

Final Lab Report

Bluetooth Motor Control System

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1 Introduction

In this final lab, the objective was to use two microcontrollers connected through Bluetooth to control two "fans". The fans are two motors that are speed controlled with potentiometers. Additionally, two sensors are used to turn the motors off at any moment given object detection. This system demonstrates the remote control of motors and the use of object detection using proximity and motion sensors for a safety systems.

Several analog to digital conversions take place to operate this system. The potentiometers are analog inputs converted into a digital number between 0 and 250. Where 0 is the motor stopped and 250 is the motor at max speed. A total of two potentiometers, each controls one of the two motors.

The sensors are also analog inputs converted into a digital signals. Two sensors were used. The SHARP 2Y0A02F18 IR distance sensor and the HC-SR501 IR motion sensor. The distance sensor was used to turn off motor1 if it detected an object within 20 cm. The motion sensor was used to turn off motor2 if motion was detected in the sensors field of view.

Two HM-10 bluetooth modules were used to communicate data from system to system. The bluetooth modules were configured to pair with one another and with the serial UART TX and RX connection with the microcontroller.

Demonstration of this system can be viewed on YouTube [1].

This Lab report should contain the following:

1. Cover page (1 page) Include title, date, authors, signature, recipient
2. Introduction
3. Procedure for design
4. Procedure for development / construction
5. Assessment
6. Conclusions
7. References
8. Appendix 1: Circuit diagram
9. Appendix 2: Program Flowchart
10. Appendix 3: Program listing

2 Design

The electrical components used in the system are as follows:

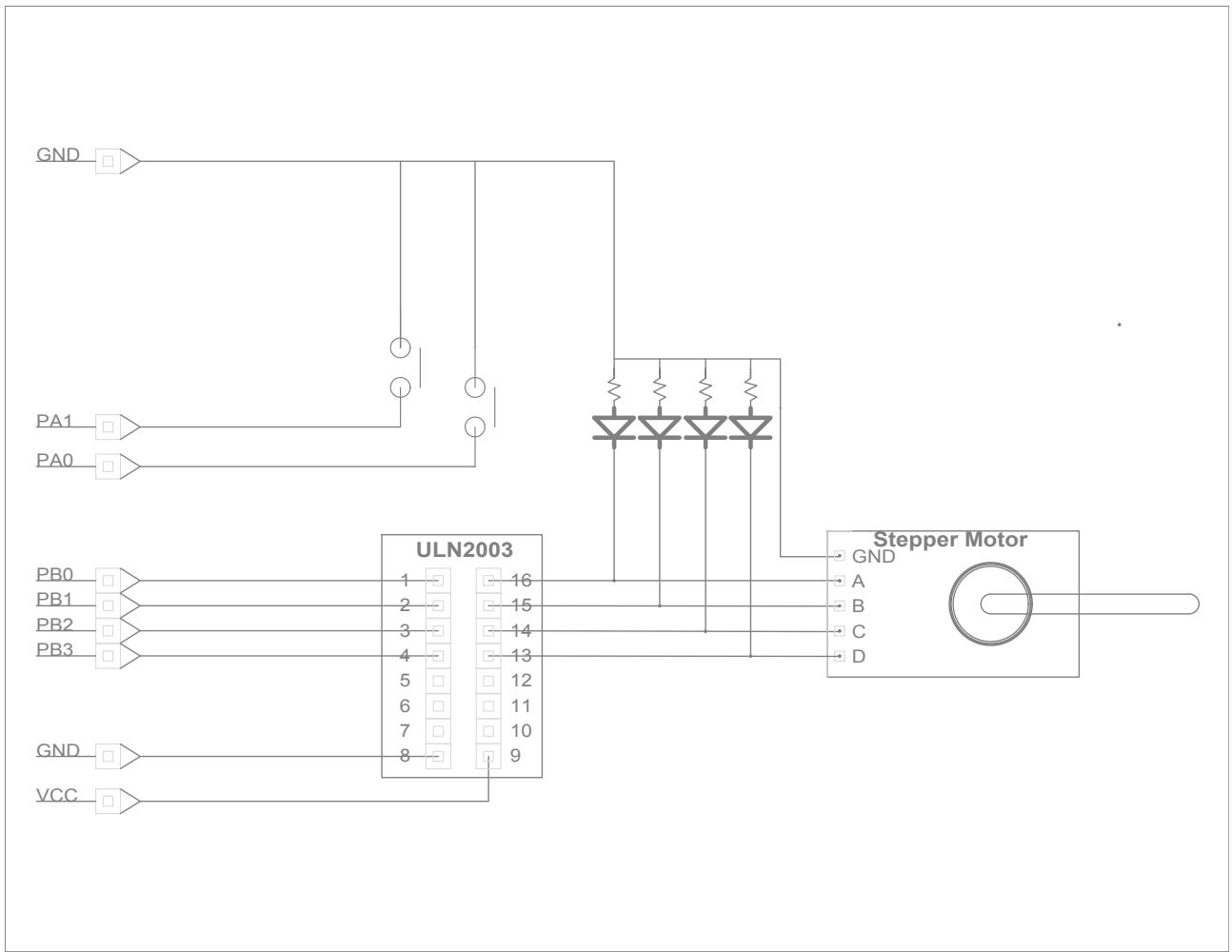


Figure 1: Circuit Diagram

Quantity	Model	Description
2	Arduino Atmega 2560	Microcontroller
2	HM-10	Low Energy Bluetooth modules
2	10k Generic Potentiometer	Variable Resistor
2	Gikfun DC Motor	3-6 Volt DC Motor

3 Development

The construction in this project is constructed as shown in figures ??, ??, and ???. The IC chip in ?? is an L293D motor driver; reference the data sheet for the pinout.

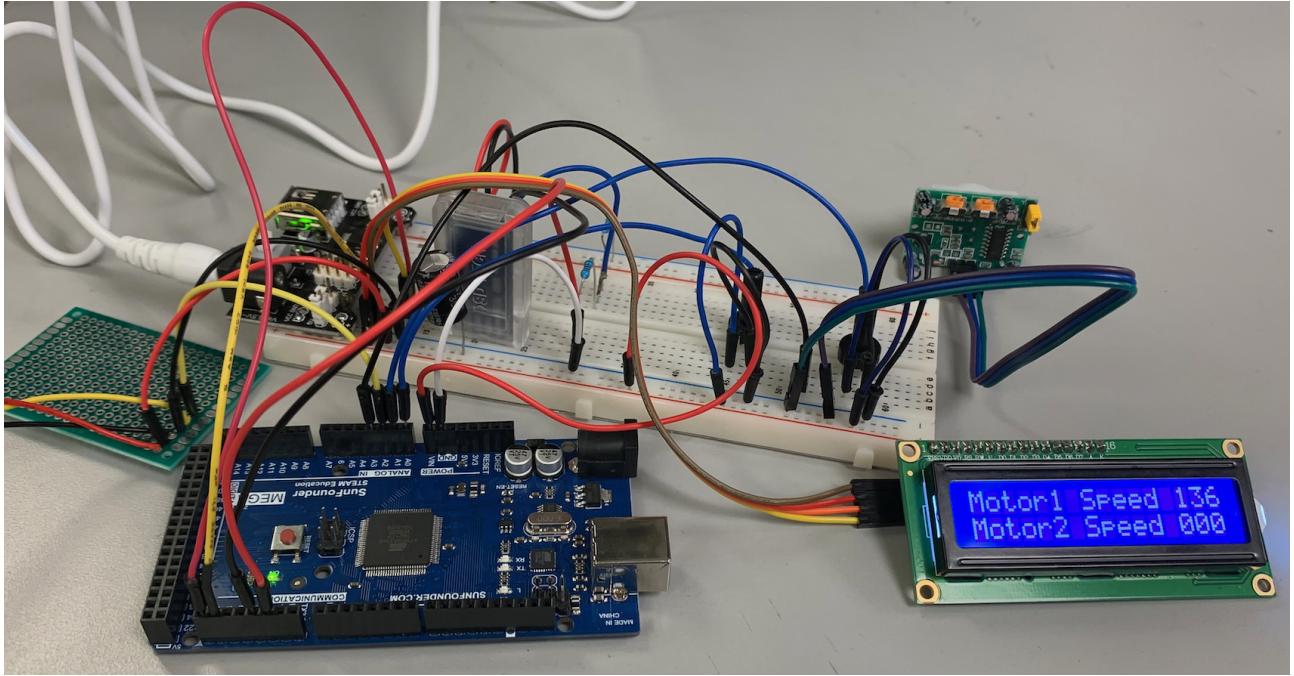


Figure 2: Breadboard and Connections

4 Assessment

To test the system, we waved an object in front of the motion sensor to see if the corresponding motor turned off. We also waved an object in front of the IR distance sensor to see if the corresponding motor turned off. At first the system did not work, so we made adjustments in the code. We initially used 8-bit PWM, but it did not work. We used 10-bit fast PWM and it worked. Since the bluetooth module can only send a byte at a time, we had to scale the 10-bit number received from the ADC to an 8-bit number. To do this, we divided the 10-bit number by 4. When the Arduino that controls the motors received a byte from the bluetooth communication, it multiplied the data by 4 to unscale the number.

5 Conclusions

6 References

- [1] <https://youtu.be/fZUjRV97KJc>

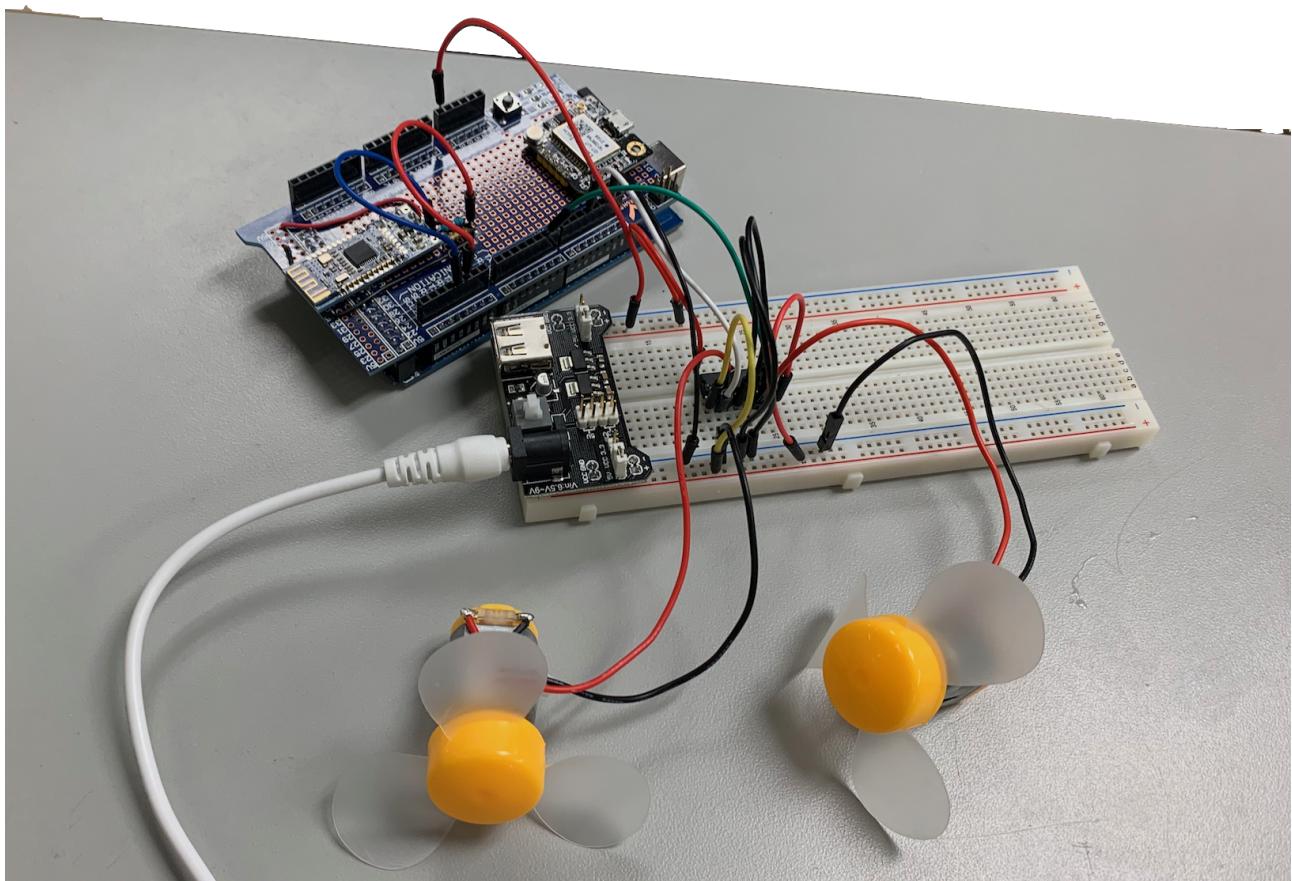


Figure 3: Breadboard and Connections

7 Appendix i: Circuit diagram

8 Appendix ii: Program Flowchart

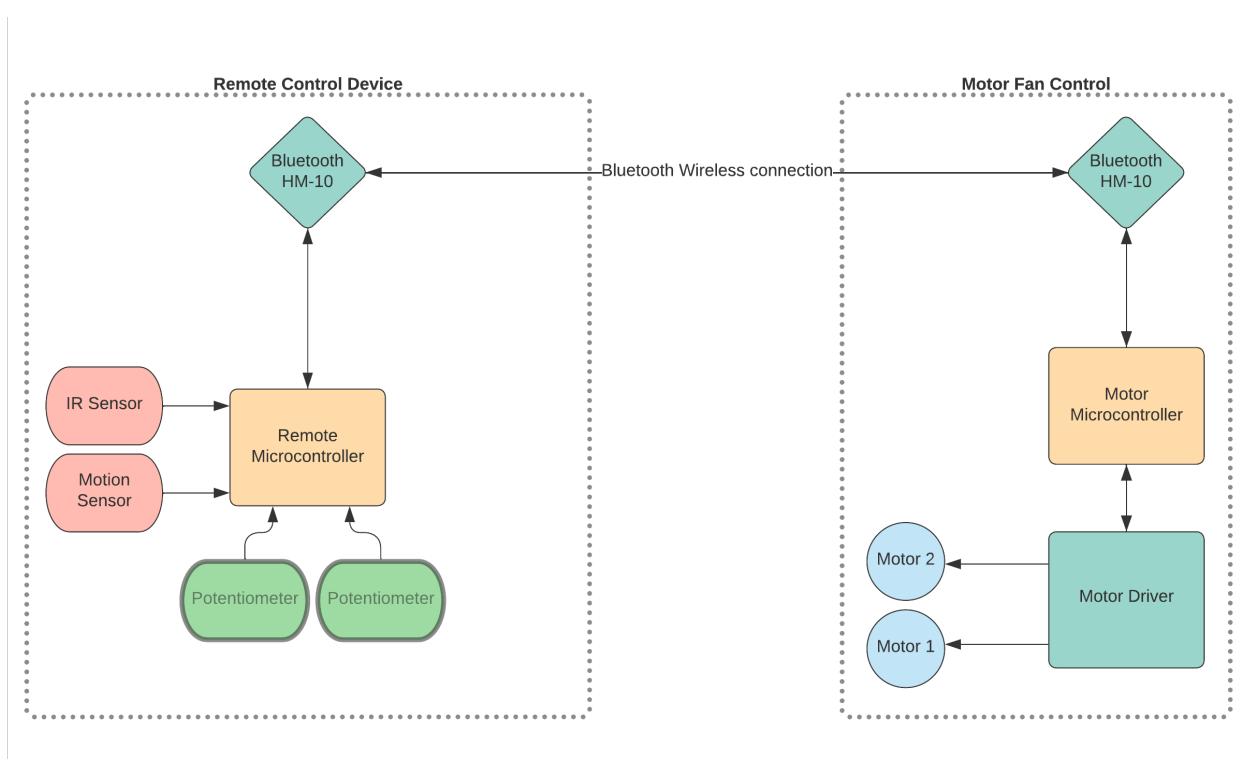


Figure 4: Program Block Flowchart

9 Appendix iii: Source Code - Remote Control

This section contains the source code from the microcontroller reading potentiometers and the sensors to control the speed of the motors, and then sending the speeds over bluetooth to the motor control microcontroller.

```
0  /*
1   */
2
3  /* I N C L U D E S */
4
5 #include <LiquidCrystal_I2C.h>
6
7  /* D E C L A R A T I O N S */
8 void u8_get_motor1_speed(void);
9 void u8_get_motor2_speed(void);
10 void average_distance(void);
11 void zero_pad_int_str(int n, char s[]);
12 void reverse_string(char s[]);
13 void integer_to_ascii(int n, char s[]);
14 void motion_detection(void);
15
16
17 /* D E F I N E S */
18 // DEFINE PIN NUMBERS
19 #define ADDRESS 0x27
20 #define COLS 16
21 #define ROWS 2
22 #define baud 9600
23
24
25 /* G L O B A L S */
26
27 uint8_t u8_start_byte = 255;
28 uint8_t u8_stop_byte = 254;
29 uint8_t u8_motor1_speed=50;
30 uint8_t u8_motor2_speed=50;
31 uint8_t u8_data = 192;
32 uint8_t i_index = 0;
33 uint8_t u8_command_state = 3;
34 uint8_t u8_motor1_state = 0;
35 uint8_t u8_motor2_state = 0;
36 uint32_t u32_average_distance = 0;
37 bool bool_motion_detection = false;
38
39
40 char message0 [] = "Motor1 Speed";
41 char message1 [] = "Motor2 Speed";
42 char message2 [] = "000";
43 char message3 [] = "000";
44
45 /* S E T U P */
46
47 // CREATE LiquidCrystal OBJECT
48 LiquidCrystal_I2C lcd(ADDRESS, COLS, ROWS);
49
50 void setup() //run once
```

```

52     // setup timer 1
53     TCCR1A = 0b00000000; // see notes , normal mode
54     TCCR1B = 0b00000100; // normal mode divide clock by 1
55     TIMSK1 = 0b00000000; // no interrupts
56
57     // Start the serial connection with the HM-10 bluetooth module
58     Serial2.begin(baud,SERIAL_8N1);
59     Serial.begin(baud,SERIAL_8N1);
60
61     // INITIALIZE THE LCD SCREEN
62     lcd.begin();
63
64     // PRINT MESSAGE
65     lcd.print(message0);
66     lcd.setCursor(0, 1);
67     lcd.print(message1);
68
69     // DISABLE DIGITAL BUFFER FOR ALL ANALOG PINS
70     DIDR0 = 0xFF;
71     DIDR2 = 0xFF;
72
73     // SET UP ANALOG TO DIGITAL CONVERSION IN FREE RUNNING MODE
74     ADCSRB = 0x00; // 0b00000000
75
76
77 }
78
79 /* MAIN */
80 void loop() // run over and over
81 {
82
83     u8_get_motor1_speed();
84     u8_get_motor2_speed();
85     average_distance();
86     motion_detection();
87     if( u32_average_distance > 400){
88         u8_motor1_speed = 0;
89     }
90
91     if( bool_motion_detection == true){
92         u8_motor2_speed = 0;
93     }
94
95
96
97
98
99 // SENDING MOTOR1 AND MOTOR2 SPEED TO BLUETOOTH
100 if( TIFR1 &= 0b00000001 ) {
101     TIFR1 |= 0b00000001; // clear the TOV flag by writing a 1 to it
102
103     //Write to motor control
104     Serial2.write(u8_start_byte);
105     // MOTOR 1
106     Serial2.write(u8_motor1_speed);
107     lcd.setCursor(13, 0);
108     integer_to_ascii(u8_motor1_speed,message2);
109     zero_pad_int_str(3,message2);
110 }
```

```

112     lcd.print(message2);
113
114     // MOTOR 2
115     Serial2.write(u8_motor2_speed);
116     lcd.setCursor(13, 1);
117     integer_to_ascii(u8_motor2_speed, message3);
118     zero_pad_int_str(3, message3);
119     lcd.print(message3);
120
121     Serial.println(u8_motor1_speed);
122     Serial.println(u8_motor2_speed);
123     Serial.println(u32_average_distance);
124 }
125
126
127
128 /* FUNCTIONS */
129
130 // ANALOG TO DIGITAL CONVERSION FUNCTION FOR CAPTURING MOTOR1 SPEED FROM
131 // POTENTIMETER
132 void u8_get_motor1_speed(void){
133     uint16_t valueADC0 = 0;
134     // READ THE INPUT ON ANALOG CHANNEL 0
135     ADMUX = 0x40; // 0b01000000;
136
137     // ENABLE THE ADC, RESET ADIF, AND SET SAMPLING RATE TO 125 kHz
138     ADCSRA = 0x97; // 0b10010111
139     // START THE CONVERSION
140     ADCSRA = 0xD7; // 0b11010111
141
142     // WAIT HERE DURING THE CONVERSION
143     while((ADCSRA & 0x10) == 0x00)
144     {
145         asm("NOP");
146     }
147
148     // IF THE CONVERSION IS COMPLETE
149     if((ADCSRA & 0x10) == 0x10)
150     {
151         // DISABLE THE ADC, RESET ADIF, AND SET SAMPLING RATE TO 125 kHz
152         ADCSRA = 0x17; // 0b00010111
153         // READ THE ADC VALUE
154         valueADC0 = ADCL;
155         valueADC0 += (ADCH << 8);
156     }
157
158     if(valueADC0 <= 50){
159         u8_motor1_speed = 0;
160     }
161     else_if(valueADC0 > 50){
162         u8_motor1_speed = (valueADC0)/4+20;
163     }
164 }
165
166 // ANALOG TO DIGITAL CONVERSION FUNCTION FOR CAPTURING MOTOR2 SPEED FROM
167 // POTENTIMETER
168 void u8_get_motor2_speed(void){

```

```

170     uint16_t valueADC1 = 0;
171     // READ THE INPUT ON ANALOG CHANNEL 1
172     ADMUX = 0x41; // 0b01000001;
173     // ENABLE THE ADC, RESET ADIF, AND SET SAMPLING RATE TO 125 kHz
174     ADCSRA = 0x97; // 0b10010111
175     // START THE CONVERSION
176     ADCSRA = 0xD7; // 0b11010111
177     // WAIT HERE DURING THE CONVERSION
178     while ((ADCSRA & 0x10) == 0x00)
179     {
180         asm( "NOP" );
181     }
182
183     // READ THE CONVERSION VALUE
184     if ((ADCSRA & 0x10) == 0x10)
185     {
186         // DISABLE THE ADC, AND RESET ADIF, AND SET SAMPLING RATE TO 125 kHz
187         ADCSRA = 0x17; // 0b00010111
188         // GET THE HIGH BITS
189         valueADC1 = ADCL;
190         valueADC1 += (ADCH << 8);
191     }
192
193     if (valueADC1 <= 50){
194         u8_motor2_speed = 0;
195     }
196     else if (valueADC1 > 50){
197         u8_motor2_speed = (valueADC1)/4 + 20;
198     }
199 }
200
201 // ANALOG TO DIGITAL CONVERSION FUNCTION FOR CAPTURING DISTANCE RF SENSOR
202 void average_distance(void){
203     uint16_t u16_index;
204     uint16_t valueADC2 = 0;
205     // READ THE INPUT ON ANALOG CHANNEL 2
206     ADMUX = 0x42; // 0b01000010;
207     // ENABLE THE ADC, RESET ADIF, AND SET SAMPLING RATE TO 125 kHz
208     ADCSRA = 0x97; // 0b10010111
209
210     for (u16_index = 0; u16_index < 20; u16_index++) {
211
212         // START THE CONVERSION
213         ADCSRA = 0xD7; // 0b11010111
214         // WAIT HERE DURING THE CONVERSION
215         while ((ADCSRA & 0x10) == 0x00)
216         {
217             asm( "NOP" );
218         }
219         // READ THE CONVERSION VALUE
220         if ((ADCSRA & 0x10) == 0x10)
221         {
222             // DISABLE THE ADC, AND RESET ADIF, AND SET SAMPLING RATE TO 125 kHz
223             ADCSRA = 0x17; // 0b00010111
224             // GET THE HIGH BITS
225             valueADC2 = ADCL;
226             valueADC2 += (ADCH << 8);
227         }
228         u32_average_distance = u32_average_distance + valueADC2;

```

```

230     }
231     u32_average_distance = u32_average_distance/20;
232 }

234 void motion_detection(void){
235
236     uint16_t valueADC3 = 0;
237     // READ THE INPUT ON ANALOG CHANNEL 2
238     ADMUX = 0x43; // 0b01000011;
239     // ENABLE THE ADC, RESET ADIF, AND SET SAMPLING RATE TO 125 kHz
240     ADCSRA = 0x97; // 0b10010111
241
242     // START THE CONVERSION
243     ADCSRA = 0xD7; // 0b11010111
244     // WAIT HERE DURING THE CONVERSION
245     while((ADCSRA & 0x10) == 0x00)
246     {
247         asm( "NOP");
248     }
249     // READ THE CONVERSION VALUE
250     if((ADCSRA & 0x10) == 0x10)
251     {
252         // DISABLE THE ADC, AND RESET ADIF, AND SET SAMPLING RATE TO 125 kHz
253         ADCSRA = 0x17; // 0b00010111
254         // GET THE HIGH BITS
255         valueADC3 = ADCL;
256         valueADC3 += (ADCH << 8);
257     }
258     if(valueADC3 > 500){
259         bool_motion_detection = true;
260     }
261     else {
262         bool_motion_detection = false;
263     }
264 }

266

267 /* integer_to_ascii: convert n to characters in s */
268 void integer_to_ascii(int n, char s[])
269 {
270     int i, sign;
271
272     if ((sign = n) < 0) /* record sign */
273         n = -n; /* make n positive */
274     i = 0;
275     do { /* generate digits in reverse order */
276         s[i++] = n % 10 + '0'; /* get next digit */
277     } while ((n /= 10) > 0); /* delete it */
278     if (sign < 0)
279         s[i++] = '-';
280     s[i] = '\0';
281     reverse_string(s); // needs to be reversed
282 }

283 /* reverse_string: reverse string s in place */
284 void reverse_string(char s[])
285 {
286     int i, j;

```

```

  char c;
290
291   for ( i = 0, j = strlen(s)-1; i < j; i++, j--) {
292     c = s[ i ];
293     s[ i ] = s[ j ];
294     s[ j ] = c;
295   }
296 }
297 /****** Zero pad a string by n amount. If myString = "5" and
298    zero_pad_int_str(4,myString) then myString == "0005" ******/
299 void zero_pad_int_str( int n, char s[])
300 {
301
302   int i;
303   i = strlen(s);
304   reverse_string(s);
305   while( i < n){
306     s[ i ] = '0';
307     i++;
308   }
309   reverse_string(s);
310 }
```

..../Remote_control.c

10 Appendix iv: Source Code - Motor Control

This section contains the source code from the microcontroller controlling the two motors.

```

0  /*
1   * The circuit:
2   * RX is digital pin rxPin (connect to TX of other device)
3   * TX is digital pin txPin (connect to RX of other device)
4   *
5   */
6
7  /* I N C L U D E S */
8
9  /* D E F I N E S */
10
11 #define baud 9600
12 #define DELAY 500
13
14 /* G L O B A L S */
15 uint8_t u8_command_state = 0;
16 uint8_t u8_motor1_speed = 0;
17 uint8_t u8_motor2_speed = 0;
18 uint8_t u8_motor1_state = 0;
19 uint8_t u8_motor2_state = 0;
20 uint8_t u8_start_byte = 193;
21 uint8_t u8_stop_byte = 194;
22
23 /* D E C L A R A T I O N S */
24
```

```

26 /* S E T U P */
27 void setup() //run once
28 {
29     // setup timer 1
30     TCCR1B = 0b00000100; // normal mode divide clock by 1
31     TIMSK1 = 0b00000000; // no interrupts
32
33     // Start the connection to the bluetooth module
34     Serial1.begin(baud,SERIAL_8N1);
35
36     // SET UP PINS FOR OUTPUT
37     DDRB |= 1<<PB7;
38     DDRH |= 1<<PH6;
39
40     // USE TCNT1
41     TCCR0A = 0b10000011; // non-inverted mode, 8 bit fast PWM
42     TCCR0B = 0b00001100; // (I/O clk)/256 (From prescaler)
43
44     // USE TCNT2
45     TCCR2A = 0b10000011; // non-inverted mode, 8 bit fast PWM
46     TCCR2B = 0b00001100; // (I/O clk)/256 (From prescaler)
47
48     // PWM COUNTER
49     OCR0A = 0;
50     OCR2B = 0;
51
52 }
53
54 /* M A I N */
55 void loop() // run over and over
56 {
57
58     if(Serial1.available()){
59
60         if(u8_command_state==1){
61             u8_motor1_speed = Serial.read();
62         }
63         if(u8_command_state==2){
64             u8_motor2_speed = Serial.read();
65         }
66
67     }
68     OCR0A = u8_motor1_speed;
69     OCR2B = u8_motor2_speed;
70
71
72
73
74     if( TIFR1 &= 0b00000001 ) {
75         TIFR1 |= 0b00000001; // clear the TOV flag by writing a 1 to it
76         Serial1.write(u8_start_byte); // Start signature
77         Serial1.write(u8_motor1_state);
78         Serial1.write(u8_motor2_state);
79
80     }
81
82 }

```

..../Motors.c