

Life Saving hanging Robot (LShR) using MSP430 (Modern Mine Surveillance)

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Abstract: This Life Saving hanging Robot (LShR) is used as the safety precaution device for the people who work in mines and tunnels. It is similar to a rope car which will be hanged in a rope and working according to the instructions and also applicable by working automated by indicating the cautions. It has sensors such as Temperature, Smoke, Gas, LDR which can sense the condition of the surroundings and ensure the normal condition periodically, also Ultrasonic sensor and motor driver are used for navigation of the robot device throughout the mine and check the conditions. MSP430 microprocessor has been used to connect the sensors and the navigation device. The indications of environmental conditions due to change in the chemical composition of surroundings are monitored by getting the values of each sensors in a periodic manner. The entire process has been automated where the alert will be ON when any causation is identified. The device is connected in wireless monitor by using the Bluetooth module for a short distance wireless communication and for more distance coverage Xbee module and GSM can also be used. This can also be monitored using mobile application.

Keywords: MSP430 (microcontroller), Bluetooth module and Xbee module (wireless modules), Temperature sensor, Smoke sensor, Gas sensor and LDR sensor (Environment checking sensors), Motor driver and Ultrasonic sensor (Navigation purpose devices)

1. Introduction

Now a day's many mine and tunnels were meeting with accidents because of the poisonous gas leakage from the joints of the rocks. By inhaling these type of gas and most of the people are affected by some side effects like blindness, asthma, severe head ach and etc.. For overcoming all this LShR is introduced. It is a hanging type robot so "no disturbance for anyone's work is done". This LShR can be created manually by special IC's and with some of the sensors which can measure the parameters of the harm causing agents like Poisonous Gas, Smoke, Heat and etc..

2. Microcontroller and the Sensors

In this work MSP430 microcontroller is used to control all the sensors and to convert the sensor values to normal usable parameters. It has 8 Analog pins, 1 Rx- Tx pair pins, 1 Vcc pin, 1 Gnd pin, 8 Digital pins and a reset, test pins. Analog pins are used to give the analog value as the input to the board from the sensors. The analog data are mostly the voltage value which purely depends on the sensitivity of sensor, the analog values will be converted to digital values by the ADC which is inbuilt of the board.

Digital pins will give the output as digital binary values like 0's and 1's, so only ON and OFF stage is decided by this pins. Some of this pin are used for the serial communication with some exceptional case sensors like Ultrasonic sensor and etc.

The Rx- Tx pair pins are used to connect the board in serial with external modules like Bluetooth module and Xbee module.

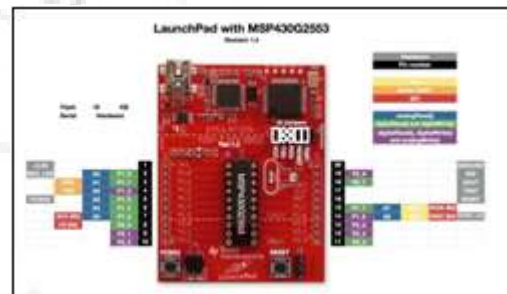


Figure 1: MSP430 interfaced with microcontroller unit

A. Abbreviations and Acronyms

Rx- Receiver, Tx- Transmitter, LDR- Light Dependent Resistor, PWM- Pulse Width Modulation.

B. Other Recommendations

This LShR project is also applicable with Arduino. It also have similar Analog, Digital and Rx- Tx pins. Arduino have 11 Digital pins, 6 Analog pins, 1 pair of Rx- Tx pins, 2 Vcc pins (3.3v and 5v), 3 Gnd pins. Among the digital pins some are used as the PWM pins for the exceptional case sensors like Ultrasonic sensors and etc..

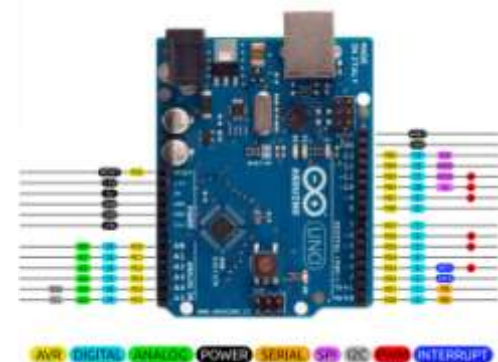


Figure 2: Arduino Uno motherboard

C. Sensors

There are different type of sensors available where we use

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Inductive type – Gas and Smoke sensors, **Thermistor type** – Temperature sensor, **Photo Resistor type** – LDR sensor, **Reflection type** – Ultrasonic sensor, and **Darlington Pair type** – Motor Driver.

In this LSHR project we use the sensors like **Gas sensor** which can detect the different type of Gases with different type of MQ sensor modules used. **Smoke sensor** can detect the smoke by its density that present in air, it can also detect different type by different MQ sensor modules used. **Temperature sensor** is used to calculate the temperature of the surrounding, it's measuring level varies with the different type of LM sensor Modules used. **LDR** is used to measure the light intensity of the place. **Ultrasonic sensor** is used to detect the obstacle on the path the robot moves, this sensor will use the PWM pin for making contact with the board. **Motor Driver** is used to connect the motor to the board, as the power of the motor can't retrieved from the board, additional power supply is given to it. Motor Driver is used to control two motors at the same time.

3. Math

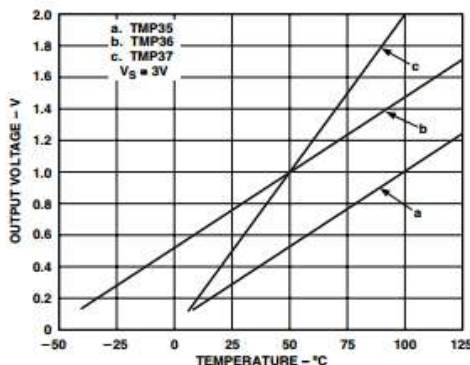
For displaying the Parameters for the different types of sensors Mathematics plays a major role.

a) Formula

As mentioned above the Analog pins can get the values in the analog voltage ie: voltage varying with some other parameters like, For Temperature sensor, the voltage varies with the temperature of the surrounding. For LDR sensor, the voltage varies with the amount of light falls on it. Similar with other sensors also. The formulas are used to convert the analog value to the digital value so that the board can process and give the output. All the sensors operates at the 5v and for 5v data transfer will be at the rate of 1023 bits. The voltage value gained will be at mv. The millivolt to parameter conversion is done as per the following graphs shown for different sensors.

$$\text{Voltage} = (\text{sensor_value} * 5.0) / 1023$$

Temperature sensor Conversion



TPC 1. Output Voltage vs. Temperature

Figure 3: This graph represents the voltage and the temperature plot for different types of temperature sensor

This graph represents the voltage and Temperature plot of the different types of sensors like LM35, LM36, LM37. In the graph at 50° C both the curves of LM36 and LM37 coincides.

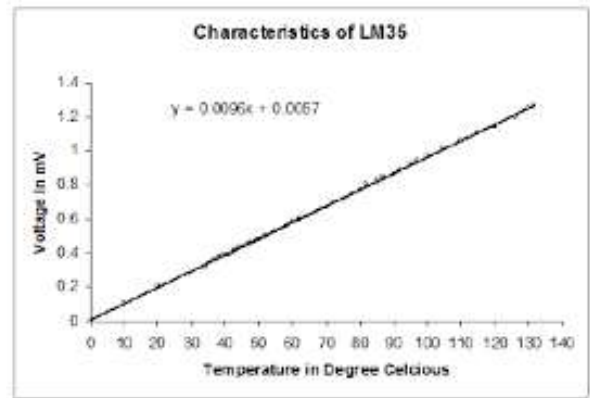


Figure 4: This graph represents the temperature and voltage variation in LM35

In this graph voltage varies with respect with the temperature increases.

b) Gas and Smoke sensor Conversion

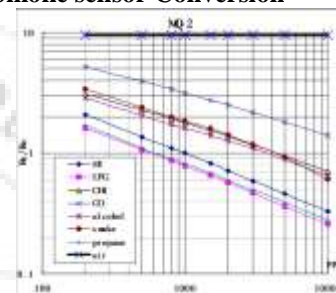


Figure 5: This graph represents the voltage and the ppm plot for MQ2 sensor

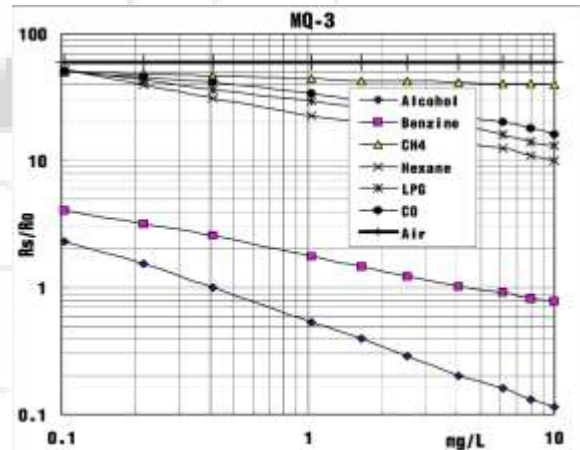


Figure 6: This graph represents the voltage and the ppm plot for MQ3 sensor

c) LDR sensor Conversion

In this sensor as much the light intensity is increased the resistivity increased and the voltage drops.

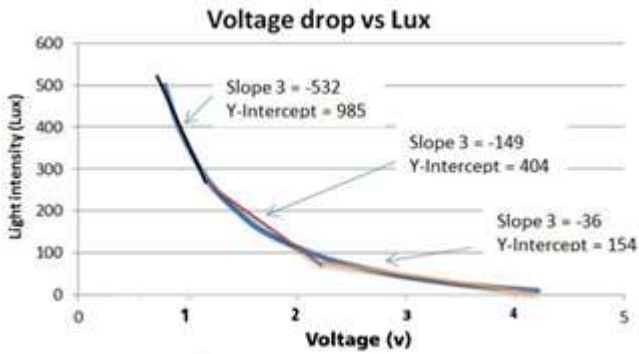


Figure 7: This graph represents the voltage and the LUX plot for LDR sensor

d) Ultrasonic Sensor Conversion

For ultrasonic sensor the formula varies from other as is uses PWM pin for the reading.

$Value = (analog\ value/2)$ //to get one length of pulse
 $Distance = Value/56.8$

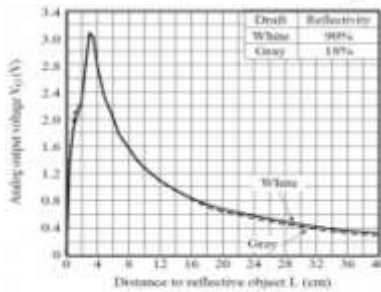


Figure 8: This graph represents the voltage and the distance plot for ultrasonic sensor

4. Units

The SI units calculated by the formula for the different sensors which are used in the LShR project are:
 ppm - Parts per mole (gas and smoke sensors)
 LUX - Lumens per meter square (ldr sensor)
 °C -Degree Celsius (temperature sensor)
 m - Meter (ultrasonic sensor)

5. Connections

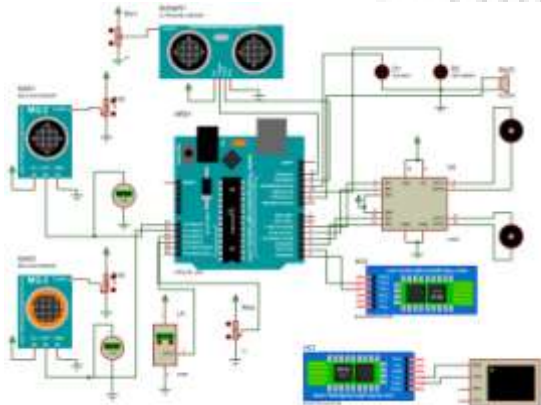


Figure 9: This circuit is given with Arduino Uno and paired with Bluetooth

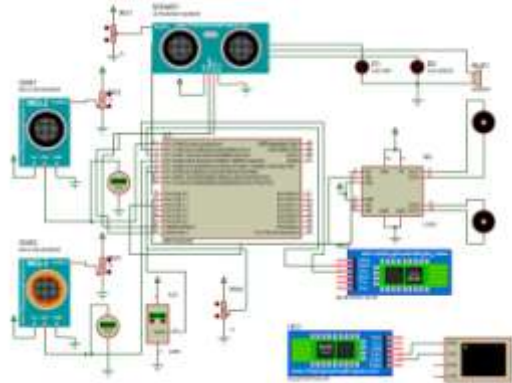


Figure 10: This connection is given with MSP430 and paired with Bluetooth

The Connections shown above are with both the Arduino and MSP430. They are paired with the serial monitor with the help of Bluetooth module.

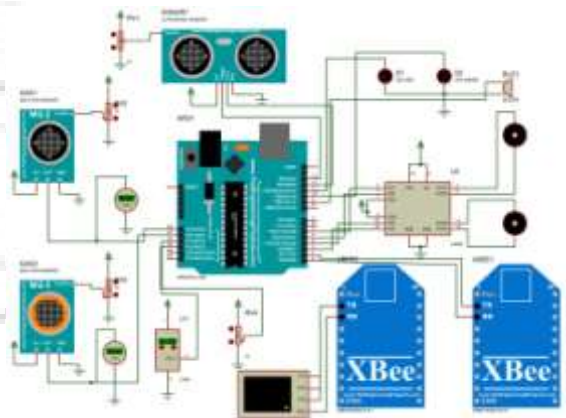


Figure 11: This connection is given with Arduino Uno and paired with Xbee

The connection shown above is with the Arduino Uno board and paired with the serial monitor with the help of the Xbee module.

6. Software and IDE used

The connections shown above with both the Arduino and MSP430 are the simulated versions of them. They are simulated using the software : **Proteus 7 Proteus 8**

The programs are programmed in Integrated Development Environment (IDE): **Arduino IDE Energia IDE**

Where Arduino IDE is for Arduino boards and the Energia IDE is for MSP430 boards.

7. Programming

a) Manual coding for LShR

The following program is the concept for manual control of the robot using Arduino or the MSP430.

```
41 int getDist()
42 {
```

```

43     int dis;
44     unsigned long pulse=0;
45
46     digitalWrite(tri,LOW);
47     delayMicroseconds(10);
48     digitalWrite(tri,HIGH);
49     delayMicroseconds(10);
50     digitalWrite(tri,LOW);
51
52     pulse=pulseIn(echo,HIGH);
53     pulse=pulse/2;
54     dis=pulse/52.8;
55
56     return dis;
57 }
58
59 /*****Looping function*****/
60
61 void loop()
62 {
63     if(a=='F' || a=='f')
64     {
65         digitalWrite(in1,HIGH);
66         digitalWrite(in2,LOW);
67         digitalWrite(in3,HIGH);
68         digitalWrite(in4,LOW);
69     }
70
71     if(a=='R' || a=='r')
72     {
73         digitalWrite(in1,LOW);
74         digitalWrite(in2,HIGH);
75         digitalWrite(in3,LOW);
76         digitalWrite(in4,HIGH);
77     }
78
79     if(a=='S' || a=='s')
80     {
81         digitalWrite(in1,LOW);
82         digitalWrite(in2,LOW);
83         digitalWrite(in3,LOW);
84         digitalWrite(in4,LOW);
85     }
86
87     if(a=='D' || a=='d')
88     {
89         e=getDist();
90         Serial.print(e);
91     }
92
93     if(a=='G' || a=='g')
94     {
95         Serial.print(b);
96         if(b!=0)
97         {
98             digitalWrite(LED_1,HIGH);
99         }
100    }
101
102    if(a=='K' || a=='k')
103    {
104        Serial.print(d);
105        if(d!=0)
106        {
107            digitalWrite(LED_2,HIGH);
108        }
109    }
110
111    if(a=='L' || a=='l')
112    {
113        Serial.print(w);
114    }
115
116    if(a=='T' || a=='t')
117    {
118        Serial.print(c);
119        if(b!=0)
120        {
121            digitalWrite(BUZZ,HIGH);
122        }
123    }
124 }
125
126 /*****End of the Program*****/

```

D. Automated coding for LShR

The following program is the concept for automatic control of the robot using Arduino or the MSP430.

```

39 /*****Function Definitions*****/
40 intgetDist()
41 {
42     int dis;
43     unsigned long pulse=0;
44     digitalWrite(tri,HIGH);
45     delayMicroseconds(10);
46     digitalWrite(tri,LOW);
47
48     pulse=pulseIn(echo,HIGH);
49     pulse=pulse/2;
50     dis=pulse/58.2;
51
52     return dis;
53 }
54
55 /*****Looping function*****/
56 void loop()
57 {
58     if(e>200)
59     {
60         Serial.println("No obstacles
61         found");
62     }
63
64     if(b!=0)
65     {
66         Serial.println("Alert on MQ2");
67         digitalWrite(LED_1,HIGH);
68     }
69
70     if(d!=0)
71     {
72         Serial.println("Alert on MQ3");
73         digitalWrite(LED_2,HIGH);
74     }
75 }

```

```

96
97     if(w==0)
98     {
99         Serial.println("Light is too
much");
100    }
101
102    if(c>=165)
103    {
104        Serial.println("Alert on Temperature");
105        digitalWrite(BUZZ,HIGH);
106    }
107
108    if(e<=200)
109    {
110        Serial.println("ObstraclesDected");
111        digitalWrite(in1,LOW);
112        digitalWrite(in2,HIGH);
113        digitalWrite(in3,LOW);
114        digitalWrite(in4,HIGH);
115    }
116
117    if(e<=100)
118    {
119        Serial.println("Movement Stoped");
120        digitalWrite(in1,LOW);
121        digitalWrite(in4,LOW);
124    }
125
126    delay(200);
127    digitalWrite(in1,HIGH);
131    digitalWrite(LED_1,LOW);
132    digitalWrite(LED_2,LOW);
133    digitalWrite(BUZZ,LOW);
134 }
135
136 /*****End of the Program*****/
    
```

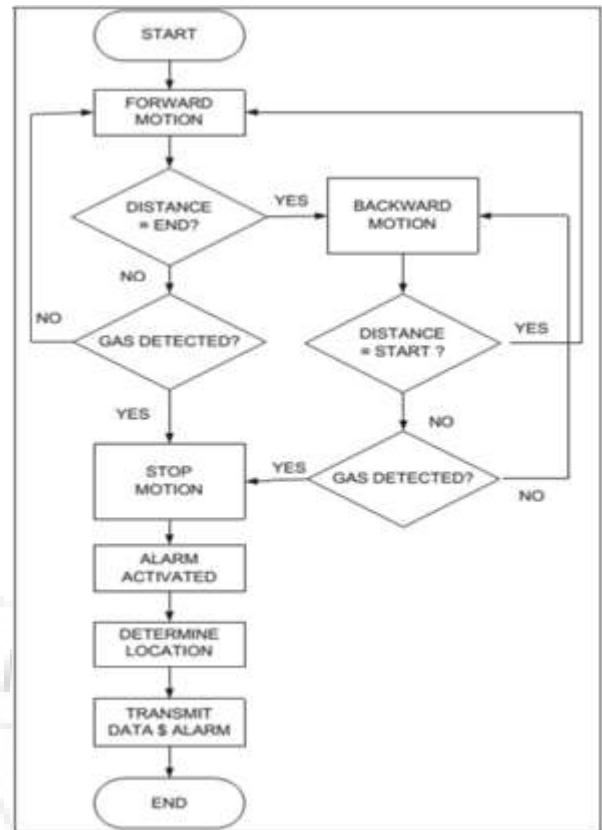


Figure 11: This flow chart describes on the working of Gas sensor with the program which is given above.

8. Practical Design of the LShR

This robot consist of a microcontroller or a microprocessor with an important sensor as per the environment where it is used, it also has the communication and navigation devices and a battery with the correct load measurement of the complete circuit. The microcontroller or microprocessor is an embedded board which can be powered up with 5v, the sensors and communication devices connected can be also powered up with the 5v or 3.3v, the only high power conception device is the motor driver it's need is 12v or more according to the load (weight) which is hanged on it.

9. Flow Chart

10. Conclusion

The complete Software and Hardware are explained in the above headings. Even though both the Arduino and MSP430 can be used to design this LShR, MSP430 is a better option than selecting Arduino as MSP430 have a ultra low power conception, and high data transfer speed than the Arduino board. This LShR project can save many people life's who are working in mines and tunnels by alarming if any cautions must be taken for any leakages and any sudden change in environment. The practical application of this project costs very less and the designing the model of the robot is also easy. Both the simulation and the hardware is constructed, checked and output is verified with the working.

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