

# Nuclear Power Plant Robots Monitoring and Control Using Lab View

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**Abstract:** Electricity plays a major role in our day to day life. Nuclear power provides a significant portion of current energy demand and is likely to become more wide spread with growing world population. The expulsion of radiation is dangerous to human beings. So this project aims to replace a robot instead of human in nuclear power generation. In this project there are three Robots used namely, Robot A, Robot B and Robot C. These three robots are monitored and controlled by using LabVIEW through Zig BEE transceiver. In nuclear power plant Robot A is used to measure the radiation using Geiger MullerCounter which is integrated with Arduino kit; it reads the signal at regular intervals. These signals are transmitted to Zig BEE transmitter and the Zig BEE receiver receives signal and send them to the LabVIEW through serial communication which are compared with the predefined threshold values. If the measured value is above than the security threshold value, a signal will be sent through DAQ arising an alarm. Robot B is used to the handle the radioactive wastewhich comes from nuclear power generation. Proximity sensor is used to detect the radioactive waste container which is integrated with Arduino kit. After detecting the container LabVIEW sends the command to Robot B through Zig BEE to pick and place the radioactive waste container. Robot C is used to inspect the Pipelines in the nuclear power plant. An ultrasonic sensor is used to inspect the pipelines which are integrated with Arduino kit. If any mechanical damages or corrosion are present in the pipeline, ultrasonic sensor detects these damages. After detecting these problems in pipeline Arduino kit sends this signal to Zig BEE transmitter. A Zig BEE receiver receives the value and sends it to the LabVIEW through Serial communication.

**Keywords:** LabVIEW, Wireless Sensor Network, Arduino kit and DAQ

## 1. INTRODUCTION

Nuclear power plants generate electricity in much the same way that other thermal power plants generate electricity. Nuclear energy service provides clean safe electricity twenty-four hours a day. The combustion of a fuel is used to generate heat, the heat is used to create steam, and the steam is used to spin turbines, which in turn generate electricity. The difference with nuclear power plants is that instead of using the burning of a fuel to generate heat, they use nuclear fission to generate heat. Nuclear fission is the splitting of large atoms into smaller atoms in this process releases huge amounts of electric energy [1].

A nuclear power plant is a thermal power station in which the heat source is a nuclear reactor. As is typical in all conventional thermal power stations the heat is used to generate steam which drives a steam turbine connected to a generator which produces electricity. The conversion to electrical energy takes place indirectly, as in conventional thermal power plants. The heat is produced by fission in a nuclear reactor. Directly or indirectly steam is produced. The pressurized steam is then usually federal to a multi-stage steam turbine. Steam turbines in Western nuclear power plants are among the largest steam turbines ever. After the steam turbine has expanded and partially condensed the steam, the remaining vapor is condensed in a condenser. The condenser is a heat exchanger which is

connected to a secondary side such as a river or a cooling tower. The water is then pumped back into the nuclear reactor and the cycle begins again [2].

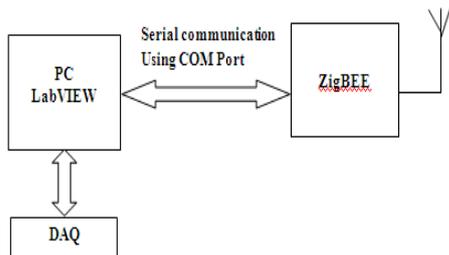
## 2. RELATED WORK

Rashad [3] explained the importance of nuclear energy. Nuclear energy is not only a solution, to have an increasing role as part of the global energy mix. In nuclear power, the main reasons for transformed interest are energy diversity and energy security, carbon emissions and environmental concerns and strong performance record of existing nuclear power plants. In the coming years, nuclear power is used for practice as a source of energy and its number of issues is the main sources for the development of nuclear power generation. Aparana and Sharma [4] described the design and implementation of the robotic automation, process control and interface features of the water jet lancing equipment. Steam generators play an important role in the availability of the plant because it is the critical components of a nuclear power plant. Swain et al [5] have proposed an integrated approach to implementation of computerized monitoring systems within a nuclear power plant is best achieved by distributed processing since diverse users and applications often require the same basic input data. A radiation

monitoring system that exemplifies the application of distributed processing to a broad area of plant operation is described as a first step to integrating plant monitoring functions. Pearce and Rizzie[6] said that CAMAC-based controller for radiation monitoring equipment is described. Due to its use of CAMAC, it can be easily configured for many monitoring and control functions by simply changing modules and software. The controller consists of a partial crate with internal power supplies and battery backup, along with a control and display panel which is hinged to the front of the crate. Typical modules used in the controller include an L2-type serial crate controller, a U-port adaptor to provide redundant serial highways, a microcomputer auxiliary crate controller to provide local intelligence, and input/output modules such as scales, analog-to-digital converters, and output registers. Oh no et al [7] explained in the Fukushima Daiichi Nuclear Power Plant, the authors developed a robotic control vehicle for measuring the radiation. There are a lot of hotspots in the nuclear power plant (over several tens mSv/h). Heavy radiation prevents humans from searching and reconstructing it. It is essential to measure the radiation to ensure worker safety. The developed robotic control vehicle can measure radiation using a  $\gamma$ -cam and TALON with a radiation sensor. The developed robotic control vehicle can realize safe radiation measurement.

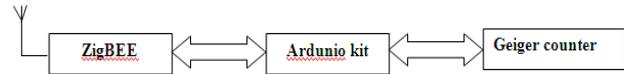
### 3. METHODOLOGY

Nuclear power plant radiation is very harmful to the human body. But robot will work in the hazardous environment and get to inside the plant with sensors and radiation detector. Measuring Radiation level, Object detection and obstacle Inspection signals are transmitted through Arduino kit to Zig BEE transmitter and the Zig BEE receiver receiving the signal and sends through serial communication to PC monitoring through LabVIEW [8,9 and 10]. This Transmission block diagram as shown in 1. Three robots are controlled by LabVIEW through Zig BEE and Arduino kit. Robot A is used to measure radiation which emerges from nuclear power plant. Geiger-Muller Counter is integrated with Arduino kit, it reads the signal at regular intervals the signals are transmitted to the receiver end and compare with the predefined threshold values. If the measured value is above than the security threshold value, its signal sends through DAQ then it will exhibit the alarm. This system is powered by high load internal batteries which ensure a life time of years.

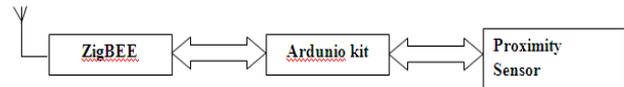


.Fig. 1. Transmission blocks diagram

ROBOT A (MEASURING RADIATION)



ROBOT B (RADIOACTIVE WASTE HANDLING)



ROBOT C (PIPE LINE INSPECTION)

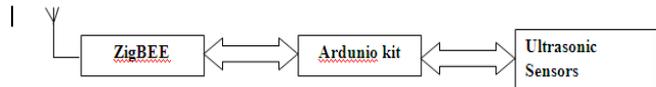


Fig. 2. Receiver blocks diagram

#### 3.1. LabVIEW

LabVIEW is a graphical language as opposed to being text-based. Execution is determined by a graphical block diagram as opposed to the order in which the code is written. This language is a dataflow language, which means that a piece of code only executes when there is data present on each input. This type of language is highly multithreaded and supports parallelism. Every object in LabVIEW is represented by an icon. These icons are located on menus called palettes. In order to place an object on the block diagram, an icon is dragged from the palette and dropped onto the diagram. In programming terms, each icon represents an instance of a particular class. Only when an object has data on all its inputs will it perform an operation. In the block diagram, variables and data are passed through wires. Each wire represents a particular data type, such as strings, chars, or arrays. If two wires of conflicting data types are connected together, the wire is said to be broken and the program will not run.

Each program in LabVIEW is called a Virtual Instrument or VI. Each VI contains three parts, a front panel, a block diagram, and a connector pane. Each VI can run separately or it can be part of a larger program. One VI may contain several other VIs. Controls and indicators on the VI's front panel allow information to be passed into or retrieved from the program. Once the programmer has a clear idea of how data is moving. These might be either variable those that might change their values during the course of the program or constants, which remain fixed. Once the inputs are identified, place the icon that processes these inputs to give an output. If the input is variable, then a control such as a knob, slider or switch is placed on the front panel. This allows the user to vary the inputs as if in a real instrument. Now, the output of a signal icon might not be sufficient [11].

#### 3.2. WSN

The NI Wireless Sensor Network (WSN) platform delivers the flexibility to connect to a wide range of sensors for a variety of monitoring, testing, and measurement applications [12 and 13]. National Instruments has worked with a number of industry-leading sensor suppliers to

make it even easier to configure and deploy wireless sensing solutions for applications such as monitoring the environment, water quality, power consumption, and resource usage. For each sensor listed below, National Instruments has tested its compatibility with the NI WSN platform. Each application note documents how to connect and use the sensor with the NI WSN nodes, and includes LabVIEW example code to illustrate the use of the sensor with NI WSN [14]

### 3.3. ARDUINO KIT

The Arduino is a programmable microcontroller board that has several analog inputs and digital IO lines. The Arduino language is text based and is used to create embedded programs which you download to the board. The Arduino's claim to fame is that all of the hardware and software is open source. The Arduino is an open-source microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs) and 6 analog input. It contains everything needed to support the microcontroller, and it can be simply connected to a computer with a Universal Serial Bus (USB) cable to get started. Alternatively, a more advanced implementation Arduino Mega2560 can be chosen with more input/output pins (54 pins compared to 14 pins of Arduino Uno). The design described here is compatible with other Arduino boards including the Arduino Mega2560. Arduino kit has been shown in Fig3.5 Arduino kit [15].The Arduino Uno can be programmed with the Arduino Integrated Development Environment (IDE) software based on the Processing IDE. The C-based simple program code for the Arduino is referred to as a sketch. Collections of sketches for specific functionalities are referred to as libraries, often simplifying the programming task of the end-user hiding the code inside the libraries. The Arduino can be programmed within the limitations of the 32 KB memory and the processing power of the microcontroller. Arduino can function autonomously without being connected to a computer, or alternatively programmed to respond mainly to commands sent from the computer via various software interfaces or to the data acquired from the input channels. Additionally, the Arduino can be programmed and controlled via third-party programming environments such as Splash. The hardware functionality of Arduino can be extended with external plug-ins referred as shields commercially manufactured or created by the user.



Fig. 3. Arduino kit

### 3.4.DAQ

A DAQ systems capture, measure, and analyze physical phenomena from the real world. Light, temperature, pressure and torque are examples of the different types of signals that DAQ system can measure. Data acquisition is the process of collecting and measuring electrical signals from transducers and test probes or fixtures, and sending them to a computer for processing. Data acquisition can also include the output of analog or digital control signals. Transducer a device that converts a physical phenomenon such as light, temperature, pressure, or sound into a measurable electrical signal such as voltage or current. Signal. The output of the DAQ system transducer. Signal conditioning Hardware that you can connect to the DAQ device to make the signal suitable for measurement or to improve accuracy or reduce noise. The most common types of signal conditioning include amplification, excitation, linearization, isolation, and filtering. DAQ hardware used to acquire, measure, and analyze data. DAQ has been shown in Fig 4. Software NI application software is designed to help you easily design and program measurement and control applications [16 and 17].



Fig.4. DAQ Kit

## 4. RESULTS AND DISCUSSION

LabVIEW ties the creation of user interfaces called front panels into the development cycle. LabVIEW programs/subroutines are called virtual instruments (VIs). Each VI has three components a block diagram, a front panel, and a connector panel. Block diagram contains graphical source code which automatically assigns an appropriate block in the front panel. The front panel contains a menu bar Select Robot A from the menu bar and give commands left, right, forward and reverse. In a nuclear power plant, Robot A will act accordingly to the command given by LabVIEW through Zig BEE transmitter. Zig BEE receiver is connected to the receiver pin of the Arduino kit and mechanical setup of robot A is connected to the parallel port of Arduino kit. Robot A is used to measure the radiation using Geiger Muller Counter which is also integrated with Arduino kit; it reads the signal at regular intervals. These signals are transmitted to Zig BEE transmitter which is connected with transmitter pin of Arduino kit and the Zig BEE receiver receives these signals and sends them to the LabVIEW through serial communication which will be compared with the

predefined threshold values. If the measured value is above than the security threshold value, a signal will be sent through DAQ which results in an alarm. In front panel give a command right and set threshold value = 5Bq (Becquerel).When the value above 5Bq an alarm will turn on.

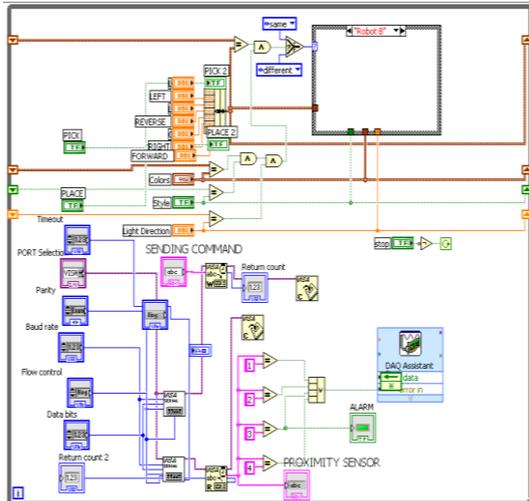


Fig.5. Graphical source code of Block diagram for Robot A

Block diagram contains graphical source code which automatically assigns an appropriate block in the front panel. Select Robot B from Front panel menu bar. In nuclear power plant, Robot B will act accordingly to the command given by LabVIEW through Zig BEE transmitter. Zig BEE receiver is connected to the receiver pin of the Arduino kit and mechanical setup of robot B is connected to the parallel port of Arduino kit. Robot B is used to handle the radioactive waste which comes from nuclear power generation. The proximity sensor is used to detect the radioactive container which is integrated with Arduino kit. After detecting the radioactive waste container, LabVIEW sends the command to Robot B through Zig BEE to pick and place the radioactive waste container

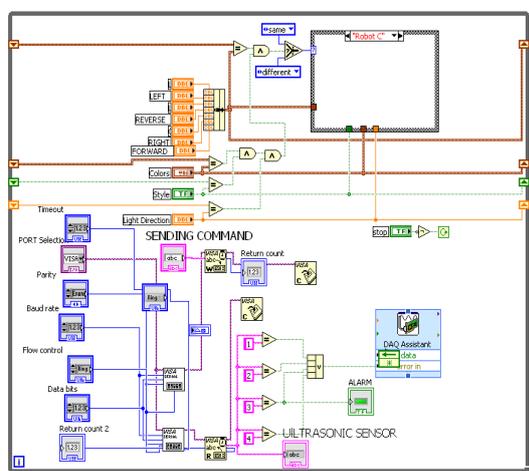


Fig. 6. Graphical source code of Block diagrams for Robot B

Block diagram contains graphical source code which automatically assigns an appropriate block in the front panel. Select Robot C from Front panel menu bar. In nuclear power plant Robot C will act accordingly to the command given by LabVIEW through Zig BEE transmitter. Zig BEE receiver is connected to the receiver pin of the Arduino kit and mechanical setup of robot C is connected to the parallel port of Arduino kit. Robot C is used to inspect the Pipelines in the nuclear power plant. An ultrasonic sensor is used to inspect the pipelines which are integrated with Arduino kit. If any mechanical damages or corrosion are present in the pipeline, an ultrasonic sensor detects these damages. After detecting these problems in pipeline, Arduino kit sends this signal to Zig BEE transmitter. A Zig BEE receiver receives the value and sends it to the LabVIEW through Serial communication.

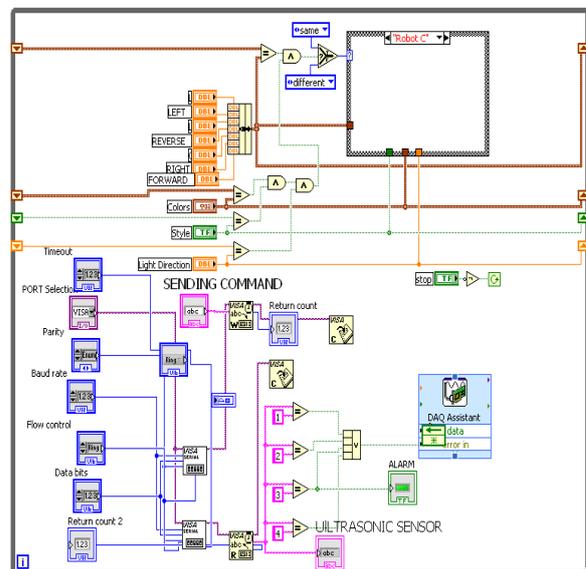


Fig.7. Graphical source code of Block diagram for Robot C

### 5. CONCLUSION

Nuclear energy is the explosive of radiation. These radiations are very harmful for the human body damaging the cells of the body. It not only makes people sick but even causes death people are exposed to the nuclear radiation. And also the disadvantage of nuclear power plant is handling of radioactive waste and inspection of pipeline in nuclear power plant. In nuclear science, protection of workers became a catalyst for the development of robotics. The most advantage of this thesis is to replace robot instead of human. In nuclear power plant Robot A measured the radiation using Geiger Muller Counter. Robot B was used to pick and place the radioactive waste container. Proximity sensor was used to detect the radioactive waste container which was integrated with Arduino kit. After detecting, LabVIEW sent the command to Robot B pick and place the radioactive waste container. Robot C was used to inspect the pipeline in nuclear power plant. Mechanical damages

or corrosion were present in the pipeline, the ultrasonic sensor detected these damages. The LabVIEW simulation of these robots gave good results, so it can be implemented practically in nuclear power plant. The main use of a human-like a robot is will able to work in the extremely dangerous situation. The main advantage of the robot is to perform automated and repetitive work or to execute hazardous tasks that are dangerous to human beings.

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