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INTELLIGENT MONITORING FOR POWER PLANT REACTOR USING WIRELESS SENSOR NETWORK

S.ASHWIN — ECE DEPT, KLNCIT
S.ASHOK RAJ — ECE DEPT, KLNCIT
K.MOHAMMED HABISH ALI — ECE DEPT, KLNCIT
ashwath9606@gmail.comashokrajsundaram@gmail.comhafizali537.ha@gmail.com

ABSTRACT-The Project Titled "INTELLIGENT MONITORING OF POWER PLANT REACTOR USING WIRELESS SENSOR NETWORK". In the competitive world of power plants, the operations and maintanence are done in manual ways, in spite of that the technical staffs are seeking high costs which leads with increase in economic level with low productivity from the power plants. So there is a implementation of automation networks using wireless sensors which are results in lowering the usage of labors in this world of technology. The configuration management of cooling valves in the power plants are mainly focused by providing the technical means of monitoring components in power plants that are only routinely monitored through automation. The wireless-enabled valve indicators that are the subject of this paper are able to provide a continuously available, rather than periodically available, valid indication. The high grade of production results in emission of heat which creates a hazardous effect on the labors of power plants, due to the reason of effect, the implementation of automation in the valve system makes easier, which results in the high productivity with increase in maintanence and operation.

Keywords-configuration ,automation, operation, maintanence.

I. INTRODUCTION

The power plant is a industrial facility implemented for the generation of electric power. There are two types of power plants based on their resources. They are renewable and non-renewable power plants. Now we are considering only about the non-renewable power plants. The non-renewable resources such as coal, fossil fuels, natural gas etc.. When the electricity is generated from the power plant, there is a large emission of heat. To avoid the heat emission, the coolant system is provided with configuration management.To improve the plant competitive position among the industries, the industry must focus on reducing the embedded workload in the ongoing operation and support of PPs. One of the ways to enhance operational efficiency of PPs is to leverage advancements in sensor and wireless communication technologies. In accordance with standards configuration management consists of five elements, including (1) configuration management planning, (2) configuration identification, (3) change control, (4) configuration status accounting, and (5) configuration audit.

One of the essential sub-elements of configuration management is data management.Plant configuration control ensures that changes to the PP and systems are properly identified. This capability can benefit the nuclear industry by reducing labor costs,reducing radiation dose, reducing nuclear and personnel safety challenges, and

improving plant and regulatory performance. Inadequate configuration management can result in the inability to perform safety and non-safety actions as needed. An example of inadequate configuration management includes not having the right information available to the right people and systems at the right time and in the right format. This could lead to human errors with potentially significant safety and economic consequences. In the current operating model of NPPs, plant configuration.Management is highly dependent on a large technical staff. This dependency is caused by NPPs having a large number of systems with many operations that are manually performed. Work processes tend to be fairly complex due to nuclear quality and documentation requirements. NPPs conduct substantial number of surveillance activities on an ongoing basis to verify NPP components are in their required positions (e.g., open/close, on/off, etc.) for current and upcoming NPP configuration.Most NPP manipulations have to be verified by second person and sometimes even a third person in high-risk situations.With rising labor costs, this puts nuclear energy at somewhat of a long-term economic disadvantage compared to non-nuclear energy generation sources. Dependence on a large technical staff also presents human error opportunities, regulatory compliance impacts, and personnel safety hazards.

II. LITERATURE SURVEY

1.Applications of Wireless Technologies in fault detection and diagnosis methods in nuclear power plants
Wireless sensors are becoming very popular in industrial processes for measurement and control, condition monitoring, predictive maintenance, and management of operational transients and accidents. In the last five years, many sensor manufacturers have teamed up with companies who make wireless transmitters, receivers, and network equipment to provide industrial facilities with integrated networks of wireless sensors that can be used to measure process temperature, pressure, vibration, humidity, and other parameters to improve process safety and efficiency,

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increase output, and optimize maintenance activities. Historically, the nuclear industry has been slower than others in implementing new technologies - wireless technologies are no exception. This is of course justified, as nuclear research and power reactors must perform a more thorough "due diligence" than other industries before they can adopt a new technology because of the increased safety and requirements.This paper reports on a research and development (R&D) effort sponsored by the U.S. Department of Energy (DOE) under the Small Business Innovation Research (SBIR) program to implement wireless sensors for equipment condition monitoring and other applications in nuclear power plants.

2. Intelligent plant configuration management using wireless sensors:

Plant configuration management is an essential element of power plant (PP) design, construction, and operation. In the current operating model of PPs, plant configuration management is highly dependent on large technical staffs. This dependency is because PPs have a large number of systems and most operations are manually performed. Work processes tend to be fairly complex due to nuclear quality and documentation requirements. PPs conduct a substantial number of ongoing surveillance activities to verify that plant components are in their required positions (open/close, on/off, etc.) for current and upcoming plant configuration. This puts nuclear energy at somewhat of a long-term economic disadvantage compared to non-nuclear energy generation sources with rising labor costs. Also, it presents human error opportunities, regulatory compliance impacts, and personnel safety hazards. Furthermore, some of these components are located in radiation control zones and result in dose to the surveillance personnel, thereby creating potential nuclear safety hazards.

Technology can play a key role in PP configuration management in offsetting labor costs by automating manually performed plant activities, such as determining the current state of equipment and process parameters. Alternatively, current PP instrumentation and control systems are approaching their end-of-life and are facing age-related issues, which presents opportunity to upgrade the systems to reduce dependence on manual activities.

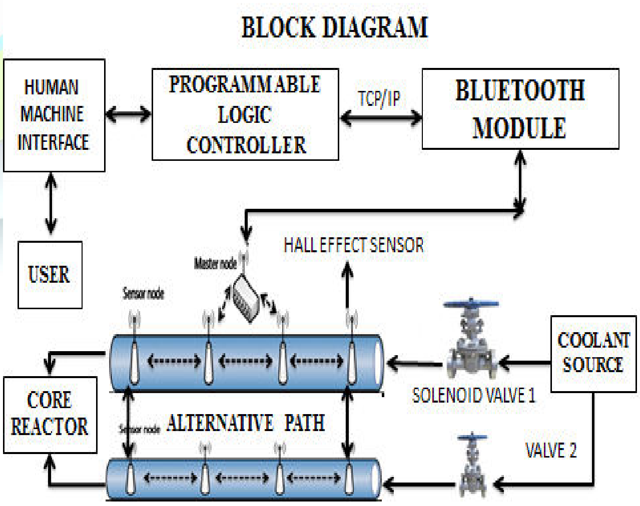
3. Internet of Things: A survey on enabling technologies, protocols, and applications:

A growing number of physical objects are being connected to the Internet at an unprecedented rate realizing the idea of the Internet of Things (IoT). A basic example of such objects includes thermostats and HVAC (Heating, Ventilation, and Air Conditioning) monitoring and control systems that enable smart homes. There are also other domains and environments in which the IoT can play a remarkable role and improve the quality of our lives. These applications include transportation, healthcare, industrial automation, and emergency response to natural and man-made disasters where human decision making is difficult. The IoT enables physical objects to see, hear, think and perform jobs by having them —talk together, to share information and to coordinate decisions. The IoT transforms these objects from being traditional to smart by exploiting its underlying technologies such as ubiquitous and pervasive computing, embedded devices, communication technologies,

sensor networks, Internet protocols and applications. Smart objects along with their supposed tasks constitute domain specific applications (vertical markets) while ubiquitous computing and analytical services form application domain independent services (horizontal markets), the overall concept of the IoT in which every domain specific application is interacting with domain independent services, whereas in each domain sensors and actuators communicate directly with each other.

III. METHODOLOGY

The coolant from the source are entering into the solenoid valve 1 which are connected to the sensor. The sensors are connected in start logic and this sensors are controlled by the master node of microcontroller. The monitoring unit of prototype consists of Bluetooth module, the information from the module are passed to the PLC ladder logic with the protocol of IP, which is interconnected to human machine interface(HMI), which interfaces the user and the Bluetooth module. The signals from the user are retransmitted to the Bluetooth which controls the sensor connected with the microcontroller. When the critical signal is received to the controller, the solenoid valve 2 gets opened with the simultaneous closing of solenoid 2, which reduces the emission of heat in the reactor core.



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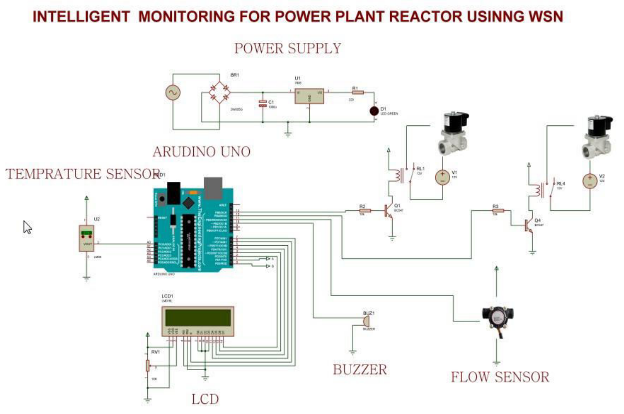

IV. HARDWARE DESCRIPTION

1.ARDUINO:

Fig: Arduino Uno

Overview the Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Summary:

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Table 2.1 Description Of Arduino

Vin: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator and can damage your board. We don't advise it.

3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

GND: Ground pins.

Memory:

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

2.BLUETOOTH MODULE

HC-05 module is an easy to use **Bluetooth SPP (Serial Port Protocol) module**, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This serial port Bluetooth module is fully qualified **Bluetooth V2.0+EDR (Enhanced Data Rate)** 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses **CSR Blue core 04**-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

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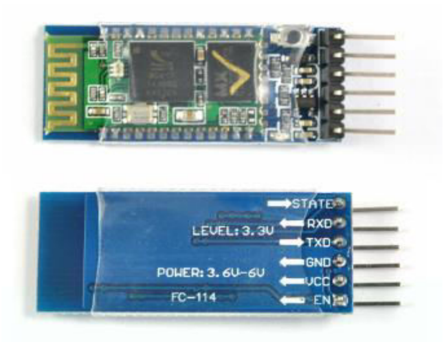

Fig. Bluetooth module

Hardware Description

- Up to +4dBm RF transmit power.
- 3.3 to 5 V I/O.
- PIO(Programmable Input/Output) control.
- UART interface with programmable baud rate.
- With integrated antenna.
- With edge connector.

Software Features

- Slave default Baud rate: 9600, Data bits:8, Stop bit:1,Parity:No parity.
- Auto-connect to the last device on power as default.
- Permit pairing device to connect as default.
- Auto-pairing PINCODE:"1234" as default.

Pin Description:

Vcc:

Supply Voltage 3.3V to 5V
GND:
Ground pin
TXD & RXD:
These two pins acts as an UART interface for communication
STATE:
It acts as a status indicator.When the module is **not connected to paired** with any other bluetoothdevice,signal goes **Low**.At this **low state**,the **led flashes continuously** which denotes that the module is **not paired** with other device.When this module is **connected to/paired** with any other bluetooth device,the signal goes **High**.At this **high state**,the **led blinks with a constant delay** say for example 2s delay which indicates that the module.

3.RELAY:

All relays contain a sensing unit, the electric coil, which is powered by AC or DC current. When the applied current or voltage exceeds a threshold value, the coil activates the armature, which operates either to close the open contacts or to open the closed contacts. When a power is supplied to the coil, it generates a magnetic force that actuates the switch mechanism.
On/Off Control: Example: Air conditioning control, used to limit and control a "high power" load, such as a compressor
Limit Control: Example: Motor Speed Control, used to disconnect a motor if it runs slower or faster than the desired speed
Logic Operation: Example: Test Equipment, used to connect the instrument to a number of testing points on the device under test

TYPES OF RELAYS

There are two basic classifications of relays: Electromechanical and Solid State. Electromechanical relays have moving parts, whereas solid state relays have no moving parts.

5.YF-S201 Hall Effect Sensor:

Fig 2.8.1 Flow sensor

This sensor sits in line with your water line and contains a pinwheel sensor to measure how much liquid has moved through it. There's an integrated magnetic hall effect sensor that outputs an electrical pulse with every revolution. The hall effect sensor is sealed from the water pipe and allows the sensor to stay safe and dry.

Pulse frequency (Hz) / 7.5 = flow rate in L/min.

Features:

- Model: YF-S201
- Sensor Type: Hall effect
- Working Voltage: 5 to 18V DC (min tested working voltage 4.5V)
- Max current draw: 15mA @ 5V
- Output Type: 5V TTL
- Working Flow Rate: 1 to 30 Liters/Minute
- Working Temperature range: -25 to +80℃
- Working Humidity Range: 35%-80% RH
- Accuracy: ±10%

Connection details:

- Red wire : +5V
- Black wire : GND
- Yellowwire : PWM output.

4.BUZZER:

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A **buzzer** or **beeper** is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system.

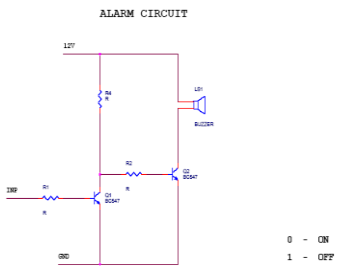


Fig: Buzzer

CIRCUIT DESCRIPTION

The circuit is designed to control the buzzer. The buzzer ON and OFF is controlled by the pair of switching transistors (BC 547). The buzzer is connected in the Q2 transistor collector terminal.

When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and close the collector and emitter terminal so zero signals is given to base of the Q2 transistor. Hence Q2 transistor and buzzer is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and buzzer is energized and produces the sound signal.

6.LIQUID CRYSTAL DISPLAY:

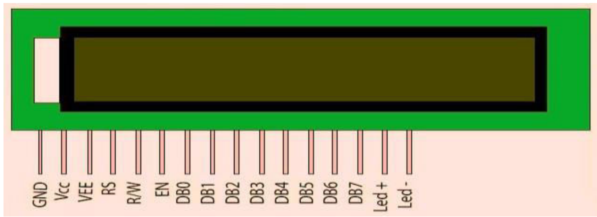
The LCD is a commonly used alphanumeric dot matrix liquid crystal display (LCD) controller developed. The control interface and protocol is a de-facto standard for this type of display. The character set of the controller includes ASCII characters, Japanese Kana characters, and some symbols in two 28 character lines. Using an extension driver, the device can display up to 80 characters.

Fig: Liquid crystal display

The LCD is limited to monochrome text displays and is often used in copiers, fax machines, laser printers, industrial test equipment, networking equipment, such as routers and storage devices.

Compatible LCD screens are manufactured in several standard configurations. Common sizes are one row of eight characters (8x1), and 16×2, 20×2 and 20×4 formats. Larger custom sizes are made with 32, 40 and 80 characters and with 1, 2, 4 or 8 lines. The most commonly manufactured larger configuration is 40x4.

PIN DESCRIPTION



1. Ground
2. VCC (+3.3 to +5V)
3. Contrast adjustment (VO)
4. Register Select (RS). RS=0: Command, RS=1: Data
5. Read/Write (R/W). R/W=0: Write, R/W=1: Read (This pin is optional due to the fact that most of the time you will only want to write to it and not read. Therefore, in general use, this pin will be permanently connected directly to ground.)
6. Clock (Enable). Falling edge triggered
7. Bit 0 (Not used in 4-bit operation)
8. Bit 1 (Not used in 4-bit operation)
9. Bit 2 (Not used in 4-bit operation)
10. Bit 3 (Not used in 4-bit operation)
11. Bit 4
12. Bit 5
13. Bit 6
14. Bit 7
15. Backlight Anode (+) (If applicable)
16. Backlight Cathode (-) (If applicable)

Operations of LCD

1. First, set D7..D4 to 0b0011, and toggle the enable bit. From State1, the LCD will see the command as 0b0011_0000, and thus remain in 8-bit mode (State1). From State3, the LCD will see the command as 0b0011_xxxx (where xxxx are unknown bits) -- which still sets the LCD to 8-bit mode (State1). From State2, the bits are simply latched as the values for D3..D0 (State3). Therefore, after this, the HD44780 can only be in State1 or State3.
2. Next, set D7..D4 to 0b0011 again, and toggle the enable bit. From State1, the LCD will again remain in 8-bit mode, as noted above. From State2, the LCD will see the command as 0b0011_0011, which sets the LCD to 8-bit mode. Therefore, after

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second command, the HD44780 is guaranteed to be in 8-bit mode (State1)

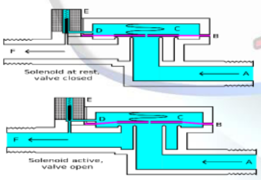
3. Now that the LCD is ensured to be set to 8-bit mode, it is safe to request that it change to 4-bit mode. To do so, set D7..D4 to 0b0010, and toggle the enable bit. The LCD will see the command as 0b0010_0000, which will change it to use 4-bit command mode. Therefore, after this third command, the HD44780 can only be in 4-bit command mode.
4. Finally, it should be noted that this sets the LCD to single-line mode, using standard 5x8 fonts, so additional FUNCTION SET commands may be needed to fully initialize the display.

Once in 4-bit mode, character and control data are transferred as pairs of 4.

SOLENOID VALVE

Fig:Solenoid Valve

Solenoid valve is a control units which, when electrically energized or de-energized, either shut off or allow fluid flow. The actuator takes the form of an electromagnet. When energized, a magnetic field builds up which pulls a plunger or pivoted armature against the action of a spring. When de-energized, the plunger or pivoted armature is returned to its original position by the spring action.



1) 2.6.1 Operation Solenoid Valve

To the mode of actuation, a distinction is made between direct- valves, internally piloted valves, and externally piloted valves. A further distinguishing feature is the number of port connections or the number of flow paths ("ways").

Types

Many variations are possible on the basic, one-way, one-solenoid valve described above:

- ➢ one- or two-solenoid valves
- ➢ direct currentor alternating current powered
- ➢ different number of ways and positions

7. POWER SUPPLY:

Power supplies or power supply units, PSU, form an essential part of very many items of electronics equipment.

The most common form takes in AC power from the mains supply and delivers a DC voltage to the item requiring power.

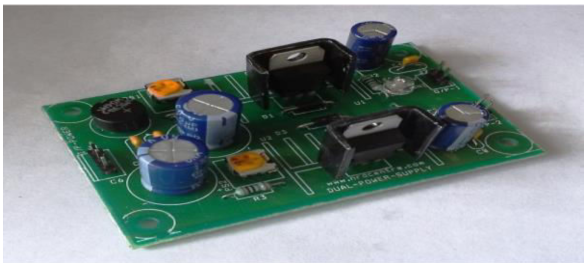


Fig: Power Supply

Accordingly power supplies are widely used in a variety of forms - some large supplying high levels of current, other power supplies, much smaller providing lower levels of power.

LINEAR POWER SUPPLY MERITS / DEMERITS

PSU MERITS

- **Low noise:** The use of the linear technology without any switching element means that noise is kept to a minimum and the annoying spikes found in switching power supplies are now found.

PSU DEMERITS

Efficiency: In view of the fact that a linear power supply uses linear technology, it is not particularly efficient. Efficiencies of arounduncommon, and under some conditions they may offer much lower

V. RESULT

The proposed leak detection method is based on the relative pressure change profile in the pipe; therefore it is unnecessary to calibrate the sensors. Raw data from the sensors in laboratory tests are illustrated in Figure 10. As can be seen from this figure four main phases of the experiment (pump start, stabilization, leak, pump off) are clearly visible from the output of the pressure sensors. These include the pressure before the pump was switched on, the increase in pressure when the pump was switched on, the drop in pressure due to the development of the leak and finally the drop in pressure due to the switching off of the pump (shortly after development of the leak). Also lays the foundation toward achievingadditional increased efficiency and reduced cost, which are consistent with the goals of Delivering the Nuclear Promise Initiative. The results of this work will allow operators to make better or more-informed decisions. This work demonstrates an opportunity to train the next generation of the nuclear workforce with the advantage of advanced sensor and wireless communication technologies.

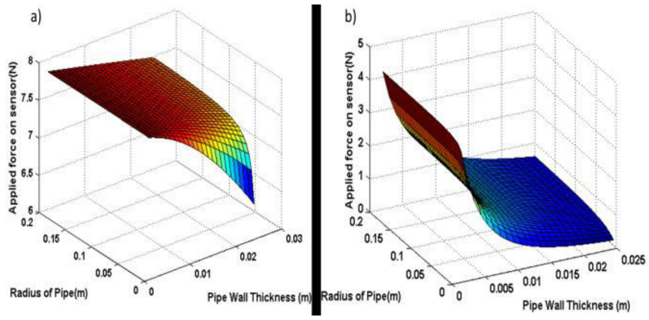


Fig: Resultant force on the Valve 1and Valve 2

VI. CONCLUSION

This Paper highlights that remote monitoring of cooling system using wireless sensors would benefit the nuclear industry in several ways, including reduced labor costs, reduced radiation dose, reduced nuclear and personnel safety challenges, and improved regulatory performance. The results of this work lay the foundation for automation of manual operation in an PP's and impact a wide range of manual activities, including field worker activities, online monitoring, PP's outages, and control room operation. Also lays the foundation toward achieving additional increased efficiency and reduced cost, which are consistent with the goals of Delivering the Nuclear Promise Initiative. The results of this work will allow operators to make better or more-informed decisions. This work demonstrates an opportunity to train the next generation of the nuclear workforce with the advantage of advanced sensor and wireless communication technologies.

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