            motorReverse_Click
            Splash.leftMotor = Splash.Left_Reverse
            Splash.rightMotor = Splash.Right_Reverse
            motorGo_Click
            delay_1sec
            If Splash.IR_left > Splash.IR_right Then
                If Splash.goingInReverse = True Then
                    motorStop_Click
                    delay_halfsec
                    motorForward_Click   'make sure motors are set to forward
                    Splash.goingInReverse = False
                End If
                motorForward_Click
                Splash.rightMotor = Splash.rightMotorLeftTurn
```

```
        Splash.leftMotor = Splash.leftMotorLeftTurn
        motorGo_Click
        delay_1sec
        motorStop_Click

    Else
        If Splash.goingInReverse = True Then
            motorStop_Click
            delay_halfsec
            motorForward_Click   'make sure motors are set to forward
            Splash.goingInReverse = False
        End If
        motorForward_Click
        Splash.rightMotor = Splash.rightMotorRightTurn
        Splash.leftMotor = Splash.leftMotorRightTurn
        motorGo_Click
        delay_1sec
        motorStop_Click
    End If
ElseIf Splash.IR_left <= 25 And Splash.IR_right <= 25 Then
   If Splash.goingInReverse = True Then
      motorStop_Click
      delay_halfsec
      motorForward_Click   'make sure motors are set to forward
      Splash.goingInReverse = False
   End If
   motorForward_Click
   Splash.leftMotor = Splash.Left_Forward
   Splash.rightMotor = Splash.Right_Forward
   motorGo_Click     'go forward
ElseIf Splash.IR_left > 25 And Splash.IR_right <= 25 Then  'there is something to the right
   If Splash.goingInReverse = True Then
      motorStop_Click
      delay_halfsec
      motorForward_Click   'make sure motors are set to forward
      Splash.goingInReverse = False
   End If
   motorForward_Click
   Splash.leftMotor = Splash.leftMotorLeftTurn
   Splash.rightMotor = Splash.rightMotorLeftTurn
   motorGo_Click    'turn!
ElseIf Splash.IR_left <= 25 And Splash.IR_right > 25 Then   'there is something to the left
   If Splash.goingInReverse = True Then
      motorStop_Click
      delay_halfsec
      motorForward_Click   'make sure motors are set to forward
      Splash.goingInReverse = False
   End If
   motorForward_Click
   Splash.leftMotor = Splash.leftMotorRightTurn
   Splash.rightMotor = Splash.rightMotorRightTurn
   motorGo_Click   'turn!
```

```
    ElseIf Splash.IR_left > 25 And Splash.IR_right > 25 Then
       If Splash.goingInReverse = False Then
          motorStop_Click   'stop motors
          delay_halfsec
          motorReverse_Click   'set motors into reverse
          Splash.goingInReverse = True
       End If
       motorReverse_Click
       Splash.leftMotor = Splash.Left_Reverse
       Splash.rightMotor = Splash.Right_Reverse
       motorGo_Click
       delay_halfsec   'do nothing for .5 sec

       'get an update
       outputBuffer = Chr(5)
       Comm1.Output = outputBuffer

       If Splash.IR_left <= 25 And Splash.IR_right <= 25 Then   '
          If Splash.IR_left > Splash.IR_right Then
             If Splash.goingInReverse = True Then
                motorStop_Click
                delay_halfsec
                motorForward_Click   'make sure motors are set to forward
                Splash.goingInReverse = False
             End If
             motorForward_Click
             Splash.rightMotor = Splash.rightMotorLeftTurn
             Splash.leftMotor = Splash.leftMotorLeftTurn
             motorGo_Click
             delay_1sec
             motorStop_Click

          Else
             If Splash.goingInReverse = True Then
                motorStop_Click
                delay_halfsec
                motorForward_Click   'make sure motors are set to forward
                Splash.goingInReverse = False
             End If
             motorForward_Click
             Splash.rightMotor = Splash.rightMotorRightTurn
             Splash.leftMotor = Splash.leftMotorRightTurn
             motorGo_Click
             delay_1sec
             motorStop_Click
          End If
       End If
    End If
 End If

 Timer1.Enabled = True   'Turn timer back on
End Sub
```

```
Private Sub delay_halfsec()
   Dim Start, Finish As Double
   Start = Timer
   Finish = Start + 0.5
   Do While Timer < Finish
            'Can do other processing, but instead just eating up time
   Loop
End Sub

Private Sub delay_1sec()
   Dim Start, Finish As Double
   Start = Timer
   Finish = Start + 1#
   Do While Timer < Finish
            'Can do other processing, but instead just eating up time
   Loop
End Sub

'**********MOTOR CONTROLS***********

Private Sub motorForward_Click()
   outputBuffer = Chr(2) + Chr(0)
   Comm1.Output = outputBuffer
End Sub

Private Sub motorReverse_Click()
   outputBuffer = Chr(2) + Chr(1)
   Comm1.Output = outputBuffer
End Sub

Private Sub motorGo_Click()
   outputBuffer = Chr(0) + Chr(Splash.leftMotor)
   Comm1.Output = outputBuffer
   outputBuffer = Chr(1) + Chr(Splash.rightMotor)
   Comm1.Output = outputBuffer
   Splash.Go = True
   If OA_on = False Then
      Suspend.Caption = ""
   End If
End Sub

Private Sub motorLeftDown_Click()
   If (Not Splash.leftMotor = 0) Then
      Splash.leftMotor = Splash.leftMotor - 1
      motorLeftText.text = CByte(Splash.leftMotor)
      If Splash.Go = True Then
      outputBuffer = Chr(0) + Chr(Splash.leftMotor)
      Comm1.Output = outputBuffer
      End If
   End If
```

```
End Sub

Private Sub motorLeftUp_Click()
    If (Not Splash.leftMotor = 100) Then
        Splash.leftMotor = Splash.leftMotor + 1
        motorLeftText.text = CByte(Splash.leftMotor)
        If Splash.Go = True Then
        outputBuffer = Chr(0) + Chr(Splash.leftMotor)
        Comm1.Output = outputBuffer
        End If
   End If
End Sub

Private Sub motorRightDown_Click()
     If (Not Splash.rightMotor = 0) Then
        Splash.rightMotor = Splash.rightMotor - 1
        motorRightText.text = CByte(Splash.rightMotor)
        If Splash.Go = True Then
        outputBuffer = Chr(1) + Chr(Splash.rightMotor)
        Comm1.Output = outputBuffer
        End If
   End If
End Sub

Private Sub motorRightUp_Click()
    If (Not Splash.rightMotor = 100) Then
        Splash.rightMotor = Splash.rightMotor + 1
        motorRightText.text = CByte(Splash.rightMotor)
        If Splash.Go = True Then
        outputBuffer = Chr(1) + Chr(Splash.rightMotor)
        Comm1.Output = outputBuffer
        End If
   End If
End Sub

Private Sub motorStop_Click()
    outputBuffer = Chr(1) + Chr(0)
    Comm1.Output = outputBuffer
    outputBuffer = Chr(0) + Chr(0)
    Comm1.Output = outputBuffer
    Splash.Go = False
    Suspend.Caption = "Motors Suspended"
End Sub


Private Sub motorHalf_Click()
    motorLeftText.text = "50"
    motorRightText.text = "50"
    Splash.leftMotor = 50
    Splash.rightMotor = 50
    If Splash.Go = True Then
    outputBuffer = Chr(0) + Chr(Splash.leftMotor) + Chr(1) + Chr(Splash.rightMotor)
```

```
   Comm1.Output = outputBuffer
   End If
End Sub

'**********END MOTOR CONTROLS*********
```

ACTUATION CALIBRATION CODE

```
Option Explicit

Private Sub Form_Load()
   'get values and display in appropriate fields

   leftMotorForward.text = Splash.Left_Forward
   rightMotorForward.text = Splash.Right_Forward
   leftMotorBackwards.text = Splash.Left_Reverse
   rightMotorBackwards.text = Splash.Right_Reverse
   leftMotorLeftTurn.text = Splash.leftMotorLeftTurn
   rightMotorLeftTurn.text = Splash.rightMotorLeftTurn
   leftMotorRightTurn.text = Splash.leftMotorRightTurn
   rightMotorRightTurn.text = Splash.rightMotorRightTurn

End Sub
Private Sub Apply_Click()
   'get changes and store
   Splash.Left_Forward = leftMotorForward.text
   Splash.Right_Forward = rightMotorForward.text
   Splash.Left_Reverse = leftMotorBackwards.text
   Splash.Right_Reverse = rightMotorBackwards.text
   Splash.leftMotorLeftTurn = leftMotorLeftTurn.text
   Splash.rightMotorLeftTurn = rightMotorLeftTurn.text
   Splash.leftMotorRightTurn = leftMotorRightTurn.text
   Splash.rightMotorRightTurn = rightMotorRightTurn.text
End Sub

Private Sub Close_Click()
   Calibration.Hide  'Close Form
End Sub

Private Sub Form_OKClick()
   Calibration.Hide  'Close Form
End Sub
```

TEST CAMERA CODE

```
Option Explicit

Private outputBuffer As String

Private Sub Form_Load()
   Comm1.PortOpen = True  'Open Com 1
End Sub
```

```
Private Sub Form_OKClick()
   Comm1.PortOpen = False
   Camera.Hide
End Sub

Private Sub Erase_Pic_Click()
   outputBuffer = Chr(6)         'Toggle through Modes
   Comm1.Output = outputBuffer
   outputBuffer = Chr(6)
   Comm1.Output = outputBuffer
   outputBuffer = Chr(6)
   Comm1.Output = outputBuffer
   outputBuffer = Chr(6)
   Comm1.Output = outputBuffer
   delay_2sec
   outputBuffer = Chr(7)         'Confirm erase
   Comm1.Output = outputBuffer
   outputBuffer = Chr(7)
   Comm1.Output = outputBuffer
End Sub

Private Sub Take_Pic_Click()
   outputBuffer = Chr(7)
   Comm1.Output = outputBuffer
End Sub

Private Sub Turn_on_Click()
   outputBuffer = Chr(6)
   Comm1.Output = outputBuffer
End Sub

Private Sub delay_2sec()
   Dim Start, Finish As Double
   Start = Timer
   Finish = Start + 2#
   Do While Timer < Finish
          'Can do other processing, but instead just eating up time
   Loop
End Sub
```

TAKE PICTURES CODE

```
Option Explicit

Private Start_on As Boolean        'Robot's main behavior is running
Private IncomingStr As String
Private outputBuffer As String
Private pyro_found As Boolean
Private wait_mode As Boolean       'In wait mode to take pic?

Private pictureTaken As Boolean
```

```
Private pictureNumber As Integer
Private Count As Integer

Public text As String
Public temp As Long
Public Const SND_SYNC = &H0         '  play synchronously (default)
Public Const SND_ASYNC = &H1         '  play asynchronously
Public Declare Function PlaySound Lib "Coredll" Alias "PlaySoundW" (ByVal lpszName As String, ByVal
hModule As Long, ByVal dwFlags As Long) As Long



Private Sub Form_Load()
   Comm1.PortOpen = True
   Timer1.Enabled = True
   Information.text = "(" & Time & ") - Waiting for pyro to stabilize..." & (Chr(10)) & Information.text
   wait_mode = False
   Splash.goingInReverse = False
   pictureNumber = 1
   Count = 1
End Sub

Private Sub Form_OKClick()

   Timer1.Enabled = False
   Timer2.Enabled = False
   Timer3.Enabled = False
   Timer4.Enabled = False
   Timer5.Enabled = False
   StopButton_Click
   Capture.Hide
   Comm1.PortOpen = False
End Sub

Private Sub Find_Pyro()
   'Found first pyro reading?
   If Splash.Pyro = 1 Then
      Timer2.Enabled = False
      Information.text = "(" & Time & ") - Pyro ready; push start to begin..." & (Chr(10)) &
Information.text
      Start.Enabled = True
   End If
End Sub

Private Sub Start_Click()
   Start_on = True
   Information.text = "(" & Time & ") - Routine Started" & (Chr(10)) & Information.text
   Start.Enabled = False
   StopButton.Enabled = True

   'Turn on camera
```

```
    Turn_on_Click
    Timer5.Enabled = True

    Timer3.Interval = Int((30000 - 5000 + 1) * Rnd + 5000)    'generating time between 5sec - 30sec
    Timer3.Enabled = True

End Sub

Private Sub StopButton_Click()
    Start_on = False
    Information.text = "(" & Time & ") - Routine Suspended" & (Chr(10)) & Information.text
    Start.Enabled = True
    StopButton.Enabled = False
    motorStop_Click     'stop motors

    'Stop all timers
    Timer1.Enabled = False
    Timer2.Enabled = False
    Timer3.Enabled = False
    Timer4.Enabled = False
    Timer5.Enabled = False
End Sub

Private Sub Timer1_Timer()      'refresh sensor readings ever 300 ms
    outputBuffer = Chr(5)
    Comm1.Output = outputBuffer
    If Start_on = True Then
       Timer1.Enabled = False  'Must turn off timer until event is know
        If Splash.Bump_right = 0 Or Splash.Bump_left = 0 Then
            If Splash.goingInReverse = False Then
               motorStop_Click   'stop motors
              delay_halfsec
               motorReverse_Click   'set motors into reverse
              Splash.goingInReverse = True
            End If
            motorReverse_Click
            Splash.leftMotor = Splash.Left_Reverse
            Splash.rightMotor = Splash.Right_Reverse
            motorGo_Click
            delay_1sec
            If Splash.IR_left > Splash.IR_right Then
                If Splash.goingInReverse = True Then
                   motorStop_Click
                   delay_halfsec
                   motorForward_Click   'make sure motors are set to forward
                   Splash.goingInReverse = False
                End If
                motorForward_Click
                Splash.rightMotor = Splash.rightMotorLeftTurn
                Splash.leftMotor = Splash.leftMotorLeftTurn
                motorGo_Click
                delay_1sec
```

```
        motorStop_Click

    Else
        If Splash.goingInReverse = True Then
            motorStop_Click
            delay_halfsec
            motorForward_Click   'make sure motors are set to forward
            Splash.goingInReverse = False
        End If
        motorForward_Click
        Splash.rightMotor = Splash.rightMotorRightTurn
        Splash.leftMotor = Splash.leftMotorRightTurn
        motorGo_Click
        delay_1sec
        motorStop_Click
    End If
ElseIf Splash.IR_left <= 25 And Splash.IR_right <= 25 Then
    If Splash.goingInReverse = True Then
        motorStop_Click
        delay_halfsec
        motorForward_Click   'make sure motors are set to forward
        Splash.goingInReverse = False
    End If
    motorForward_Click
    Splash.leftMotor = Splash.Left_Forward
    Splash.rightMotor = Splash.Right_Forward
    motorGo_Click     'go forward
ElseIf Splash.IR_left > 25 And Splash.IR_right <= 25 Then  'there is something to the right
    If Splash.goingInReverse = True Then
        motorStop_Click
        delay_halfsec
        motorForward_Click   'make sure motors are set to forward
        Splash.goingInReverse = False
    End If
    motorForward_Click
    Splash.leftMotor = Splash.leftMotorLeftTurn
    Splash.rightMotor = Splash.rightMotorLeftTurn
    motorGo_Click    'turn!
ElseIf Splash.IR_left <= 25 And Splash.IR_right > 25 Then   'there is something to the left
    If Splash.goingInReverse = True Then
        motorStop_Click
        delay_halfsec
        motorForward_Click   'make sure motors are set to forward
        Splash.goingInReverse = False
    End If
    motorForward_Click
    Splash.leftMotor = Splash.leftMotorRightTurn
    Splash.rightMotor = Splash.rightMotorRightTurn
    motorGo_Click   'turn!
ElseIf Splash.IR_left > 25 And Splash.IR_right > 25 Then
    If Splash.goingInReverse = False Then
        motorStop_Click   'stop motors
```

```
            delay_halfsec
            motorReverse_Click   'set motors into reverse
            Splash.goingInReverse = True
          End If
          motorReverse_Click
          Splash.leftMotor = Splash.Left_Reverse
          Splash.rightMotor = Splash.Right_Reverse
          motorGo_Click
          delay_halfsec   'do nothing for .5 sec

          'get an update
          outputBuffer = Chr(5)
          Comm1.Output = outputBuffer

          If Splash.IR_left <= 25 And Splash.IR_right <= 25 Then   '
            If Splash.IR_left > Splash.IR_right Then
              If Splash.goingInReverse = True Then
                motorStop_Click
                delay_halfsec
                motorForward_Click   'make sure motors are set to forward
                Splash.goingInReverse = False
              End If
              motorForward_Click
              Splash.rightMotor = Splash.rightMotorLeftTurn
              Splash.leftMotor = Splash.leftMotorLeftTurn
              motorGo_Click
              delay_1sec
              motorStop_Click

            Else
              If Splash.goingInReverse = True Then
                motorStop_Click
                delay_halfsec
                motorForward_Click   'make sure motors are set to forward
                Splash.goingInReverse = False
              End If
              motorForward_Click
              Splash.rightMotor = Splash.rightMotorRightTurn
              Splash.leftMotor = Splash.leftMotorRightTurn
              motorGo_Click
              delay_1sec
              motorStop_Click
            End If
          End If
        End If
      ElseIf wait_mode = True And Start_on = False Then
        If Splash.Pyro = 1 Then     'If person detected, then take pic
          Take_Pic_Click
          Information.text = "(" & Time & ") - Picture " & pictureNumber & " taken..." & (Chr(10)) &
Information.text

          'Stop taking pictures
```

```
        Timer4_Timer
      End If
   End If

   Timer1.Enabled = True   'Turn timer back on
End Sub

Private Sub Comm1_OnComm()
  Select Case Comm1.CommEvent
  Case comEvReceive
    IncomingStr = Comm1.Input
    Process_data (IncomingStr)  'Process data when data is recieved
    Case comEvSend
    ' do nothing here
  End Select
End Sub

Private Sub Process_data(temp As String)
   Dim Size As Integer
   Size = Len(temp)
   If Size = 4 Then    'Only process data when data is 3 bytes long
      Splash.IR_right = CInt(Asc(Mid(temp, 1, 1)))
      Splash.IR_left = CInt(Asc(Mid(temp, 2, 1)))
      Splash.Bump_right = CInt(Asc(Mid(temp, 3, 1))) And 1
      If (CByte(Asc(Mid(temp, 3, 1))) And 2) = 2 Then     'AND with 2 to get value of Bit1
         Splash.Bump_left = 1
      Else
         Splash.Bump_left = 0
      End If
      If (CByte(Asc(Mid(temp, 4, 1))) And 128) = 128 Then     'AND with 128 to get value of Bit7
         Splash.Pyro = 1
      Else
         Splash.Pyro = 0
      End If
   End If
End Sub

Private Sub delay_halfsec()
   Dim Start, Finish As Double
   Start = Timer
   Finish = Start + 0.5
   Do While Timer < Finish
            'Can do other processing, but instead just eating up time
   Loop
End Sub

Private Sub delay_1sec()
   Dim Start, Finish As Double
   Start = Timer
   Finish = Start + 1#
   Do While Timer < Finish
            'Can do other processing, but instead just eating up time
```

```
   Loop
End Sub


'**********MOTOR CONTROLS**********

Private Sub motorForward_Click()
   outputBuffer = Chr(2) + Chr(0)
   Comm1.Output = outputBuffer
   Splash.goingInReverse = False
End Sub

Private Sub motorReverse_Click()
   outputBuffer = Chr(2) + Chr(1)
   Comm1.Output = outputBuffer
   Splash.goingInReverse = True
End Sub

Private Sub motorGo_Click()
   outputBuffer = Chr(0) + Chr(Splash.leftMotor)
   Comm1.Output = outputBuffer
   outputBuffer = Chr(1) + Chr(Splash.rightMotor)
   Comm1.Output = outputBuffer
   Splash.Go = True
End Sub

Private Sub motorStop_Click()
   outputBuffer = Chr(1) + Chr(0)
   Comm1.Output = outputBuffer
   outputBuffer = Chr(0) + Chr(0)
   Comm1.Output = outputBuffer
   Splash.Go = False
End Sub



'**********END MOTOR CONTROLS*********

Private Sub servogo_Click()
   outputBuffer = Chr(4) + Chr(Splash.left_right)
   Comm1.Output = outputBuffer     'Output left/right commands to uP
   outputBuffer = Chr(3) + Chr(Splash.up_down)
   Comm1.Output = outputBuffer     'Output up/down commands to uP
End Sub

Private Sub Timer2_Timer()
   Timer2.Interval = 300       'make sure interval is at 300 ms and see if
                       'pyro is ready
   Find_Pyro
End Sub

Private Sub Timer3_Timer()
```

```
    Timer3.Enabled = False   'Turn off timer that caused this event
    Start_on = False        'Stop OA


    temp = PlaySound("abouttotake" & Count Mod 4 & ".wav", 0, SND_ASYNC)
    'stop motors
    motorStop_Click

    'Randomlly generate up/down and left/right position on pan-and-tilt
    Splash.up_down = Int((129 - 40 + 1) * Rnd + 40)
    Splash.left_right = Int((255 - 23 + 1) * Rnd + 23)
    servogo_Click
    delay_halfsec

    Timer4.Enabled = True    'Turn on 5 sec timer


End Sub


Private Sub Take_Pic_Click()
    outputBuffer = Chr(7)
    Comm1.Output = outputBuffer
    Timer5.Interval = 62000       'reset timer that keeps camera on
    pictureTaken = True
End Sub

Private Sub Turn_on_Click()
    outputBuffer = Chr(6)
    Comm1.Output = outputBuffer
End Sub

Private Sub Keep_on()
    outputBuffer = Chr(6)
    Comm1.Output = outputBuffer
End Sub
Private Sub Timer4_Timer()         'event occurs when time to wait to take pic
    If wait_mode = False Then
        wait_mode = True
        pictureTaken = False
    Else
        Timer4.Enabled = False

        'generate time when OA will stop again
        Timer3.Interval = Int((30000 - 5000 + 1) * Rnd + 5000)    'generating time between 5sec -
30sec
        Timer3.Enabled = True

        wait_mode = False
        'randomally spin in some direction
        If Splash.IR_left > Splash.IR_right Then
            If Splash.goingInReverse = True Then
```

```
            motorStop_Click
            delay_halfsec
            motorForward_Click   'make sure motors are set to forward
            Splash.goingInReverse = False
         End If
         Splash.rightMotor = Splash.rightMotorLeftTurn
         Splash.leftMotor = Splash.leftMotorLeftTurn
         motorGo_Click
         delay_1sec
         motorStop_Click

      Else
         If Splash.goingInReverse = True Then
            motorStop_Click
            delay_halfsec
            motorForward_Click   'make sure motors are set to forward
            Splash.goingInReverse = False
         End If
         Splash.rightMotor = Splash.rightMotorRightTurn
         Splash.leftMotor = Splash.leftMotorRightTurn
         motorGo_Click
         delay_1sec
         motorStop_Click
      End If

      If pictureTaken = True Then
         temp = PlaySound("picturetaken" & Count Mod 5 & ".wav", 0, SND_ASYNC)
         pictureNumber = pictureNumber + 1
         Count = Count + 1
      Else
         temp = PlaySound("nopicturetaken.wav", 0, SND_ASYNC)
         Count = Count + 1
      End If

      'Go straight forward
      Splash.leftMotor = Splash.Left_Forward
      Splash.rightMotor = Splash.Right_Forward
      motorGo_Click
      Start_on = True     'start OA again

   End If
End Sub

Private Sub Timer5_Timer()          'Keeps turning on camera
   Keep_on   'Keep Camera On
End Sub
```