Mine security by FPGA based robot

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Abstract—**In mines the security of workers is the major concern thats why it is necessary to know the environmental condition inside the mine and control them. This system used to make remote controlled robot to increase the life safety of mine workers. This robot equipped with sensors, camera, wireless transmitter and receiver is used to analyze mine area. Previously sensor node is based on microcontroller so it has limited reconfigurable capability thats why system uses the field programmable gate array and raspberry pi based for an early detection of hazardous condition in mines area and controlling them. Xilinx simulator can be used for simulate particular code.**

Keywords-FPGA; Raspberry pi; PIC; Wireless robot; Camera; Xilinx; Proteus

I. INTRODUCTION

At mines the safety of workers is very essential. In mines many people lost their life because of risky environmental conditions, poisonous gases, explosion, fire and earthquakes. With this, there are major losses in property too. The existing system [1]-[4]used in such environment are having many limitation to save the life of workers who work at this type of area. For increasing safety of workers many system are available. In this we use the system in which we send robot in mines or we can say in coal mines. In this system robot have different types of sensors to study the environmental condition inside the mines and having the camera to view the situation inside the mines. Robot moves inside mine with remote control and send all information to the control room. Previously the sensors were fixed at mine area so they me damaged at explosion. The different thing about this project is that, the robot is moving with remote control which having different sensors to detect the condition in mines area, camera to view the situation and water pump to control fire there is any fire and having so many controlling action. One of the best thing about this project is our robot is moving and we can move this robot at any place in mines to monitor the environmental situation and to control them. We can use this system any industries also.

A. System Overview

The basic concept of this project is to implement a FPGA based wireless robot for mines safety applications. In this use of raspberry pi is done for camera interfacing and FPGA is used instead of microcontroller because of its flexibility.

II. LITERATURE REVIEW

Several approaches have been taken to implement such wireless communication systems which are based on FPGA and also on both microcontrollers and FPGAs.

Previous system was based on microcontroller which having a limited computational capability. [1]Figure 1st is the transmitter part and figure 2nd is the receiver part. This previous system only gives the indication not controlling.

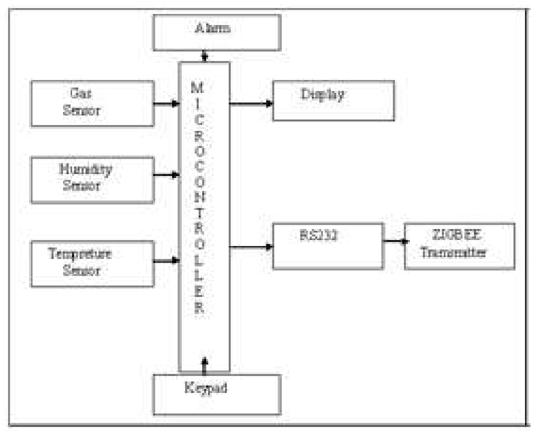

Fig. 1. Transmitter system

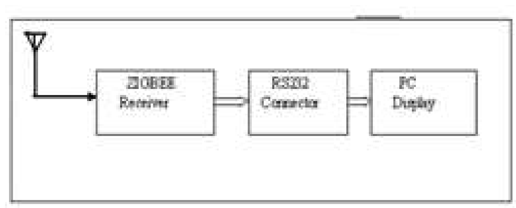

Fig. 2. Receiver system Design

So we developed a system which is [2]FPGA based wireless robot for mine safety application.

III. PROBLEM FORMULATION

The wireless communication systems developed yet are not quite satisfactory up to the mark when we are taking complex and real time operations and applications in to the account. Furthermore we can say that those systems are not enough

flexible for various requirements and applications. Each time for new the application we have to change the hardware and also the programming of whole system when we are not using FPGAs in the system.

The communication systems designed previously based on microcontroller are quite slower for emergency application like fire control, smoke control, temperature control and light control at mines and industries. Microcontroller needs to generate interrupt routine for communication between two systems that will generate delay. Also the program complexity will get increase. Instead of using microcontroller for controlling purpose if we use FPGA that will definitely solves the problem.

IV. PROPOSED SYSTEM ARCHITECTURE

A. Block diagram

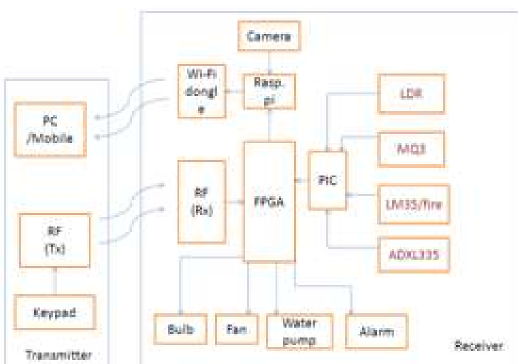

Fig. 3. Proposed System Block Diagram

B. Description

The block diagram of proposed system is as shown above. In this system the receiver block is movable. In a particular coal mine this receiver block is continuously moving, the direction of the moving robot is getting controlled by user. This system is used to continuously monitoring the environment of mine area.

In this system we are controlling fire with water pump, methane gas with fan or oxygen, light by bulb and indicating vibrations with alarm. For this we are having LM 35 sensor, MQ3 sensor, LDR and ADXL335 respectively for fire indication, methane gas indication, light indication and vibration indication. These four sensors are connected to FPGA through PIC microcontroller as shown in above diagram. And the controlling devices here bulb, fan, water pump and alarm are also connected to FPGA through relays. Camera is also connected to FPGA through raspberry pi to observe the environmental situation inside the mine area As receiver system is continuously getting moved by the user and camera is attached to this moving receiver, user can see the situation inside mine area and this continuous streaming of the camera can be achieved through raspberry pi and Wi-Fi dongle. Wi-Fi dongle gives continuous streaming to the user in controlling room on pc or mobile. By observing the mine area in the above manner user can provide the moving direction to receiver robot. Communication between transmitter and receiver can be achieved through RF module. Transmitter RF module is connected to keypad to get the instruction from user and send the same to receiver robot.

As soon as the value of particular sensor gets increase beyond the threshold level this get displayed on pc. By observing this user can move this robot in that direction and particular action can be taken. If there is fire robot spray water using instruction given by user and same for the other condition.

Here in this system we are using FPGA instead of microcontroller to control the situation because we are dealing here with real time applications such as fire control, gas control so we need faster speed which can be achieved by FPGA easily. Microcontroller needs to generate interrupt for different action to take. [4]This will generate delay in operations and can cause serious damage.

Also another advantage of FPGA is, FPGA is a reconfigurable device which can be used for another application just by changing its program. No need to change whole system hardware.

[2]Use of FPGA in the system is essential because of following reason. Here we are dealing with some real time operation, like sensing fire and smoke and spontaneously controlling them. These all operations have to be done simultaneously and accurately. If a microcontroller is used here instead of FPGA, microcontroller needs to generate interrupt for different operations to do. That will generate delay in the operations and can cause serious damage due to fire or smoke. Also programming microcontroller for above mentioned operation is complex task. To avoid this we are going for FPGA.

C. Spartan-3 FPGA Kit

The Spartan-3 FPGA kit is having the specification which support for handling high volume its cost sensitive family. New Spartan 3 FPGA kit is just the advance version of older one in terms of number of logic resources, internal RAM, Input Output pins used and performance as well.

1) Features

- Its a Xilinx Spartan-3 XC3S200 FPGA
- 4,320 logic cells

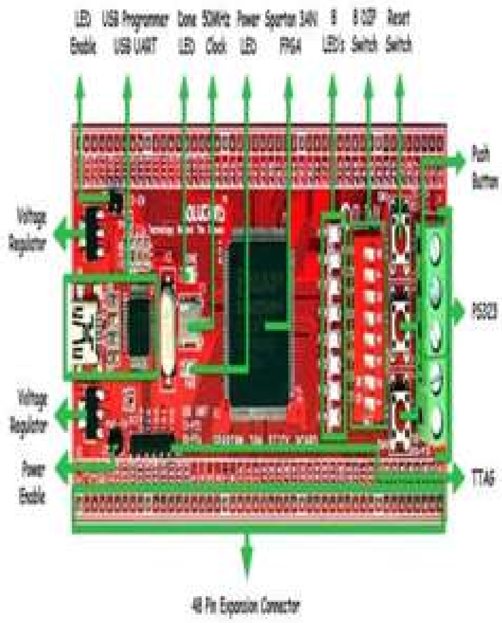

Fig. 4. Spartan-3 FPGA Kit

- 216K bits of RAMs
- Twelve multipliers (18x18)
- Up to 173 Input/output signals
- Individual byte enables
- 3-bit, 8-color VGA display port
- 9-pin RS-232 Serial Port
- DB9 9-pin female connector (DCE connector)
- RS-232 level translator

D. Raspberry pi

Fig. 5. Raspberry Pi Model

Here Raspberry pi used is of ATM card size computer which can perform tasks that can be done by standard desktop. The application of this raspberry pi is to interface camera module to our system. its having RAM of 512 Megabytes, Ethernet controller along with two USB port. its having a SD card for booting and long-term storage. to power on this raspberry pi model we require a power source of 5V 1.2 Amp which do have a mini USB connector.

E. System implementation

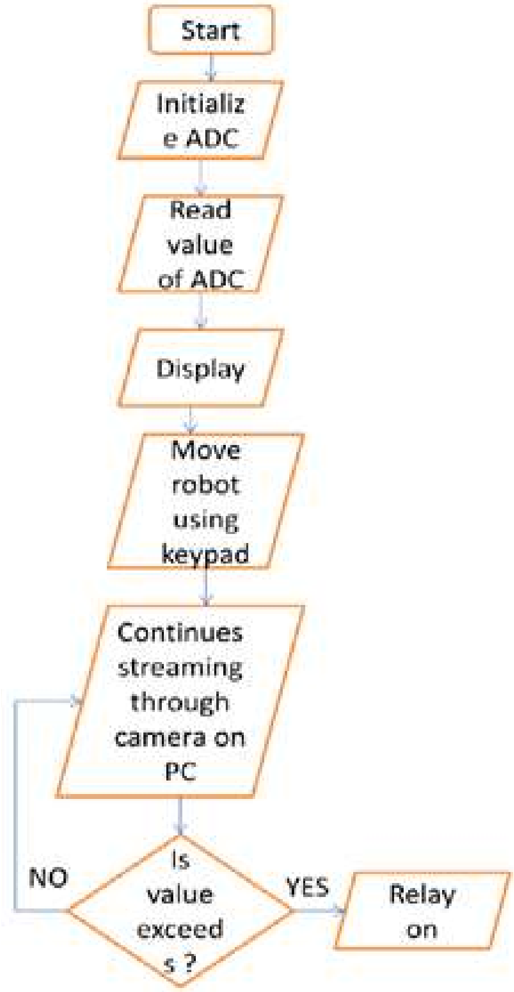

Fig. 6. Flowchart

F. Reliability of system

System makes the use of FPGA, raspberry pi and having a camera mounted on it due to which flexibility and reliability get increased. Also due to the use of wireless network the disadvantages of wired communication reduces that will further increase the system reliability.

G. Results

the sensors used for safety purpose here in the system can be simulate using proteus simulator to check whether the temperature, light or gas sensed by the sensor getting displayed or not and the same output after convergence in digital form is given to FPGA to check threshold level of the same. This output is shown in following Fig.7. fig.8 shows the Robot displaying environmental parameters like temperature, gas quantity, accelerations, light intensity and controlling them.

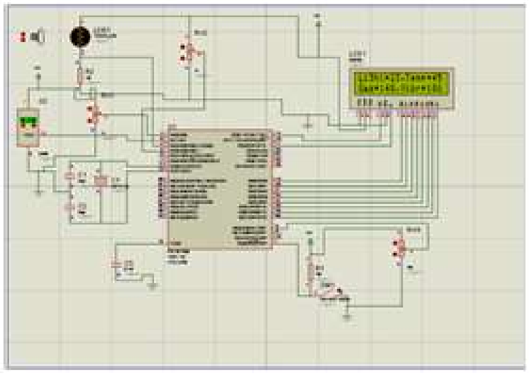

Fig. 7. Sensor value

Fig. 8. Robot displaying environmental parameters

V. CONCLUSION

The system or robot equipped with sensors monitor and control the parameter like temperature, fire, smoke, vibration and gas leakage and also help to observe the mine area using camera on it. If the explosion occurs then this system solves the issues like second explosion caused if the amount of methane gas is high in air by early detection. Increase the life safety of rescuers and coal mine workers, reduces the risk taken by rescuers and complexity. The FPGA receives data from the sensors and after doing programming, it transmits data to PC for display using RF module. It gives a wide range of applications; we can use it anywhere in our day today life such as industries, hospitals, colleges or any other public places to improve the health quality of people.

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