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DESIGN AND IMPLEMENTATION OF MULTI-SENSOR ROBOT FOR RIGID INDUSTRIAL ENVIRONMENT

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Abstract- The scope of this proposed system is to implement the architecture of a multi-sensor robot. Reduction of the human activities in dangerous environment is the first objective of employing the autonomous mobile robots in many applications. bomb detection is a risky action that can be done by either human or robot. The implemented robot is an autonomous four wheels system that is designed to detect the bombs, hazardous leakage gases, humidity and high temperature and sending it to a remote location and visualized in SCADA type application. Wireless connection is established between the general controller on the robot and the control room. A personal computer (PC) acts as the general controller which is responsible for mapping the bombs, hazardous conditions and determining some general settings for local controller. The local controller navigates the robot based on the feedbacks from several sensors to detect the barriers and bombs. The camera is attached to the robot which continuously capturing the surrounding areas and sending the same video data wirelessly with the separate channel to the control room simultaneously. If it detects any hazardous conditions, alarm should be activated manually/ automatically, which alerts people to vacate that area immediately.

Keywords- *Autonomous Mobile robot; Cortex-m3; Smart sensing sensors; Zigbee transceiver*

1. INTRODUCTION

A robot is a virtual or mechanical artificial agent in practice, it is usually an electro-mechanical machine which is guided by computer or electronic programming, and is thus able to do tasks on its own. The robotic industries association define robot as follows: "A robot is a reprogrammable multifunctional manipulator designed to move material parts, tools or specialized device through variable programmed motions for the performance of a variety of tasks."Recently however, the industry's current working definition of a robot has arm to be understood as any piece of equipment that has three or more degree of movement or freedom. Robotics is an increasingly visible and important component of modern business, especially in certain industries.

These robots, termed "industrial robots" were found almost exclusively in automobile manufacturing plants as little as 15 to 20 years ago. But industrial robots are now being used in laboratories, research and development facilities, ware house, hospitals, energy –oriented industries (petroleum, nuclear power, etc) ,and other areas. this involves manually guiding a robot from point to point through the phases of an operation. the point of an operation are defined through computer commands.

This is refered to as manipulator level off-line programming. An important area of research is the development of off-line programming that makes use of higher- level languages, in which robotic actions are defined by tasks or objectives.

The use of industrial robot is becoming more wide spread. An industrial robot is used for monitoring the temperature, leakage of gases, humidity and bombs.

2. BLOCK DIAGRAM OF MULTI-SENSOR ROBOT

The block diagram depicts the hardware modules under use: cortex m3, 4 wheels, zigbee transceiver, temperature sensor, humidity sensor ,leakage of gases, bomb detector and sets of batteries.

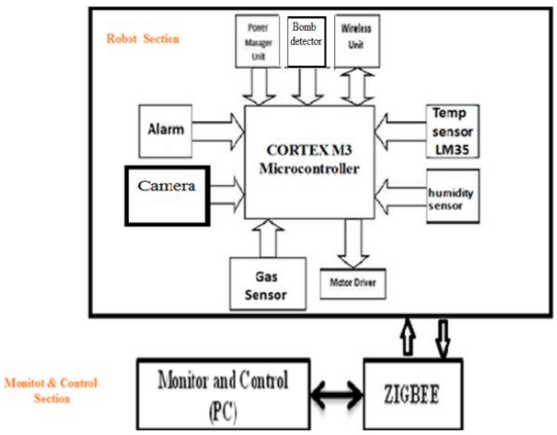

Fig: 2.1 Block diagram of Robot

Description of block diagram:

This system was formed by a computer and a zigbee transceiver for wireless communications among robot section and control & monitor section. The main working module of this robot consists of LPC 1768 Cortex M-3 processor. It is interfaced with temperature, leakage of gases, humidity sensor and bomb detector sensor. The device framework of the robot works with L293D device drivers. Location of the robot is traced with camera and the Zigbee transceiver is used to send the serial port data to the hyper terminal of the computer. MAX 232 is used as a connector device between the parallel ports of Cortex communication to that of the Zigbee Module.

3. ARM CORTEX M3 LPC1768

The LPC1768 is ARM Cortex-M3 based microcontrollers for embedded applications featuring a high level of integration and low power consumption. The ARM Cortex-M3 is a next generation core that offers system enhancements such as enhanced debug features and a higher level of support block integration. The LPC1768 operates at CPU frequencies of up to 100 MHz The ARM Cortex-M3 CPU incorporates a 3-stage pipeline and uses Harvard architecture with separate local instruction and data buses as well as a third bus for peripherals.

The ARM Cortex-M3 CPU also includes an internal prefect unit that supports speculative branching. The peripheral complement of the LPC1768 includes up to 512 kB of flash memory, up to 64 kB of data memory, Ethernet MAC, USB Device/Host/OTG interface, 8-channel general purpose DMA controller, 4 UARTs, 2 CAN channels, 2 SSP controllers, SPI interface, 3I2C-bus interfaces, 2-input plus 2-output I2S-bus interface, 8-channel 12-bit ADC, 10-bit DAC, motor control PWM, Quadrature Encoder interface, four general purpose timers, 6-output general purpose PWM, ARM Cortex-M3 processor

The ARM Cortex-M3 is a general purpose, 32-bit microprocessor, which offers high performance and very low power consumption. The ARM Cortex-M3 offers many new features, including a Thumb-2 instruction set, low interrupt latency, hardware divide, interruptible/continual multiple load and store instructions, automatic state save and restore for interrupts, tightly integrated interrupt controller with wake-up interrupt controller.

4. DEVELOPED SYSTEM

The developed system is based on a cortex-M3, communicating with a central station (Figure2.1).The cortex-M3 is connected to different sensors, which giving analog voltage signals. These signals are measured and “translated” into the responding value. All of these values are send trough the ZigBee Module to a base station, which stores the data into an Access Database.

The Values can then be monitoring the personal computer

4.1 HUMIDITY SENSOR

Humidity is the presence of water in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries. The presence of water vapor also influences various physical, chemical, and biological processes. Humidity measurement in industries is critical because it may affect the business cost of the product and the health and safety of the personnel.

Fig: 4.1HS-610 Humidity Sensors

Hence, humidity sensing is very important, especially in the control systems for industrial processes and human comfort.

4.2 TEMPERATURE SENSOR

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in oC).

4.2.1 LM35

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

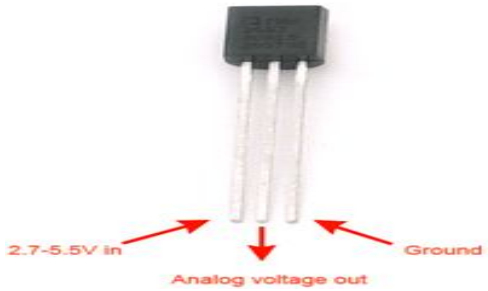

Fig: 4.2.1temperature sensor

The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. As it draws only 60 µA from its supply.

4.3 CAMERA

The camera we are using in the project is the wireless camera which can send transmit using RF technology developed by JiaMeiKang(HK) Technology Limited.

Fig: 4.3 Block diagram of Camera

Specifications:

- Technical parameters of transmitting unit:
  - ✓ 1/3”- or ¼”-inch image sensor
  - ✓ System: PAL CCIR NTSC EIA
- Technical parameters of receiving unit:
  - ✓ Wireless audio video receiver
  - ✓ Receiving frequency: 1.2G - 2.4G
  - ✓ Receiving signal: video, audio

4.4 BOMB DETECTOR

In fact the bomb detector is the most critical part in the Robot. The sensor detects the bomb that is used inside a industry and simply, it can be considered as a bomb detector. The type of bomb detector on this Robot is pulse induction (PI) that exploits mono coil configuration. Consequently a single search coil is fitted at the front of the robot .A simplified diagram of the bomb detector circuit is illustrated in Fig.

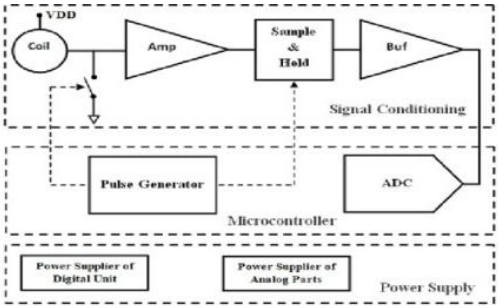

Fig: 4.4 Block diagram of bomb detector

The main part of a PI detector is a MOSFET transistor as the coil switch, with a high current capacity and a high breakdown voltage. The MOSFET, shorts the coil across the battery voltage, which yields a large coil current; and turns the coil current off as quickly as possible. A parallel resistor with coil absorbs the energy that was stored in the coil to turn the coil current off rapidly and it leads to energy dissipation as heat.

4.5 GAS SENSOR

Explosion due to gas leakage is one of the most potential hazard in the industrial.The Gas Sensor Modules are designed to allow a microcontroller to determine when a preset gas level has been reached or exceeded. The type of gas detected depends on which module you are using. Interfacing with these sensors is done through a 4-pin SIP header and requires two I/O pins from the host microcontroller. The sensor modules are intended to provide a means of comparing gas sources and being able to set an alarm limit when the source becomes excessive.

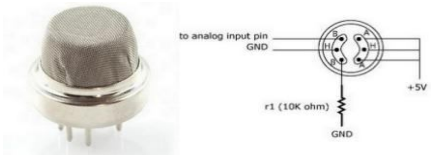

Figure: 4.5. Image of gas sensor

MQ-6 gas sensor modules are used in gas leakage detecting equipments in family and industry.

4.6 ZIGBEE TRANSCEIVER

ZigBee is a new wireless technology developed by theZigBee Alliance to overcome the limitations of BLUETOOTH and Wi-Fi. ZigBee is developed on the top of IEEE 802.15.4 standard. It is designed for low-power consumption allowing batteries to essentially last forever. ZigBee devices allow batteries to last up to years using primary cells (low cost) without any chargers (low cost and easy installation).The ZigBee standard provides network, security, and application support services operating on top of the IEEE 802.15.4.IEEE 802.15.4 standard has two basic layers medium Access Control (MAC) and Physical Layer (PHY) wireless standard. Then network layer supports various topologies such star, clustered tree topology and self healing mesh topology. Apart from easy installation and easy implementation.

5. RESULT ANALYSIS

In this project we have developed an environmental monitoring system using multi-sensor robot. Two sections are there, one is robot section and another one is monitor and control section. In control and monitoring section is equipped with PC and zigbee is shown in fig 5.1 The main objective of my project is design and implementation of multi-sensor robot.

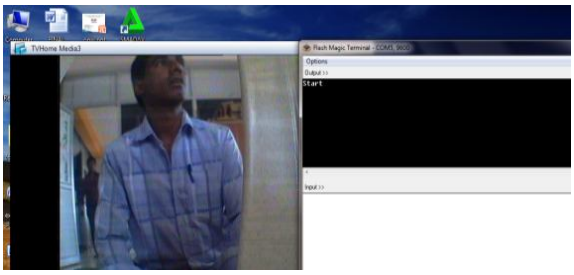

Fig.5.1 Control and monitoring section

For monitoring and controlling the robot the zigbee is connected to the PC with the help of serial communication. Now the software Flash magic Term is to be installed and the camera is attached to the robot which continuously capturing the surrounding areas and sending the same video data wirelessly with the separate channel to the control room simultaneously. If it detects any bombs ,then we get the output as shown in fig:5.2 using Flash magic term.

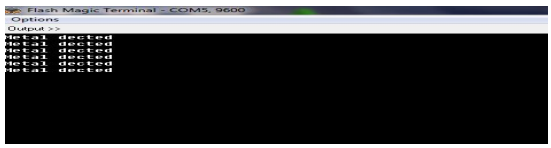

Fig.5.2 Flash magic term window

If it detects any leakage of gases ,then we get the output as shown in fig:5.3

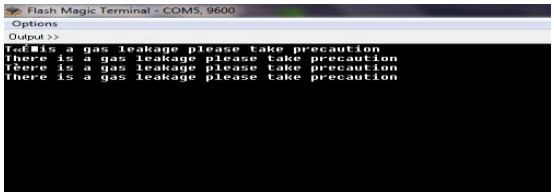

Fig: 5.3 Flash magic term window

To observe the present temperature, we give input as letter " t " then we get the output temperature as shown in fig:5.4 t=temperature

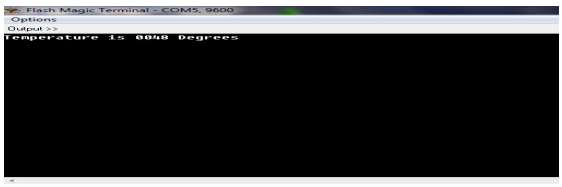

Fig:5.4 Flash magic Term window

To observe the present humidity, we give input as letter " h " then we get the output humidity as shown in fig 5.5
h=Humidity

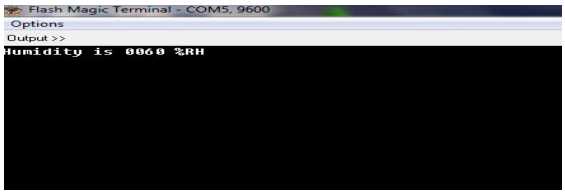

Fig:5.5 Flash magic Term window

If we want to move robot in forward, we give input as letter " f " then robot will move forward direction and output is shown in fig 5.6.
f= forward

Fig:5.6 Flash magic Term window

If we want to move robot in backward, we give input as letter " b " then robot will move backward direction and the output is shown in fig 5.7
b=backward

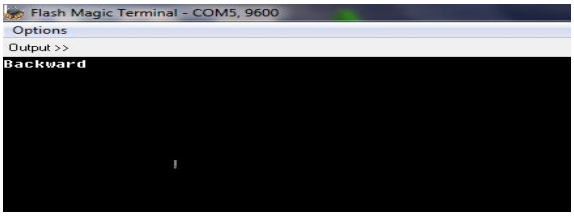

Fig:5.7 Flash magic Term window

The developed robot sections carry's cortex-M3 processor, zigbee, different sensors and battery's. the cortex-M3 processor is interfaced with temperature, humidity, leakage of gases and metal detector. For robot movement the H-Bridge is connected to the cortex-M3 port. For the communication between control and monitoring and robot section the zigbee is connected to the cortex-M3 processor by using MAX-232.

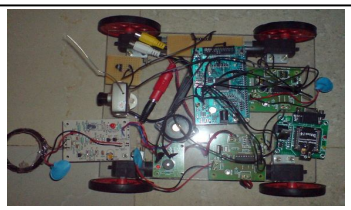

Fig .5.8 Robot section

6. CONCLUSION AND FUTURE SCOPE

The proposed system was formed by a computer with, Tera Term software and a zigbee transceiver for wireless communications among the robot section and control and monitoring section. The camera is attached to the robot which continuously capturing the surrounding areas and sending the same video data wirelessly with the separate channel to the control room simultaneously. If it detects any hazardous conditions like temperature, humidity, leakage of gases and bombs , alarm should be activated manually and automatically, which alerts people to vacate that area immediately. The robot consists of LPC 1768 Cortex-M3 processor. It is interfaced with temperature, humidity, leakage of gases and bomb detector. For robot movement the H-Bridge is connected to the cortex-M3 port. For the communication between control and monitoring and robot section the zigbee is connected to the cortex-M3 processor by using MAX-232. The further extension of this project is our robot chassis is made of four wheel which can be better replaced with tanker wheel or insect legs for its movement in improper surface.

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