International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 5 Issue: 11 199 – 205

Design and Fabrication of Remote Operated Robot with Bomb Detection using MEMS Technology

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***Abstract*—**The applications & advantages of remote controlled robots are plenty, especially in specific areas where people cannot go there to perform specific task, there these robots are playing major role. The system designed here can be used for picking any small object from the hazardous place. The same robot with little modifications can be used for many applications, as it is it can be used as spy Robot. The main advantage is that the Robot can be controlled from the safe zone through the remote monitoring designed using wireless video camera and MEMS. MEMS (Micro Electro Mechanical Sensor) is the device often used as position displacement sensor, the applications of MEMS are plenty and to prove the application practically this system is designed to control the robot as well as the robotic arm by changing the position of MEMS devices. The robotic arm designed here is having two degrees of freedom. The system designed with microcontroller unit functions according to the command signals generated and transmitted from the remote control unit by moving the MEMS. Based on this information the vehicle will be moved in all directions and the robotic arm is also controlled. This robot is equipped with a gripper mechanism at its front side for picking and placing of an object. In addition, the vehicle is also equipped with a metal detector for detecting the explosives (bombs). Whenever the bomb is detected, automatically the vehicle will be stopped and buzzer will be activated as an acknowledgement. This entire mechanism can be viewed in the television set at the control unit as the vehicle will be transmitting the live video signals through the wireless video camera.

Keywords*-*remote controlled robots; MEMS; degrees of freedom.

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I. INTRODUCTION

This project is aimed to detect the presence of any metallic mine in the field, it can detect the explosives or bombs also, which are positioned under the ground. Detecting these kind of explosives manually with ordinary handheld portable metal detectors is quite dangerous, because terrorists are designing these bombs with advanced technologies, these bombs can be exploded in many ways like through mobile phones, using timers, using pressure sensors, using remote control, etc. and the technology facilitates that the terrorist can blast these bombs from anywhere from the world. Sometimes, while searching for the explosives, all of sudden it may blast that leads to major damages. To save the lives of our hero's (those who are searching for the explosives, generally called as bomb squad or search party) we need a special kind of metal detectors, by which squad can stay away from the explosives. In this regard this project work is taken up, which functions the performance of mobile Robot to detect metal mine or to detect any explosives that contains metallic objects like nails, balls, sharp metal pieces, etc. and also the fire in a particular location. The system can be designed in two ways; a) one huge vehicle with high speed can be constructed for outdoor applications like search in jungles or deserts, b) one small vehicle (miniature) can be constructed for indoor applications. Here for the demonstration purpose a prototype module is constructed for detecting the metal mines and with slight modifications the same vehicle can be used for both the applications. This vehicle is designed to detect the metal, and as the vehicle is built with a gripper mechanism, it can dig and pick the metal mine if necessary by the user through video analyzing in the monitoring station. Various methods can be implemented to defuse the bomb, in general most of the bombs are exploded by igniting them from remote place, in such cases, whenever the system detects the bomb, weather it is under the ground or over the ground, it should able to pour water over the bomb through a automatic system, by which bomb can be defused. he metal mine detecting pick and place vehicle is designed with four DC motors in which two DC motors are used to move the vehicle in all directions and two more DC motors are used as arm mechanism with two degrees of freedom for picking and placing. The DC motors with inbuilt reduction gear mechanism are driven by the microcontroller according to the defined instructions given through the remote that is designed using MEMS technology. A Microcontroller based on ATMEL 89C51 which is an 8- bit Microcontroller with 32 I/O lines configured as four ports, 4Kbytes of flash programmable memory, 128 bytes of data memory five interrupts and optimized 111 instruction set is used in the project work which can receive the information of movement of vehicle, drive the vehicle left, right directions or change the direction for reverse movement, control the gripper and lifting it up or down, etc.

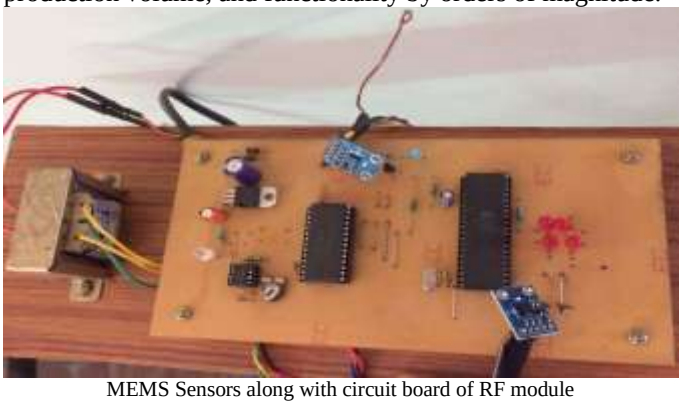
The main goal of this project is to present a working solution for search navigation, to be implemented in a vehicle for operation in forest, mountain terrains, etc that detects metal mines. Further this module is also equipped with a wireless video camera that captures the picture signals and transmits to monitoring station depending on which the user can control the vehicle effectively through video analyzing system. To detect the metal mines a pick up coil energized through an oscillator is used as a metallic detector and whenever any metallic object is detected, the reluctance of the magnetic pick up coil changes and in turn produces a high output to the Micro controller and this gives an indication of the mine detection. Whenever any metal object is detected, automatically the vehicle is stopped and an alarm is activated for indication. The complete vehicle, which is designed to perform multi functions, acquires energy from the battery; the entire circuitry including DC motors is designed to operate at 12V DC. For this purpose 1.3AH maintenance free battery is used. Since reduction gear mechanism motors are used, speed is decreased and torque is increased, such that the vehicle can carry heavy loads. To charge the battery from 230 V AC Mains, a separate battery charger is designed with a 12V step down transformer. The pick and place robot is a microcontroller based mechatronic system that detects the object, picks that object from source location and places at desired location. For detection of object, infrared sensors are used which detect presence of object as the transmitter to receiver path for infrared sensor is interrupted by placed object. As soon as robot senses presence of object, it moves towards object, picks it with end effectors, and moves along way gantry and finally place it on destination. If another object causes interrupt, it again does the same job. Whole process is controlled by micro controller. But here in our project work for detecting the object infrared sensors are not used, and in fact the objects are picked and placed through video analysing system as the robot is equipped with an in-built wireless video camera and the robot is controlled through a MEMS remote sitting at a place and analysing through the pictures seen in the television set.

II. HARDWARE ESSENTIALS AND BLOCK DIAGRAM

As mentioned in the introduction the pick and place robots are either operated physically (manually) or through wireless networks i.e., remote. The module constructed here is the remote operated one. Through this remote the robot is controlled and the view of that area is seen in the television set at the monitoring station as the robot is equipped with a wireless camera. The remote is designed with two MEMS modules, ADC, micro-controller and the RF transmitter. Out of these two MEMS modules, one is used to control the robot vehicle's direction i.e., to operate the robot in forward, backward, right and left directions. And the other MEMS is used to control the robotic arm direction upwards and downwards as well as the gripper to hold and leave the object. The wireless video camera is placed over the vehicle to have the front view of the vehicle always and it is still. But by the movement of the vehicle, the camera also moves along with it to have a clear view in front of the vehicle.

A. MEMS (Micro Electro Mechanical Systems)Technology

Micro - Small size, micro fabricated structures **Electro -** Electrical signal / control (In / Out) **Mechanical -** Mechanical functionality (In / Out) **System** Structures, Devices, Systems, Control MICRO ELECTRO MECHANICAL SYSTEMS or MEMS represent and extraordinary technology that promises to transform whole industries and drive the next technological revolution. The devices can replace bulky actuators and sensors with micron-scale equivalents that can be produced in large quantities by fabrication processes used in integrated circuit photolithography. This reduces cost, bulk, and weight and power consumption while increasing performance, production volume, and functionality by orders of magnitude.



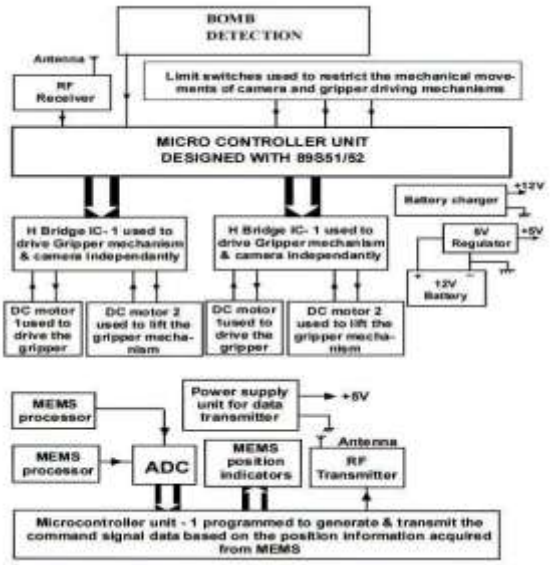
MEMS Sensors along with circuit board of RF module

Micro electro mechanical systems are devices that have static or moveable components with some dimensions on the scale of a micrometer to nanometer. For comparison, a human hair is about 80 micrometers in diameter. MEMS combine micro-electronics and micromechanics and sometimes micro optics and micro magnetic. **Sensors** and **actuators** are the two main categories of MEMS. Sensors are non-invasive while actuators modify the environment. **Micro sensors** are useful because their physical size allows them to be less invasive while **Micro actuators** are useful because the amount of work they perform on the environment is small and therefore can be very precise. MEMS is very small in size with dimensions of less than 1 mm (1000 microns) and with feature sizes on the order of microns (0.001 mm). The pin configuration of MEMS module is given below:

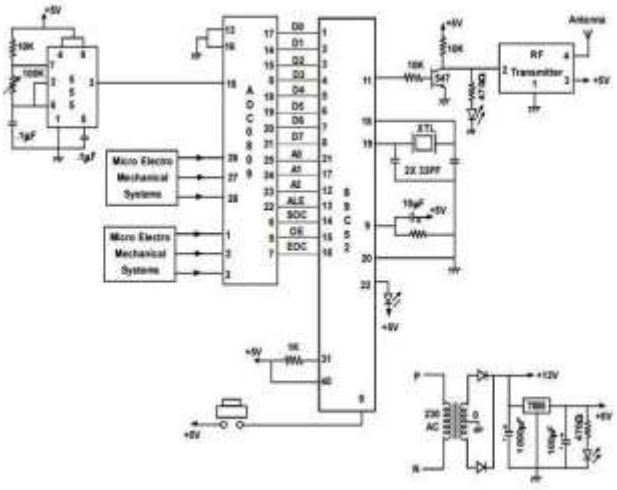
Pin No	Pin Name	I/O	Details
1.	VCC	Power IN	Positive Power supply,5V
2.	GND	Power GND	Negative(ground)connection of power supply
3.	Z	O/P	Z direction output voltage
4.	Y	O/P	Y direction output voltage
5.	X	O/P	X direction output voltage
6.	SLP	I/P	Logic input pin to enable product or sleep mode
7.	OGD	O/P	Linear freefall digital output signal
8.	GSEL	I/P	Logic input pin to select g level
9.	ST	I/P	Input pin to initiate Self Test

So from the pin configuration of the MEMS module, we can identify three output pins i.e., X, Y and Z direction output voltages. As the controller cannot read the analog voltages, these are given to ADC to convert the analog voltages to digital format and then fed to the controller.

B. Basic Block Diagram



C. Circuit Diagram



III. SOFTWARE TOOLS

The software version used in this project is **Keil micro vision** for the **simulation** of the program.Keil is the software used where the machine language code is written and compiled. After compilation, the machine code is converted to hex code which is to be dumped into the microcontroller for further processing.

The hex file created as shown earlier will be dumped into the microcontroller with the help of another software called proload.

Proload is a software which accepts only hex files. Once the machine code is converted into hex code, that hex code has to be dumped into the microcontroller placed in the programmer kit and this is done by the proload. Programmer it contains a microcontroller on it other than the one which is to be programmed. This microcontroller has a program written in such a way that it accepts the hex file from the keil compiler and dumps this hex file into the microcontroller which is to be programmed. As this programmer kit requires power supply to be operated, this power supply is given from the power supply circuit designed above. It should be noted that this programmer kit contains a power supply section in the board itself but in order to switch on that power supply, a source is required. Thus this is accomplished from the power supply board with an output of 12volts or from an adapter connected to 230 V AC.

A. Working of the Bomb detection Robot

- After the compilation, the machine source code is converted into hex code using keil software which is to be dumped into the microcontroller for further processing.
- Once the machine code is converted into hex code that hex code has to be dumped into the microcontroller placed in the programmer kit and thus is done by the proload.
- This microcontroller has a program in it written in such a way that it accepts the hex file from the keil compiler and dumps this hex file into the microcontroller which is to be programmed.
- As this programmer kit requires power supply to be operated, this power supply is given from the power supply circuit designed above.
- It should be noted that the circuit contains a power supply section in the board itself but in order to switch on that power supply, a source is required. Thus this is accomplished from the power supply board with an output of 12volts or from an adapter connected to 230volts.
- The robot moving on the surface ic controlled using MEMS sensor. It can be moved forward and backward with the help of 30RPM DC motors.
- The robot can also take sharp turnings towards left and right directions. MEMS sensors which are in our hands are used to control the actions of the robot.
- The arm movement of the robot and gripper mechanism for pick and place are also controlled by the second MEMS sensor. Each and every action of the robot and its arm are controlled by the movement of the sensor.
- To move the robot in forward, backward , left and right direction the MEMS sensor is turned by 90 degrees in that particular direction. Similarly to for the arm and gripper movement the other MEMS sensor is to be moved by 90 degrees direction.
- The whole action of the robot can be viewed in laptop through wireless video camera connected to it through a tuner card

B. Program code

PROGRAM CODE FOR TRANSMITTER UNIT

```
org         0000h
rt:
MOV         SCON,#40H
MOV         TMOD,#20H
MOV         TH1,#0FAH
SETB        TR1
CLR         TI
main:
```

 ISSN: 2321-8169
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```
JB              P1.7,NXT;ROT
MOV             A,#05H
MOV             SBUF,A
JNB             TI,$
CLR             TI
MOV             A,#55H
MOV             SBUF,A
JNB             TI,$
CLR             TI
LJMP            MAIN
NXT:        JB  P1.6,NXT1;ROT
MOV             A,#10H
MOV             SBUF,A
JNB             TI,$
CLR             TI
MOV             A,#60H
MOV             SBUF,A
JNB             TI,$
CLR             TI
LJMP            MAIN
NXT1:       JB  P1.5,NXT2;HRZ
MOV             A,#15H
MOV             SBUF,A
JNB             TI,$
CLR             TI
MOV             A,#65H
MOV             SBUF,A
JNB             TI,$
CLR             TI
LJMP            MAIN
NXT2:       JB  P1.4,NXT3;HRZ
MOV             A,#20H
MOV             SBUF,A
JNB             TI,$
CLR             TI
MOV             A,#70H
MOV             SBUF,A
JNB             TI,$
CLR             TI
LJMP            MAIN
NXT3:       JB  P1.3, NXT4;UD
MOV             A,#25H
MOV         SBUF,A
JNB             TI,$
CLR             TI
MOV             A,#75H
MOV             SBUF,A
JNB             TI,$
CLR             TI
LJMP            MAIN
NXT4:       JB  P1.2, NXT5;UD
MOV             A,#30H
MOV             SBUF,A
JNB             TI,$
CLR             TI
MOV             A,#80H
MOV             SBUF,A
JNB             TI,$
CLR             TI
LJMP            MAIN
NXT5:       JB  P3.3,NXT6;FRW
MOV             A,#35H
MOV         SBUF,A
JNB             TI,$
CLR             TI
MOV             A,#85H
MOV             SBUF,A
JNB             TI,$
CLR             TI
LJMP            MAIN
NXT6:       JB  P3.4, NXT7;LFT
MOV             A,#40H
MOV             SBUF,A
JNB             TI,$
CLR             TI
MOV             A,#90H
MOV             SBUF,A
JNB     TI,$
CLR             TI
NXT7:           LJMP    MAIN
End
```

PROGRAM CODE FOR RECEIVER UNIT

```
org0000h
;>
rt:
MOV             P2,#00H
MOV             SCON,#50H
MOV             TMOD,#20H
MOV             TH1,#0FAH
SETB            TR1
CLR             RI
main:
RCV:        JNBRI,MAIN
CLR             RI
MOV             A,SBUF
CJNE        A,#05H,NXT   ;hold
JNB             RI,$
CLR             RI
MOV             A,SBUF
CJNE            A,#55H,MAIN
ROT1:
SETB            P2.6
CLR             P2.7
LCALL           DELAY
CLR             P2.6
CLR             P2.7
LJMP            MAIN
NXT :       CJNE    A,#10H,NXT1   ;hold
JNB             RI,$
CLR             RI
MOV             A,SBUF
CJNE            A,#60H,MAIN
ROT2:
CLR             P2.6
SETB            P2.7
LCALL           DELAY
```

```
CLR             P2.7
CLR             P2.6
XX:         LJMP MAIN
NXT1:
NXT3:       CJNE A,#15H,NXT4
JNB             RI,$
CLR             RI
MOV             A,SBUF
CJNE        A,#65H,XX ;STP
UD1:        SETB P2.4
CLR             P2.5
LCALL           DELAY
CLR             P2.4
CLR             P2.5
LJMP            MAIN
NXT4:       CJNE A,#20H,NXT5
JNB             RI,$
CLR             RI
MOV             A,SBUF
CJNE            A,#70H,NT9
UD2:        SETB P2.5
CLR             P2.4
LCALL           DELAY
CLR             P2.4
CLR             P2.5
NT9:        LJMP MAIN
NXT5:       CJNE A,#25H,NXT6
JNB             RI,$
CLR             RI
MOV           A,SBUF
CJNE          A,#75H,NT9
FRW:  SETB  P2.3
CLR           P2.2
SETB          P2.1
CLR           P2.0
LCALL         DELAY
CLR           P2.3
CLR           P2.2
CLR           P2.1
CLR           P2.0
LJMP          MAIN
NXT6:       CJNE A,#30H,NXT7
JNB           RI,$
CLR           RI
MOV           A,SBUF
CJNE          A,#80H,NT9
LFT:        SETB P2.3
CLR           P2.2
CLR           P2.1
SETB          P2.0
LCALL         DELAY
CLR           P2.3
CLR           P2.2
CLR             P2.1
CLR             P2.0
LJMP            MAIN
NXT7:       CJNE A,#35H,NXT8
JNB             RI,$
CLR             RI
MOV             A,SBUF
CJNE            A,#85H,NXT9
RGT:        CLR P2.3
SETB            P2.2
SETB            P2.1
CLR             P2.0
LCALL           DELAY
CLR             P2.3
CLR             P2.2
CLR             P2.1
CLR             P2.0
LJMP            MAIN
NXT8:       CJNE A,#40H,NXT9
JNB             RI,$
CLR             RI
MOV             A,SBUF
CJNE            A,#90H,NXT9
BCK:        CLR P2.3
SETB            P2.2
CLR             P2.1
SETB            P2.0
LCALL           DELAY
CLR             P2.3
CLR             P2.2
CLR              P2.1
CLR             P2.0
NXT9:       LJMP MAIN
DELAY:MOV R4,#0FFH
LOOP: MOV R5,#0FFH
DJNZ            R5,$
DJNZ            R4,LOOP
RET   end
```

IV. RESULTS AND DISCUSIONS

A. Results

The design and fabrication of BOMB DETECTION ROBOT USING MEMS TECHNOLOGY is developed successfully. The main aim of our project is to detect land mines in the remote areas where bomb detecting personnel cannot be reached. The robot can be controlled with the MEMS sensors that are fixed on the hand band and the whole procedure can be viewed through a video camera. The main technology used in our project is MEMS technology with wireless video camera. This autonomous robot is used to detect the land mines with the help of a metal detector also, in pick and place of the land mine far away there by reducing human interference.

B. Advantages

- It can be altered to suit the needs of the user.
- It can be controlled remotely.
- It has a video feedback.
- For real time applications the same robot can be increased with high number of degree of variations and can be enhanced.
- It is not sensitive to light.
- It is not much sensitive to environmental and weather conditions.
- It has longer range and has quick response.

C. Applications

- Bomb detection.
- It can also be used for detecting bombs other than land mine just by replacing metal detector with Ion Moiblity Spetrometer (IMS) and Mass Spectrometer (MS).
- Pick and place operations in industrial areas.
- The same robot can be used for real time application with increase number of degrees of freedom.

D. Conclusion

The design and fabrication of REMOTE CONTROLLED BOMB DETION ROBOT USING MEMES TECHNOLOGY prototype has been successfully achieved. The MEMS technology is upcoming technologies in the field of engineering. For the demonstration purpose a prototype has been developed and the results are found to be satisfactory. In this project we have demonstrated the pick and place operation of the robot along with metal bomb detection action. All these functions are automated and can be operated simultaneously using MEMS sensors. It primarily helps to reduce human effort and helps in diffusing the bomb without human interference. Integrated features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced ICs with the help of growing technologies, the project has been successfully implemented. Thus the project has been successfully designed and tested.

ACKNOWLEDGMENT

I would like to express my special thanks of gratitude to my teacher Dr K Sudhakar Reddy, Profeesor and Head of Mechanical Engineering Dept, MGIT who gave me the golden opportunity to do this wonderful project. Also I would like to extend my gratitude toMr B Rajnaveen, Assistant Professor who helped me in doing this project, which also helped me in doing a lot of Research and I came to know about so many new things I am really thankful to them..

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Figure 1. (a)Opening of the gripper (b) Closing of the gripper.

ISSN: 2321-8169
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Figure 2. (a)Upwardmovement of the arm (b) Downward movement of the arm