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Lab VIEW based Smart Rescue Robot

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Abstract-----LabVIEW is a virtual system design platform and development environment for a visual programming language. MyRIO is a real time embedded evaluation board made by National Instruments which provides reliable data acquisition. It is used to develop applications that utilize its onboard FPGA and microprocessor. A rescue robot is one which is designed for the purpose of rescuing people. Common situations that employ rescue robots are mining accidents, urban disasters like collapsing of huge infrastructures. This employment of rescue robots reduces the human efforts and fatigue conditions. Our proposed model navigates by visualizing arena's clearance. The arena's situation is monitored by the observer from the video transmitted from a camera embedded in the robot to get a better picture of the accidents. Our proposed model is also embedded with Gas detection and Temperature sensors to get a clear understanding of the arena's environment so that the rescue team can take necessary precautions before performing the rescue operation.

Keywords --LabVIEW; myRIO; FPGA; Mobile Robotics; rescue scenarios.

1. INTRODUCTION

Robotics is becoming an emerging field in this modern era. There are a number of industries which employ robotics for their use. The application of robots in every field is rapidly increasing because of the demands and flexibility in this technology. Although this technology mostly employs Arduino [1], but over a few decades National Instruments have been efficiently developing its software and hardware to create virtual instruments. LabVIEW helps in controlling many mechatronics systems through reliable acquisition of data using devices myDAQ, compactRIO, myRIO [2] etc.
MyRIO is being used worldwide effectively over a last few years as it provides economical and reliable acquisition of signals from many sources. Now-a-days myRIO is also being used as main control system in many projects and applications especially due to its versatility and possibility to use both Real Time System and FPGA programming.

It can also support a large number of connections on a single board which includes analog, digital, PWM, UART etc. It also has a support for Wi-Fi, high speed USB port 2.0 through which we can interface many external devices.
In this paper we will present and discuss about the challenges in rescue operations and the need of robotsin rescue scenarios, our proposed model for rescue operations and results of our model.

2. ROBOTS IN RESCUE SCENARIO

There are a lot of challenges and risks involved in rescue operations like, the rescue team will not get the detailed information regarding the accident and also there may be some situations where the team cannot directly go and involve in rescue operations, even if they do there may be a chance of losing their lives. In order to reduce such risks and challenges, these rescue teams if aided with a mobile robot[3] which can monitor the environment of the accident well before the starting of rescue operation can favour a lot. These robots can also be used to manipulate the hazardous environment. These robots are similar to Automated Guided Vehicles (AGV) [4] which navigates in the arena using path planning and obstacle avoidance mechanisms. Our aim is to design such a robot with low cost which simulates the hazardous conditions of the environment where the accident occurred so that the rescue team can take necessary precautions before proceeding into the rescue operations.

3. RELATED STUDY

Our study includes the number of possible ways in which a robot can be designed using the onboard peripherals of myRIO in the best possible and the cheapest way which consumes less power and provides more efficient transmission and processing of the acquired data. We also studied the methods involved in the surveillance of hazardous environment, methods involved in path planning based on the obstacle avoiding conditions. We have also studied the advantages of using myRIO over Arduino [5] for robotic applications.

We have also studied the working of Automated Guided Vehicles for rescue applications and also regarding the positioning of sensors, external devices to get the accurate and reliable acquisition of the signals from the surroundings.

4. PROPOSED MODEL

STRUCTURE

Our idea is to reduce the risks and challenges faced by the rescue teams in hazardous conditions. We have developed the structure shown below for monitoring the environment where the accident has occurred. Our proposed structure has dimensions of 20cmx14cmx20cm. The dimensions of the model can be further reduced which helps in the efficient navigation of robot inside the arena.

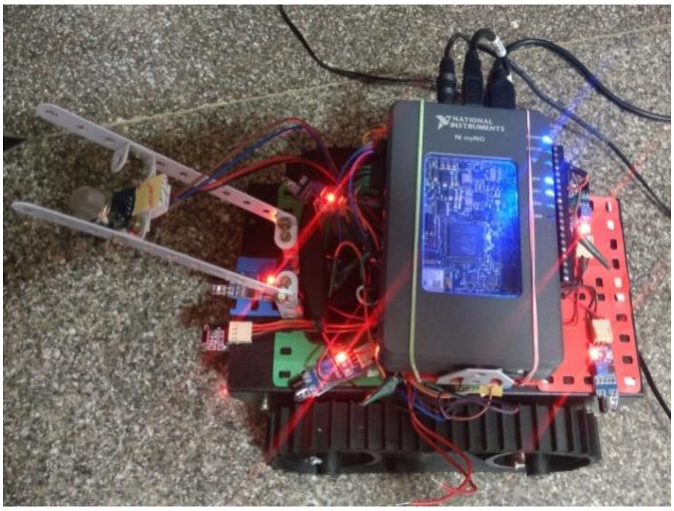

Fig 1: Our Proposed Smart Rescue Robot

MOTOR CONTROL

Motor control is mainly achieved using a L293D driver circuit which acts as a current amplifier providing an output voltage of 12V. Our proposed structure consists of 4 DC Motors paired into two groups. Each motor has a rotation speed of 500RPM when terminals are supplied with a voltage of 11.2V with each motor drawing a current of 100mA.The motors are driven using PWM technique with Duty Cycles of 100% when in motion and 0% in case of turnings and halt respectively. The speed of rotation can be varied by varying the input voltage at the terminals of driver board.

SENSORS

The data acquisition from sensors [6] is divided into 4 phases. The first phase includes the detection of obstacles using 3 IR sensors which gives digital outputs.

The outputs from these three IR sensors give rise to 8 combinations based on which the robot navigates in a specified direction.In addition to the 3 IR sensors we have equipped the structure with another 2 IR sensors in the back to indicate whether the robot has crossed the obstacle or not. The IR sensor consists of LM393 chipset and can detect obstacles in the range of 2cm-30cm. In second phase the gas sensor (MQ2), temperature sensor records the data and indicates whether these values in the limit or not.The gas sensor detects Methane, CO, alcohol, smoke concentrations in the range of 300-1000 PPM. In the third phase the video of the environment is acquired using HP webcam connected to the USB port of myRIO. This camera module has a wide angle and provides videos with better quality and resolution.

ADDITIONAL FEATURES

Our model also has features like flash light to get a clear picture of arena even in low light conditions. We have included an option for manual control for our model to provide better and efficient navigation. As our model is a belt driven one, it can easily move on irregular terrains.

POWER DISTRIBUTION

The task of distribution of power to the components is very simple. We have used Lithium Polymer (LiPo) battery with variable voltages like 3.4V, 7.6V, 11.2V with a current of 2200mAh. We have connected the robot to 3.4V supply and myRIO board can be connected to either of 7.6V or 11.2V.

5. ARCHITECTURE OF OUR SMART RESCUE ROBOT

Our proposed model overview can be understood easily through the following structure.

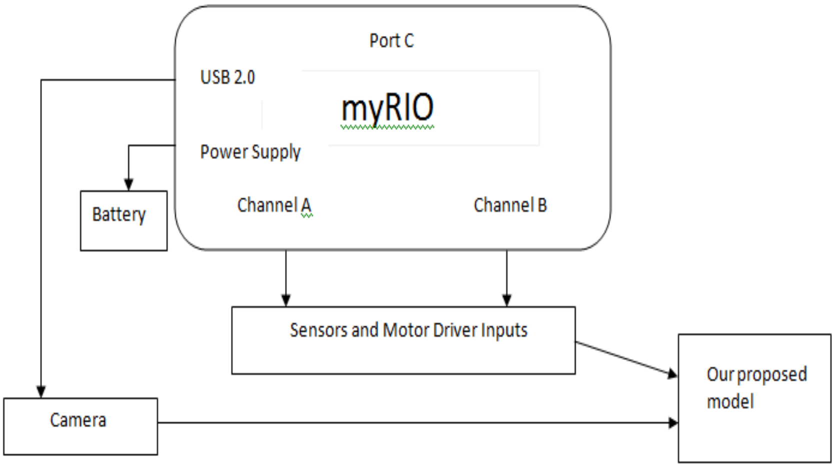

Fig 2: Overview of our proposed model

All the 5 IR sensors are connected to DIO pins of channel-A of myRIO. The Gas sensor, Temperature sensor are connected to two AIO pins of channel-A. The PWM control for motors is provided by PWM pins from both channels A, B of myRIO. The camera module is connected to the USB port of myRIO. The input to the driver board is given from LiPo battery using 3.3V terminals.

6. DESIGN METHODOLOGY OF SMART RESCUE ROBOT

The tasks performed by our proposed model are controlled by series of commands created in the LabVIEW. The software architecture is mainly divided into two parts which includes automatic motion and also manual control to provide efficient navigation to our proposed model to get clear view of the surroundings.
The figure shown below depicts the view of our front panel consisting of Boolean, string indicators, controls for manual operation, indicators to showcase the acquired image from the HP web camera. Since rescue operations must involve continuous monitoring the whole VI must be kept in a while loop. The whole process can be terminated by clicking the stop button created as a control for while loop.

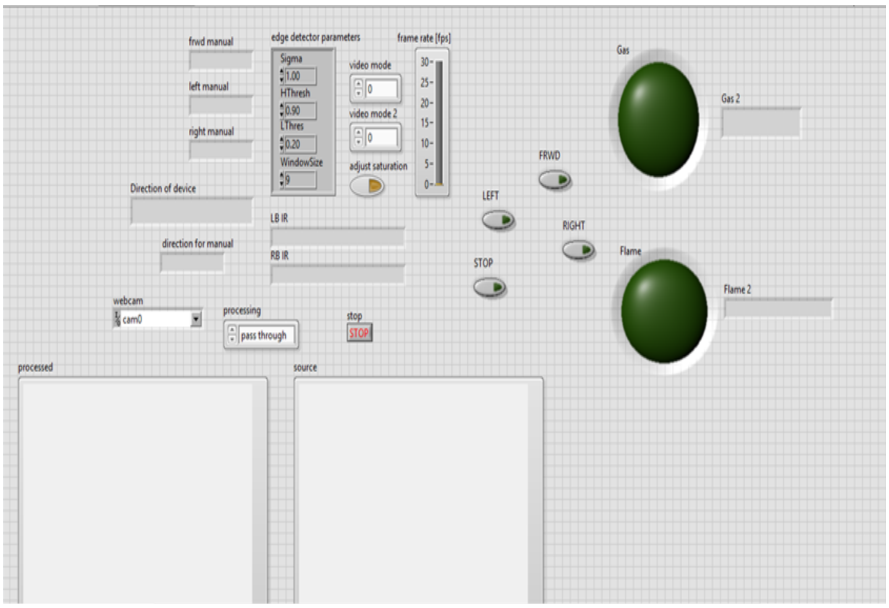

Fig 3: Front Panel of our design

7. IMPLEMENTATION OF SMART RESCUE ROBOT

The working of our proposed model is better understood from the below design flow.

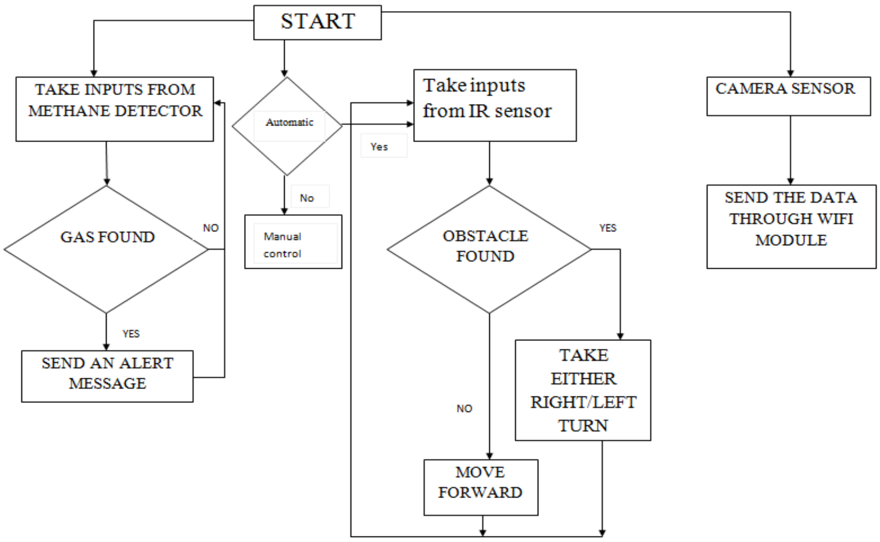

Fig 4: Flow Chart

The IR sensors continuously checks for obstacles which helps our proposed model to move in a particular direction. The situation of the arena is continuously monitored using the web camera connected to myRIO [7]. The Gas and the Temperature sensors continuously checks whether the concentration of Gas, temperature and displays the output in the front panel whether the values are in limit or they are above the threshold level. The main important point to be considered is the model either operates in manual mode or in automatic mode at any instance of time.

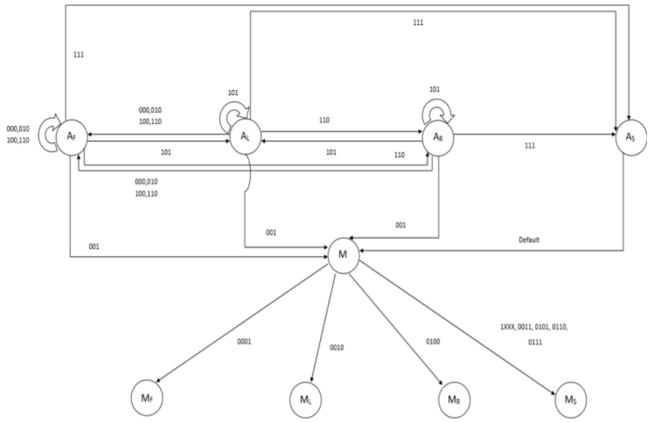

Fig 8: State Diagram of our proposed model

8. RESULTS AND DISCUSSIONS

Each and every part of the software and hardware is successfully tested and integrated to get the required design as per our plan. Our proposed model has followed a clear path by successfully avoiding the obstacles. The video was also acquired successfully from 640x480 pixel web camera.

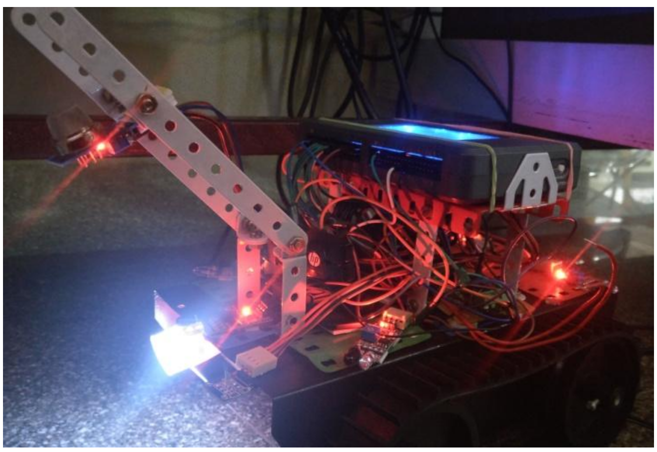

Fig 5: Robot inside the arena

Fig 6: Front Panel during automatic mode

Fig 7: Front Panel in Manual mode of operation

Each IR sensor consumes a current of 6.25mA and the power required to transmit this current is consumes power of 19.9mW. The heating element of Gas sensor requires 800mW of power and to operate this sensor at 5V it requires a minimum current of 160mA.

CONCLUSION

The proposed model thus designed to aid the rescue teams to some extent has succeeded in performing the assigned tasks. The inbuilt Wi-Fi facility is used to transmit the data to the control area outside the arena. Since we can control two myRIO boards using a single front panel, it is of a great help if we employ a network of rescue robots in rescue scenarios. This network of robots if employed in rescue scenarios will definitely decrease the death tolls that occur in hazardous environments and rescue scenarios. By designing small sized robots of such kind these can also be employed in military operations. The structure of these robots is very flexible and also easy to alter so that these can best suited for a wide range of applications.

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