Abstract: Robots play a major role in many walks of life and are extensively used in the areas of defense, industries, medical and home appliances. They can carry out different risky jobs that cannot be done by human. This paper presents multipurpose autonomous robot that has PIR sensor, Inductive proximity sensor, and fire sensor which get activated based on external stimuli. The system provides continuous visual monitoring through the wireless camera attached to the robot and sends continuous data to the control unit. The robotic arm fitted on the robot is employed for pick and place operations while the laser gun attached to the robot is utilized for pointing laser rays to hit the target object.

Keywords – Arm9, Arm7, Robot, sensors, Laser Pointer Gun, camera, Zigbee

I. INTRODUCTION

This paper presents multipurpose autonomous robot that activates different functionalities in the robot unit based on the signal received from the control unit.
In the existing systems, personal computer using Zigbee protocol is used to monitor the mobile robot [1]. Robot was developed to provide security using Zigbee communication and web server [2], to provide security and electronic control of the entire house from a single place [3] and to trace out the intruders and take necessary action automatically [4].
In the proposed system, a robot is developed that is controlled through mini ARM9 (S3C2440) instead of PC, since ARM9 is portable. The outcome of different activities can be monitored and displayed on ARM9 screen. Robot is used to sense moving objects, metals and fire. A robotic arm is programmed to pick and place the object. Another differentiating factor about this robot is the wireless video camera combined with laser pointer gun that can be effectively utilized to pinpoint the captor’s location and neutralize them.

II. SYSTEM DESCRIPTION

The Multifunction robot system comprises of Robot unit and Control unit.
Robot unit: The heart of the system is ARM7 (LPC 2148), which controls all the activities of the robot section. Zigbee is configured to transmit and receive signals between robot and control unit. Five motors have been used in this project out of which two motors are for robotic movements, two for gun control and one motor is used for opening and closing of robotic arm clip. Microcontroller sends a signal to ARM9 when sensors get activated.

Fig1: Functional block diagram of Robot unit
A relay is used to supply power to the motor used for triggering the laser pointer gun. The signal from the wireless camera is directly sent to monitor unit of the control section for displaying the surrounding.

**Control unit:** Control unit comprises of Zigbee transceiver, monitor unit, ARM 9 (S3C2440) and power supply. The screen of ARM9 is used to display the various functions provided for robot control. There are eleven buttons, of which first button is “Connect” button, used to connect with the COM2 port to set the baud rate. Four buttons are for controlling the robotic motion in four different directions viz. forward, backward, left and right. Three buttons are used for gun control – two for upward and downward movements of the gun and third for triggering it. Another two buttons are used for opening and closing of robotic arm clip. The last button is meant for controlling the laser pointer.

![Fig2: Functional block diagram of Control unit](image)

To execute any desired function, suitable button is pressed on the screen of ARM9 and the command signal gets transmitted to microcontroller. Zigbee transceiver is employed for communication between control section and robot section.

### III. SYSTEM HARDWARE DESIGN

The hardware of the system consists of two units as shown in Fig 3 & 4.

![Fig3: Control unit hardware](image)  ![Fig4: Robot unit hardware](image)

Power supply is interfaced to provide 5v supply to ARM7 and to other modules in the system. Logic circuits of fire sensor, PIR sensor and metal sensor are interfaced to microcontroller Port (0.16 to 0.18) respectively. Two L293D drivers are interfaced to port (0.2 to 0.5) & port (0.10 to 0.13). Gun trigger and laser are interfaced to port (0.19 to 0.20) and Zigbee is interfaced to port (0.0 to 0.1) for transmitting and receiving the data.

**A. ARM7 LPC2148:**

The LPC2148 microcontroller is 32 bit, 64 pin operating at 3.3V, 12 MHz crystal for system clock and 32 KHz crystal for RTC. Internal MUC has 512 KB flash memory and 40KB static RAM. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty.

**B. ARM9 S3C2440:**

ARM9 S3C2440 is designed to provide hand-held devices for general application with low power and high performance. It has speed of 400 MHz with RAM of 64 MB. Flash memory capacity is 1 GB. It has special features like audio I/O, camera, USB and Ethernet. Its Operating supply is at 5V and it supports Windows and Linux.
C. Zigbee:
Zigbee is a low-cost, low-power, wireless protocol defined in IEEE standard 802.15.4 (2003 version) for low-rate WPANs. It is highly secure, reliable and easy to install. Data transmission rates vary from 20 kilobits/second in the 868 MHz frequency band to 250 kilobits/second in the 2.4 GHz frequency band.

D. L293D driver:
L293D driver is a 16 pin Motor Driver IC which allows DC motor to drive in either directions. It can supply a maximum current of 600mA per channel. In the proposed system two L293D are used.

E. PIR Sensor Module:
Passive Infra-Red Sensor is used for detecting moving objects. Its operation is based on infrared technology. It operates with high sensitivity, high reliability and ultra-low voltage operating mode. This sensor is used to detect presence of intruders in the secure zone.

F. Inductive proximity sensor:
Inductive proximity sensor is used to detect metallic targets. The main components of the inductive proximity sensor are coil, oscillator, detector and the output circuit. Any metallic target in the coil’s magnetic field absorbs some energy which affects the oscillator field. Once the oscillation amplitude of the disturbance reaches a threshold value, the sensor is triggered. This sensor is used to detect presence of explosives.

G. Fire Sensor:
Fire sensor is actually an NPN photo transistor that converts infra red radiation from any hot object into electrical energy. When light of the proper wavelength hits a semiconductor material such as a PN or NP junction, it increases the concentration of charge carriers. Small base current is created by infrared radiation coming from fire. The current output of the sensor is directly proportional to the strength of infra red radiation from the hot object (fire). This sensor is used specially to detect explosions in coal mines.

H. Wireless Camera:
Camera mounted on the robot section has linear transmission distance of 50 - 100M. The operating voltage level of transmitting unit is 9V DC and the current level is 300mA.It has resolution up to1280 x 480 pixels. This is used for broadcasting live information to control unit for necessary action to be taken.

IV. SYSTEM SOFTWARE DESIGN
Operation of the system requires following software
Embedded C: Source code is written in C. Writing in c simplifies code development for large projects. It can be reused, and is easy to maintain and debug.
Flash Magic is a tool which supports ISP (In System Programming) feature. It is used to burn a hex code in EEPROM of microcontroller.
Keil µVision IDE: The µVision IDE from Keil combines project management, source code editing, programe debugging, and complete simulation in one powerful environment. The µVision editor and debugger are integrated in a single application that provides a seamless embedded project development environment.

V. RESULTS
The front page of the control section on ARM9 screen is shown in Fig5. Eleven buttons present on the screen control different events in the robot section.

Fig5: Activation of COM2
Initially, “COM2” port is selected to initialize the communication between robot and control section. Afterwards, various events can be triggered based on the requirement.

When fire is detected by the fire sensor, “Fire Detected” message is displayed as shown in Fig6. “Metal Detected” message is displayed as shown in Fig7, when presence of explosives is detected.

“Human Motion Detected” message is displayed when some movement is observed in the vicinity of the robot. This is shown in Fig8. Laser pointer gun is used for training the soldiers in aiming at the target. “GUN-UP” function is activated by pressing the corresponding button in the control panel resulting in the gun being lifted up as shown in Fig9.

Similar to the above three activities, a number of other activities are possible like pick and place, robot movement, laser triggering etc.

VI. CONCLUSION

The proposed robot has scope of widespread industrial, defense and home applications. The laser gun attached to the robot is an excellent substitute for the conventional weapons carried by the army. Remote command can be sent to trigger the laser gun once the web camera shows the location of the targets. It can be used to analyze the environment of a coal mine without any human intervention. Based on the visuals received from the web camera, suitable action can be taken to get rid of potential risk in the coal mine. It can also be employed in a hostage situation to pin point the exact location of terrorists with the help of web camera, saving many lives during rescue mission. Another application is home security system to sense movement of intruder through PIR sensor. In industries, this robot can be used to pick and place objects that could be hazardous to human.

Various advantages of this system are its range of operation up to 100m, secure data transfer and easy to install. The laser pointer gun has several benefits over traditional weapons viz. less impact of gravity; it can cover range up to 300m. A laser speed gun is very accurate in pointing to the target.

VII. FUTURE SCOPE

Other wireless technologies like Wi-Fi or Bluetooth can be used as communication protocol instead of Zigbee technology. Touch screen/Voice based robot control can also be used in future to make the system sophisticated.
REFERENCES


