

DESIGN AND IMPLEMENTATION OF REMOTE OPERATED SPY ROBOT CONTROL SYSTEM

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Abstract- Spy robots are remotely controlled robots, equipped with a camera, transmitting video data to the intervention troop. They are made to small and compact enough to easily transport. In this paper, the project supposes a movable spy robot with a remote controller by using PIC 16F628A and PIC 16F877. The spy robot is made up of a wireless camera, an antenna, batteries and four movable wheels. The two different PICs are used to remotely control along wireless system and to control Spy robot. CCD camera is used to capture information surrounding the robot. A 4 bits LCD display is mounted on remote controller to view user command. To use the Spy robot in the dark area as night, the CCD is set up with LED that connected by lighting circuit. Radio Frequency modules signals are used in wireless remote control system for transmitting and receiving wireless logic signals to control the motors of the Spy robot control system. The three Brush DC motors and the two L298N are involved in Remote Operated Spy Robot. L298N are used to drive the Brush DC motors respectively. In this paper, Remote Operated Spy Robot is a small robot designed for spying, surveillances and inspection purposes.

Index Terms-Microcontroller, CCD camera, L298N, spy robot

I. INTRODUCTION

In practice, it is usually an electro-mechanical machine which is guided by computer or laptop, mobile or electronic programming, and is thus able to do tasks on its own. Wireless controlled robots use RF circuits which have drawbacks of limited working range, frequency range and limited control. Spy robot can capture audio and video information from the surroundings and can be sending to a remote station through RF signal [1]. The control of robot involves three distinct phases: perception, processing and action. Generally, the preceptors are sensors mounted on the robot, processing is done by the on-board microcontroller or processor, and the task is

performed using motors or with some other actuators [2]. When the user controls by remote controller, the spy robot will move to desired destination and spy images around the robot in this project. This robot is not quite huge one and designed to be easy transportation. The block diagram of remote operated spy robot is shown in figure 1;

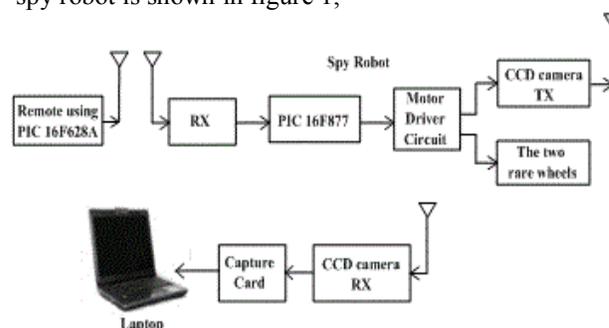


Figure 1: Overview Block Diagram of the System

II. SYSTEM COMPONENTS

A. Microcontroller

A remote operated Spy robot is based on the two microcontrollers such as PIC16F628A and PIC16F877. In these two types of microcontrollers, a total of 35 instructions (reduced instruction set) are available, complemented by a large register set. These devices have integrated features to reduce external components, thus reducing system cost, enhancing system reliability and reducing power consumption.

In figure 2(a), PORTA pins 1,2,3,18,17 and 13 are connected with LCD display which is mounted in the remote controller. The controls bits of these pins are RA0, RA1, RA2, RA3, RA4 and RA7 of PORTA. PORTB 0 to 6 except PORTB2 and the controls bits PORTB6,7,9,10,11 and 12 are used for the user inputs which are forward, backward, left, right, CCD left and CCD right. PORTB7 bit no: 13 is used for data output pin. The power supply of this controller is +5V DC and connected the pin no: 14. The Ground is pin no: 5.

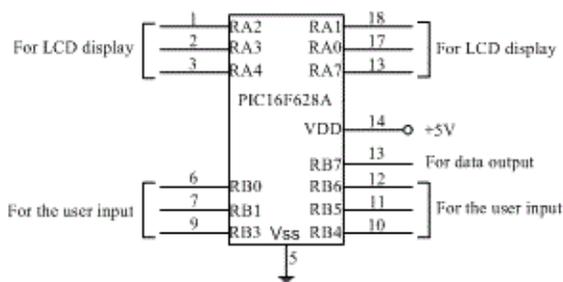


Figure 2(a): PIC16F628A microcontroller pins assign

In figure 2(b), the motor is driven by motor driver circuit which controls by PORTB0 to 5 (pin no: 33 to 38). The power supply of this controller is also +5V DC and connected the pin no: 11 and 30. The Ground is pin no: 12 and 31.

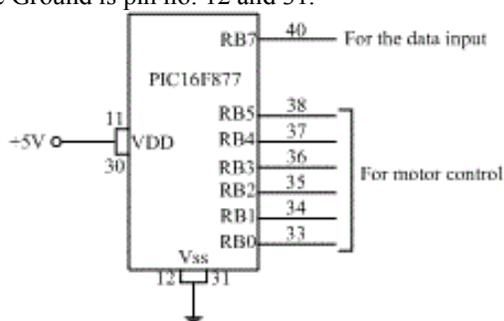


Figure 2(b): PIC16F877 microcontroller pins assign

B. L298N Motor Driver

L298N is a dual H-Bridge motor driver, so it can drive the motors which can be controlled in both clockwise and counter clockwise direction. L298N is an integrated monolithic circuit in a 15-lead Multiwatt. It has operating supply voltage up to 46V, total DC current up to 4V and also had an over temperature protection. L298N motor driver has four inputs and outputs pin so that it can drive two DC motors and one stepper motor.

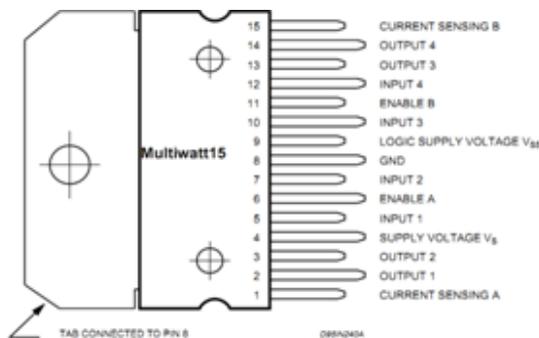


Figure 3(b): L298 Motor Driver pin assign

In the project, L298N motor driver is connected with PIC16877 microcontroller for CCD camera rotation of left and right function. As shown in fig

3(b), PORTB5 and PORTB4 (pin no: 38 and 37) are connected the motor driver’s pin no: 5 and 7 (input 1 and input 2) for data input. And then, motor driver’s pin no: 2 and 3 are used for data output which is connected the Brush DC motor.

The next L298N motor driver is connected with PIC16F877 for Spy robot movement direction. PORTB3 and PORTB2 (pin no: 36 and 35) are connected the motor driver’s pin no: 5 and 7 (input 1 and input 2) for data input and pin no: 2 and 3 as data output for rare wheel left motor activate. PORTB1 and PORTB0 (pin no: 34 and 33) are connected the motor driver’s pin no: 10 and 12 (input 3 and input 4) are used for data input and pin no: 13 and 14 as data output for rare wheel right motor activate. +12V power is supplied L298N motor driver because 12V Brush DC motors are used in this project.

Most permanent magnet DC powered electric motors use Brushes to transmit power from the source (battery) to commutate. The brushed DC motors are used in this project because the brushes will wear down and needs replaced, similar to how brake pads wear on disc brakes. Therefore, three brushed DC motor are using for rotating camera and rare wheels respectively mounted in this system.

C. CCD Sensor

Charge-coupled devices (CCDs) find wide applications in almost all digital image-acquisition devices. The wireless CCD camera (in figure 4) has audio and video system.



Figure 4: Wireless CCD Camera

The range of transmitted is 100ft visible around the Spy robot and resolution is 1024×800. Power is supplied to CCD camera by +12V from lead acid battery. This camera can move left and right direction to see survey around the robot. There is no USB port in this camera so that saving and records process of the project need capture card as shown in figure 5.



Figure 5: Wireless CCD Camera

III. HARDWARE CONFIGURATION

A. Remote Controller Configuration

The remote controller consist six press button which is forward, backward, left, right, CCD left and CCD right as shown in figure 6(a). Moreover, it consists of (16×2) LCD which is used for user’s command directions.

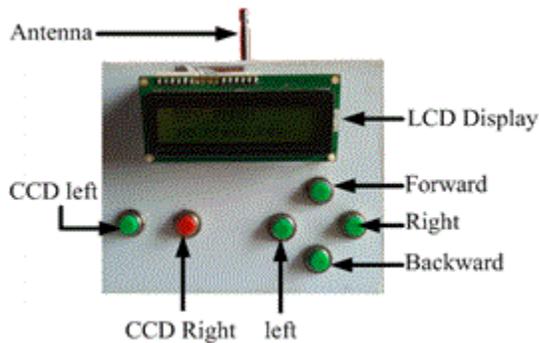


Figure 6(a): Remote controller

In figure 6(b), Drawbars antenna is used because the frequency is determined by the length of antenna. A 9V battery is used to supply the power to the whole controller circuit.

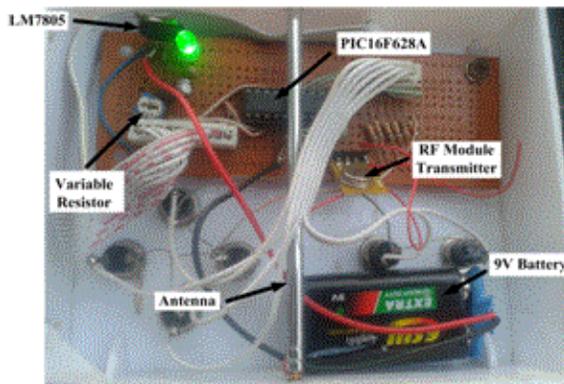


Figure 6(b): Remote controller circuit

The project uses mainly two different PIC 16F628A and PIC 16F877 microcontrollers respectively to develop the remote operated spy robot. In remote controller circuit, PIC 16F628A is used. PIC 16F628A is an 18 pins and 8 bits microcontroller. RF module is mainly used to command the robot by wireless communication.

RF module operates at Radio Frequency and transmits data or command with 434 MHz. RF modules comprises of an RF Transmitter and RF Receiver. The transmitter RF module on the remote

controller takes serial input and transmits these signals through RF through its antenna connected at pin 4. The transmission occurs at the rate of 1 Kbps-10 Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

The voltage Regulator LM7805 is used to supply power the microcontroller. For versatile PIC 16F628A microcontroller, LM7805 regulator is suitable to control the incoming voltage stable. LM7805 regulator is used not only to be stable the voltage but also the voltage to be 5.

LM7805 regulator is connected with a battery. The regulator supplies power to the RF transmitter module and the PIC 16F628A respectively. The microcontroller records the user command and then sends it to the RF transmitter module. The RF module sends the data to the spy robot as radio frequencies via its antenna. The whole remote controller circuit is composed as in figure 7.

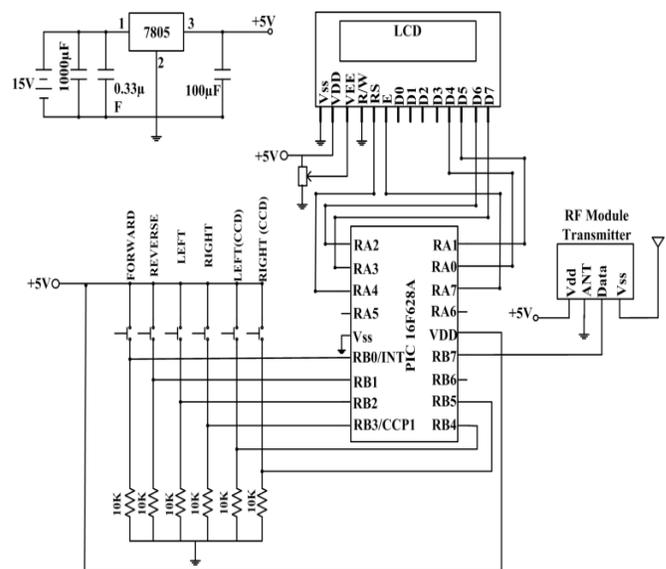


Figure 7: Circuit Diagram for the remote controller

B. The Spy Robot Configuration

In Spy Robot (vehicle), it consists of a microcontroller, a CCD sensor (camera), four movable wheels, three DC motors, three motor drivers, two voltage regulators, a RF receiver module. The PIC 16F877 microcontroller which has 40 pins is used in construction of spy robot. The voltage regulator LM7805 is used again to have stable power 5V for the microcontroller.

PIC 16F877 is performed not only receiving the user command via RF receiver module but also instruct the motor driver to move as directly as by use command. There are two motors for rare wheel and one motor for camera motion. These three motors need 12V power supply. To activate the motors, L298N motor drivers are used in this project.

There are required two motor drivers: ones for motor of CCD sensor camera and next for motors of rare wheels. In this system, Brush DC motors are used for all required motorized equipments. Each Brush DC motor is applied on each rare wheel. Rare wheels can perform forward and backward functions because of Brush DC motor's reversible abilities. Brush DC motors join with worm gear as a set in this project for moving control as shown in figure 8. The two set are mounted on rare wheels respectively and also one for camera motion. Worm gear is used to reduce a large speed ratio of the motors.

In left and right operation of spy robot, the system proposes the PIC's controls. To rotate the left direction, while the left motor will move reverse, the right motor will move forward. To rotate the right direction, while the right motor will turn reverse, the left motor will turn forward.

This project builds a rotatable CCD sensor camera on top of the Spy Robot. For rotation of camera, the system uses a motor especially for camera. If the motor spins forwardly is left camera rotation, the motor spins reversely is right camera rotation, vice versa.



Figure8: Brush DC motor connect with worm gear

To control the angle of camera rotation, two limited switches are mounted on the both left and right side of the camera respectively. When the CCD camera touches the limited switch, it's stopped. The camera is not worked for reverse function after it reached the limited switch. So diodes are mounted on each limited switches respectively. These diodes will help the limited switch in the function of rotating the camera reversely. These diodes permit the motor for reverse direction.

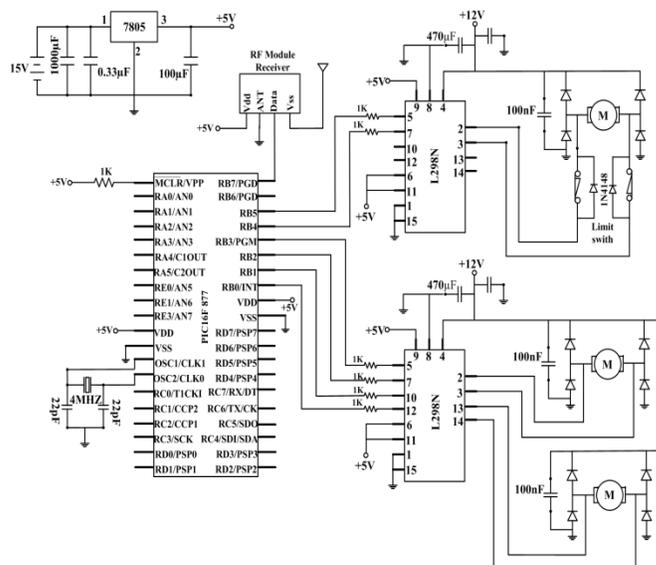


Figure 9: Circuit Diagram for the spy robot vehicle

IV. SIMULATION AND TEST RESULT

For the system, the simulation result is done by using Proteus professional schematic software. After the two programs are compiled as hex files, the compiled code sent to a PICs microcontroller to load the microcontrollers with no errors. The programs have successful complication and then the circuit is tested using the proteus software as shown in figure 10. This control system is completely tested and can be used remotely to enter and exit dangerous places. In this system, remote is used as the main controller. PIC16F628A sends the signals to the PIC16F877 to operate the Brush DC motor from the L298N motor driver.

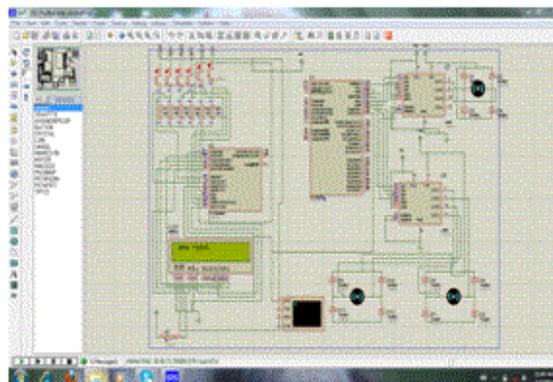


Figure10: Simulate Result of Spy Robot

For "Straight Forward", the two rare wheel motors are rotated clockwise in direction. When the two rare wheel motors are rotated counter clockwise,

the spy robot will move “Straight Backward” direction. The spy robot turns to the left when rare wheel’s left motor rotates counter clockwise and rare wheel’s right motor rotates clockwise direction. To work the camera turn to right, rare wheel’s left motor is rotated clockwise and rare wheel’s right motor is rotated counter clockwise direction. When CCD camera turns to Left, CCD camera’s motor is rotated clockwise direction. If CCD camera’s motor is rotated counter clockwise direction, the camera will move to the right.

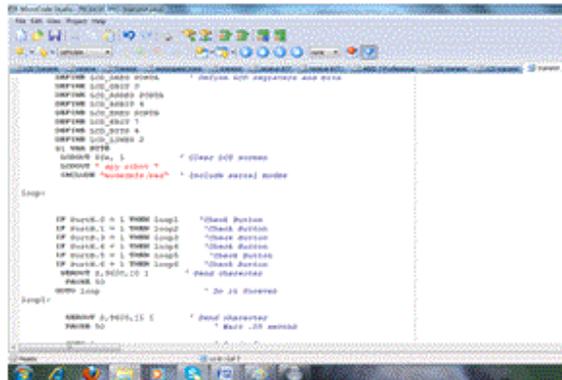


Figure 11(a): Programming for Remote Controller

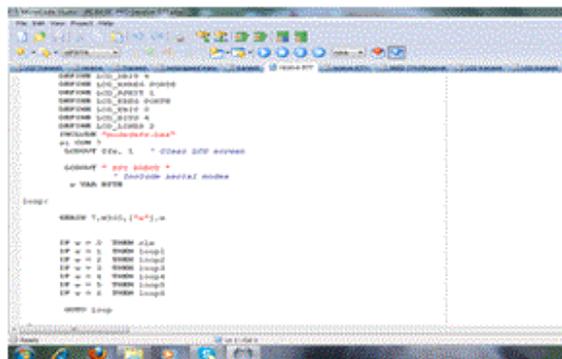


Figure 11(b): Programming for Spy Robot Vehicle

Basic Pro programming language is used for the development of PIC microcontroller. They include file “**modedefs.bas**” has to be declared because it assigns the variables such as ‘**B1**’ for transmit in figure 11(a) and ‘**w**’ for receive in figure 11 (b) that are used in the program. PICs pin of PORTA and PORTB are used as input and output pins. PIC16F628A’s PORTA pins which are analog inputs are connected with LCD display which is mounted in the remote controller. PIC16F877’s PORTB pins are used to drive the L298N motor driver.

The RB7 is used for serial data input/output pins with the baud rate 9600 and password “a”. Loop command is used to perform all of the function in this program transmission and receiving.

Program flowchart for Spy robot is shown in figure 12 (a) and figure 12 (b).

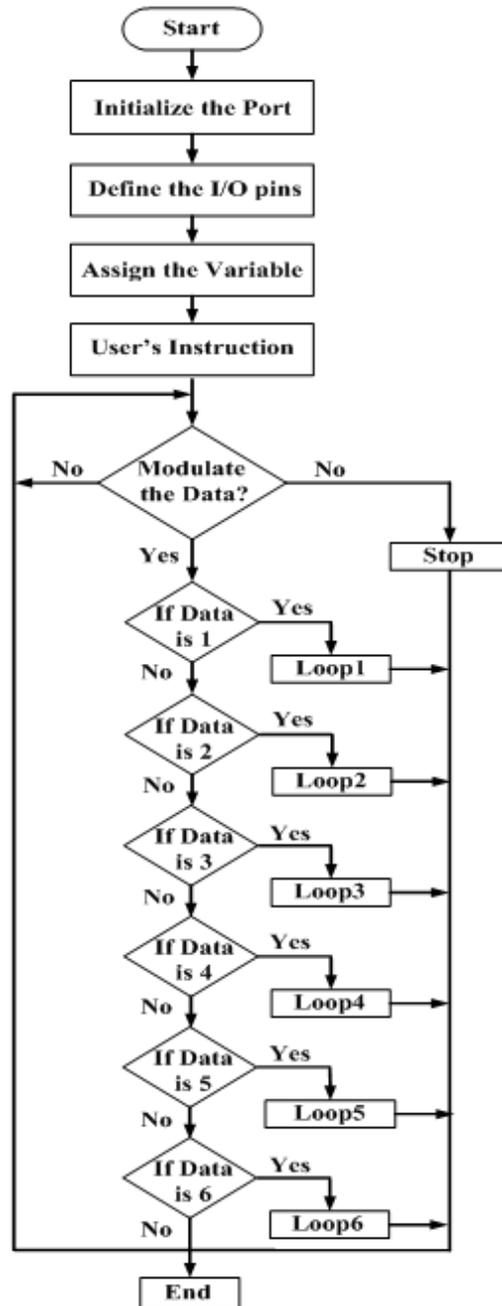


Figure 12(a): Program for Transmission

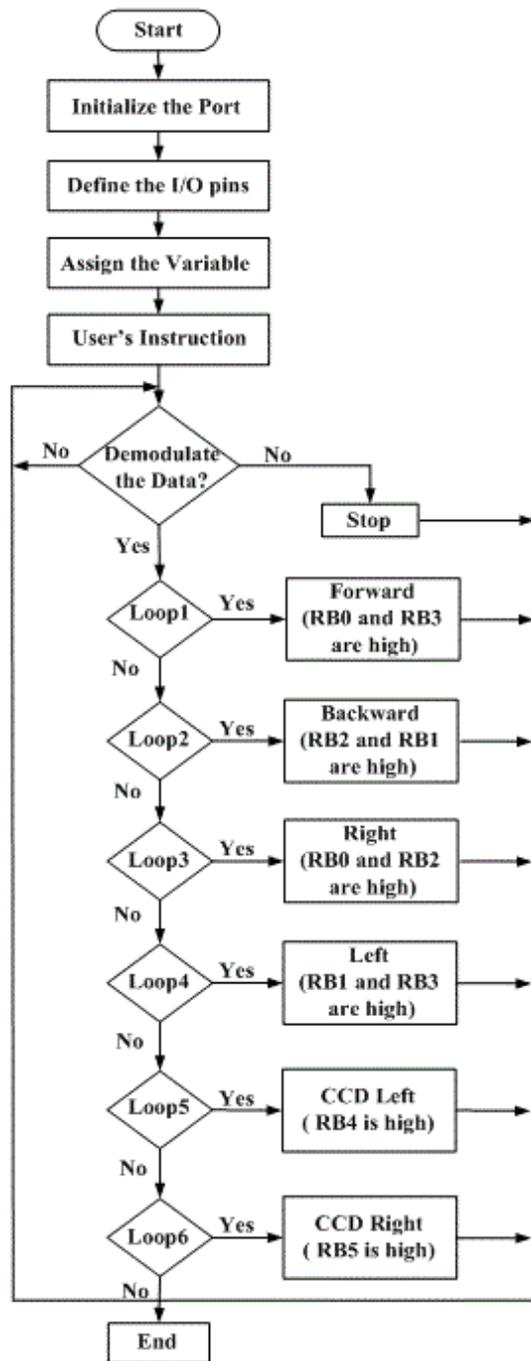


Figure 12(b): Program for Receiving

The robot equipped with a wireless camera, which is not very useful in situations where the visibility or light level is very low. For night or dark area, Spy robot will be almost impossible for identifying objects because the lights, which are provided on the robot, are fixed therefore it may not be possible to view those objects which are in the dark. At night or dark area where light is low a lighting circuit can be mounted on the robot instead

of a night vision camera, which will increase the visibility in case of no light at all. Lighting circuit is shown in figure 13(a) used in this project to use the Spy robot in the dark area as night. For night vision in figure 13(b), three LED is set up on the top of the CCD camera that connected by lighting circuit. Lighting circuit need +12V power supply.

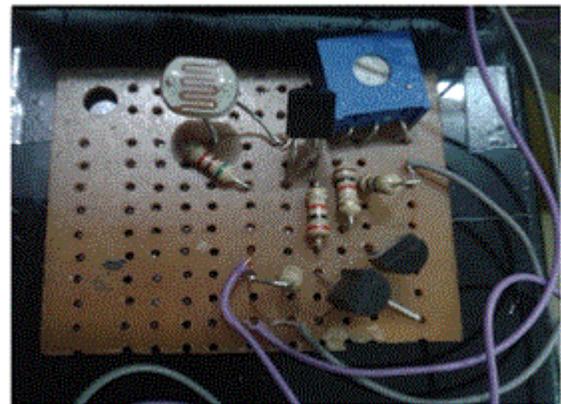


Figure 13(a): Night Vision Circuit

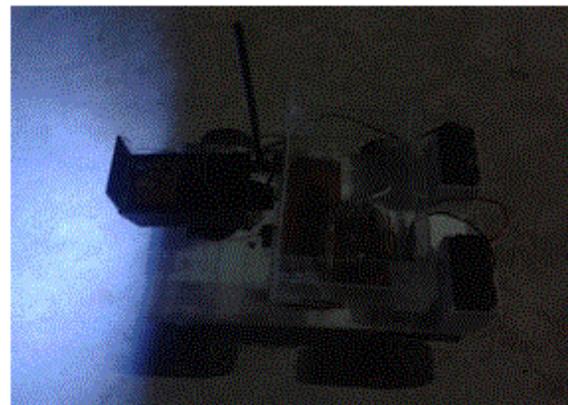


Figure 13(b): Night Vision at dark area

The system is designed to develop a spy robot with wireless CCD sensor by using two different PICs. The spy robot contains especially two main sections. The first section of spy robot is transmission and receiving between spy robot and remote controller for the robot movement. There are also two main parts; between the CCD sensor's transmitter and receiver. And another is that the robot sends back the images and capturing it. In these processes, Radio Frequency (RF) module is used for wireless communication between the remote controller and spy robot. The remote controller will send user commands to the robot. The camera set on the robot captures the surrounding conditions while the robot moves along user desired direction. And then the robot sends back the images captured by the camera as video and audio format. The remote controller

consists of by six buttons and a 4 bits LCD (16×2). This LCD is used to show the user’s command in words and the user can know clearly that the user has given what command to the robot. Six buttons is built for six functions such as forward, backward, left, and right operations for the robot movements and another left, right operation for the camera rotation.

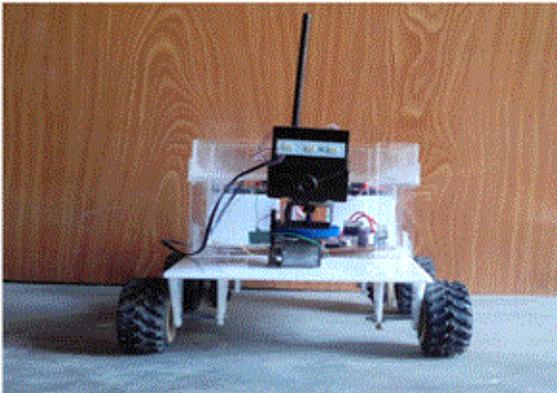


Figure 14(a): Front View of Spy Robot

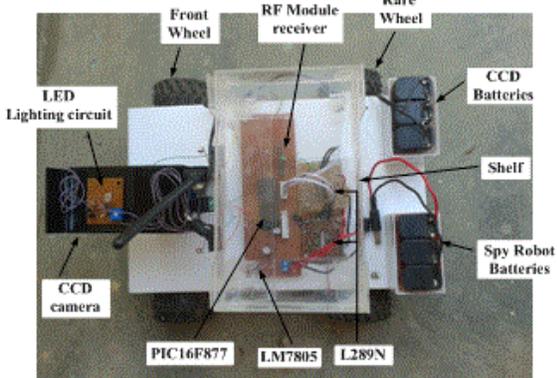


Figure 14(b): Top View of Spy robot

The spy robot is made up of four wheels vehicle and a camera. Each rear wheels of the vehicle has been set by each motor for vehicle’s motion. The front wheels of the vehicle are permanently fixed on an axis is shown in figure 14(a). The vehicle can move forward and backward directions and also move left and right directions easily. LED lighting circuit is mounted on each below side of the camera for the purpose of night vision or to view in dark areas. The camera is placed on the head of the vehicle and it is made to perform left and right rotation. Performing to be able rotating the camera is intended to view more widely. While the spy robot makes motivation, the camera records the video and audio and then sends back to the user directly and simultaneously. The project uses the capture card to record and store the video and audio that sent from

the camera transmitter. Then the capture card is connected to the Laptop. In figure 15, the user can see the vision about the surrounding conditions of the spy robot and can save as video file for later review. Lead acid battery can be rechargeable but it can last an hour longer and detect within the transmit range 100ft area. The user can also click the record button to make the recording while the robot is moving and resting.



Figure 15: Capturing Images with Laptop

V. CONCLUSION

This type of robot can perform difficult and repetitive works for humans. It can have a very risky job and such dangerous job could be done by using small spy robot. But it is useful to check and look out the places where dangerous poison gases have. Spy robot can also be used in searching people who are in building destroyed by the earthquake. Because of the wireless camera is installed in spy robots, it can be used remotely to enter and exit dangerous place that human cannot. When the user controls by remote controller, the spy robot will move to desired destination and spy images around the robot. The user can check and recommend from computer with the wireless remote controller. Lightening LED is mounted on Spy robot and has a stand which is a place for rescuing device. The robot is not quite huge one and designed to be easy in transportation. For the whole system, the required power is supplied by Lead acid batteries which connected the voltage regulator.

VI. FURTHER EXTENSION

This operation system is the spy robot with wireless remote control. The CCD camera can modify range more than 100ft .The wireless camera can be able to upgrade with the 360 degree left and right directions by using PIC program so that the functionality is having a movement at many sides. Moreover, this camera can upgrade to move up and

down directions. Instead of DC motors which driver the CCD camera, stepper motors can also be used. The spy robot can be commanded directly by laptop keyboard without using remote controller. For the advance of spy robot, it can be built a robot with wireless visual system that the user can observe and control the situation via computer or mobile.

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