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AI-Driven Factory Robot Remote Control Monitoring Equipment Using Machine Learning and Cloud-Based System

Anas Ahmed Nicola[1*]

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ABSTRACT

Researcher on this study suggest robot agent work builds remotely, works in the system with cloud-based system for remote monitoring and control system in the domains of industrial automation and intelligent scenarios. The system is based on Xbee architecture, and clients can access it anytime and anywhere. Clients can remotely monitor and control the testing machine in real time through the cloud. After experimental verification, the real-time monitoring and control messages delay is 5 sec, which can meet the actual needs of remote. This remote monitoring agent control system fixed to the server control system, can improves the automation of the machine. And improves the working environment of the experimenters. Researcher on this survey used virtual software remotely Arduino board controlling the system implying a broader connectivity and integration between decentralized industrial and business.

INTRODUCTION

In recent years, the utilization of cloud technology has witnessed a surge, particularly in the domains of industrial automation and intelligent scenarios and due to the development, that occurs in the technologies in information systems, many techniques were introduced and played an important role in the connection between machines and people through the internet, it is also used to control and monitor equipment. With the replacement of computing resources with manufacturing resources cloud computing named converted into cloud manufacturing (Yin, Li, & Zhou, 2014). Cloud computing is coming into development step by step recently. The activity of the executive methods of the cloud computing can be acquired in the assembling field, which can be an original thought for the information development for the assembly ventures, therefore the idea of the cloud manufacturing is placed forward. Based on the network with manufacturing and cloud computing, the cloud manufacturing is characterized as a server. The cloud manufacturing is a novel arranged assembling mode which uses the internet and the cloud manufacturing stage, sorts out different sorts of manufacturing assets (to be specific the manufacturing cloud web), and gives clients a wide range of services for their requests. the internet of things, and so on, to give each manufacturing action high quality and low-cost services whenever and anyplace on demand (Wang, 2013). The board, and strategic applications. An assembling organization can require the assets and administrations in the cloud fabrication stage alongside a compensation as-you-go evaluating approach (Caggiano, Segreto, & Teti, 2016). Information and communication technologies to ultimately realize the value creation networking of smart machines, products and systems, across different industrial sectors (Esmaeilzadeh, 2021). As a multi-viewpoint platform, Industry 4.0 applies to a wide range of applications driven by ICT that unifies the design and implementation of automation and data exchange in manufacturing business. It leads to performance improvement from strategy level to process level through the digital transformation as an industry agnostic driver. It must be noted that major intrinsic concepts of Industry 4.0 are envisioned for smart manufacturing and operation efficiency which is a tremendous scope of research and development and is beyond the discussions of this thesis work. The industry 4.0 components like machines, products, systems are called Cyber Physical Systems (CPS) which rely on embedded systems technology to interlink the abstraction of physical process dynamics with the abstraction related to transforming data. The embedded systems monitor and control the physical processes and the process, in turn, affects the computations. The vision of Industry 4.0 is using internet for coordination and networking of the CPS to establish systems of Machine-to-Machine communication and Human-Machine interactions although CPS did not originally depend on the internet protocols and standards (Pereira, 2009). This view is in the direction of enhancing the collaboration of cyber physical systems to act as System of Systems (SoS) model .In SoS point of view, the CPS provides an infrastructure to access the components flexibly from product level to the connected world. For decades, many industrial applications such as remote monitoring and control were implemented based on Machine-to-Machine (M2M) communication which were more centralized on devices,

[1] Faculty of Telecommunication, Engineering and Space Technology, Future University, Khartoum, Republic of the Sudan
[*] Corresponding author's e-mail: anasnicola2018@gmail.com

connectivity, and application-specific solutions for certain problems (Salkin *et al.*, 2018). With advances in ICT, the basic M2M solutions are being extended to deploy application-independent devices along with service and Data- driven approaches called Internet of Things (IoT) that are scoped from a certain industrial domain to the entire value chain (Wang, Törngren, & Onori, 2015).

LITRITURE REVIEW

Related Works Remote monitoring and control technology is mainly concentrated in several fields such as industry, agriculture, education, electricity, mining, transportation, smart home, etc. Many scholars have conducted research on this. In the field of mechanical manufacturing, in order to optimize the structure of mechanical systems and improve work efficiency, many scholars have introduced cloud technology into existing systems. Riccardo presents a control-loop performance monitoring system, which obtains remote sensor data in JSON format through the MQTT publish–subscribe mechanism, stores the data in the cloud database, and displays it on the web browser after evaluating the loop status. In case of any abnormality, the system will notify the experimenter via email (Consortium, 2017). Md Tahmid built a cloud-based digital twin framework to monitor and control a remote assembly system. The system uses the MQTT protocol to store sensor data in a Google Cloud database and can send simple control instructions such as start and stop to the robot (Liu *et al.*, 2020).

Liu *et al.* built a cloud-based digital twin manufacturing system, which also uses MQTT to store sensor data in the cloud database. The difference is that this system is based on a local private cloud system. The web browser communicates with the private cloud through RESTful APIs to monitor and control remote devices. Finally, the system delay is 1.24 s. These systems are mainly for monitoring, and their control capabilities are relatively weak. Remote control requires higher real-time performance of the system, but the remote communication capabilities of these systems have not been tested in detail. In the field of engineering and science education, due to the uneven distribution and inaccessibility of educational resources, many scholars have carried out remote experimental research. Students can remotely access experimental equipment, conduct experiments, and complete learning tasks. The remote operating system designed by Stefanuto and Vanegas uses the laboratory computer as a cloud server, opens the port to the public network, and uses a publish–subscribe mechanism to communicate between the web application and the robot server, ultimately realizing remote robot control. Control, the remote communication delay is about 500 ms.Viswanadh proposed a remote laboratory solution, using Blynk Cloud Service as a communication intermediary, using HTTP(S) GET and POST. In the field of actual mechanical reliability experiments, Feng *et al.* developed an ARM-based remote monitoring system for creep testing machines, which consists of an ARM controller, a cloud server, and a client. The ARM controller collects sensor parameters of the creep testing machine through the RS485 bus and uploads them to the database of the cloud server through Ethernet. The database is the bridge between the experimenter and the testing machine. The experimenter can monitor data, configure parameters, and start and stop the remote testing machine by reading and writing the cloud database (Vanegas-Guillén *et al.*, 2023). Hua developed a wireless remote monitoring and control test system based on ZigBee technology and LabVIEW (Hua *et al.*, 2016). The system collects sensor information of equipment through ZigBee wireless, and can realize remote monitoring of the test equipment with the help of local LabVIEW web services, but cannot remotely control it (Kandala *et al.*, 2025) . (Li *et al.*, 2023) built a private cloud on the internal LAN and established web services and SQL server database services on the cloud. The experimenter accessed the database through the website on the public network. (Qi *et al.*, 2022) proposed a multi-channel fatigue test IoT remote monitoring system. The system consists of a cloud platform, a client, and a test server. The cloud platform is responsible for information storage and information communication, and the web client is responsible for monitoring and visual display of real-time data. The system realizes the functions of data collection, online monitoring, and information management of fatigue test equipment. The real-time communication of this system is completed through Ajax short polling and WebSocket, with a polling interval of 1.5 s (Wang *et al.*, 2024). However, this system mainly focuses on the status monitoring of remote devices, and the software architecture of the system is relatively complex (Liu & Xiao, 2021).

Problem statement

The problem is that there are some materials that are not safe to keep workers in touch with it, or the manufacturing process needs the place to be kept clean, such as IC manufacturing and factory equipment, these processes must be remote controlled and manufactured.

Main Objective

The main objective is to simulate a cloud-based factory equipment, to remote control, and monitoring this equipment.

Specific objectives

- Facility for capturing data like energy and ability of the data to be fetched via the network.
- Remote safety precautions and monitoring.
- Data visualization using cloud monitoring platform.
- Reduce and minimize wastage of time, power and effort

MATERIALS AND METHODS

Proteus software will be used to simulate the system of controlling factory equipment wirelessly over cloud network and Arduino microcontroller units. An authenticator signal is sent by the equipment user's controller to the equipment's modem. This signal consists information about the required function and the receiver modem relays this control function to the microcontroller unit which triggers the respective action or sends the status of the equipment to the user controller.

Industrial Internet of Things

System block diagram

As shown in figure 1, the transmitter system consists of Arduino board controlling the system, the sensors data are fed to Arduino to control the process. All the system is controlled via Arduino controller. The block diagram consists of the following components:

- Arduino Controller
- Voltage sensor
- Speed sensor
- Temperature and humidity sensor.
- Gas sensor
- Flame sensor
- Motor and motor driver.
- Display unit.
- Xbee transmitter.

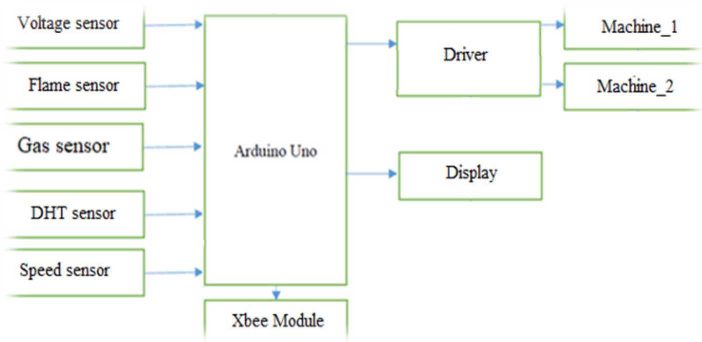

Figure 1: Transmitter block diagram

Figure 1. shows the receiver system which consists of Xbee module, display unit and alarm set for the factory station. The alarm set consists of red and green lamp in addition to buzzer

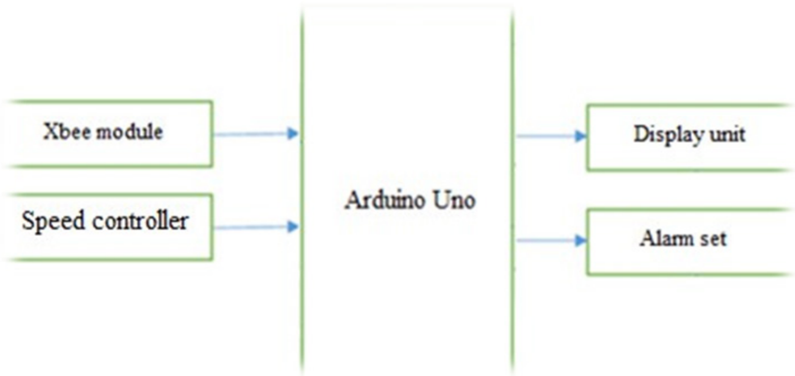

Figure 2: Receiver block diagram

Alert Smart Industrial System Components

As Figure .1 shown the circuit of the system, the circuit consists of the following components.

Arduino Uno

The Arduino Uno is a microcontroller board grounded on the ATmega328.It comprises of 14 digital input/output pins (out of which 6can be utilized as PWM outputs), 6analog inputs, a 16MHz ceramic resonator, a facilitation for USB connectivity, a power jack, an ICSP header, and a reset button. Its designs comprise of assistances that supports the microcontroller in every possible way. In order to get to work with it one has to simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery. It is accessible in two different versions namely Arduino Uno and Genuino Uno. The Uno is unique from all its former boards in the way that it does not make use of the FTDI USB-to serial driver chip. The word "Uno" refers to one in Italian and it is named so to mark the forthcoming release of Arduino 1.0. The Uno and version 1.0 are the reference versions of Arduino in the forward journey. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform. Arduino IDE is open-source software which makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. Interrupts are used in programming to make system more effective and respond to changes accordingly. Arduino is an open-source physical processing element which is based on a microcontroller board and an incorporates development environment for the board to be programmed. Arduino additionally rearranges the methodology of working with microcontrollers; moreover, it offers some advantages for instructors, students, and intrigued individuals such as:

• **Inexpensive** - Arduino boards are moderately cheap compared with other microcontroller boards. The cheapest version of the Arduino module can be amassed by hand, and even the Preassembled Arduino modules cost short of what $50.

• **Cross-platform** - The Arduino programming runs multiple operating systems Windows, Macintosh OSX, and Linux working frameworks.

• **Straightforward,** clear programming method - The Arduino programming environment is easy to use for novices, yet sufficiently versatile for cutting edge customers to adventure as well. For educators, its favorably engaged around the Processing programming environment, sounder studies finding ways to understand how to program in that environment will be familiar with the nature of Arduino.

Open source and extensible programming.
The Arduino program language is available as open source, available for development by experienced engineers. The lingo can be reached out through C++ libraries, and people expecting to understand the specific purposes of different interests can make the leap from Arduino to the AVR C programming language on which it is based. Basically, you can incorporate AVR-C code clearly into your Arduino programs.

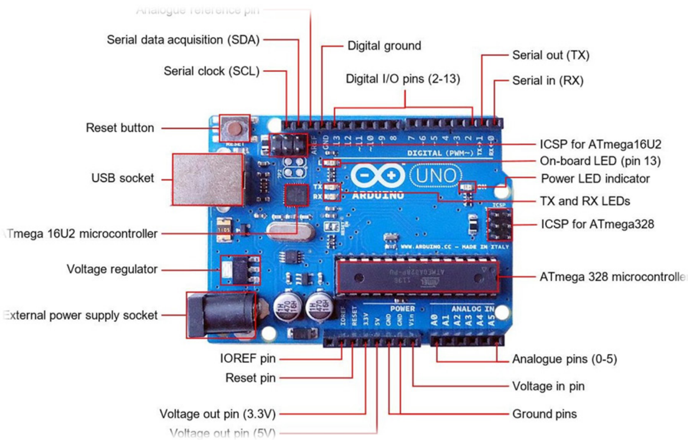

Figure 3: Arduino Uno

System Components

XBee

In WSN every node is wirelessly communicate with each other. Xbee is basically used for this purpose. Many people do believe that ZigBee and Xbee are same. But that is not true. XBee is a Zigbee compliant hardware. ZigBee is a standard communications protocol for low-power, low-throughput, low-cost wireless mesh networking applications, which is built on top of IEEE 802.15.4. XBee is a brand of radio that supports a variety of communication protocols, including Zig-Bee, 802.15.4, and Wi-Fi. There are two basic varieties of XBee radio physical hardware.

XBee Series 1 Hardware

These radios use a microchip made by free scale to provide simple, standards based point-to-point communications, as well as a proprietary implementation of mesh networking.

XBee Series 2 Hardware

The Series 2 uses a microchip from Ember Networks that enables several different flavors of standards-based ZigBee mesh networking.

XBee Transceiver Module

XBee from Digi International is a family of compatible radio modules based on the IEEE 802.15.4 standard designed for point-to-point and star communications. The XBee module is presented in several versions that own similar pin outs but are different in the power output, antenna style, operating frequency and networking abilities. The XBee transceivers afford very reliable, cost effective, and simple communication between the microcontrollers and are supported by sleep mode for extended battery life. The 1 mW XBee adopted in this work operates at 2.4 GH and has at least a range of 30 meters.

Liquid Crystal Display (LCD)

LCDs are used in wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and indoor and outdoor signage. LCD is an Alphabetic Display it means that it can display Alphabets, Numbers as well as special symbols thus LCD is a user-friendly Display device which can be used for displaying various messages unlike seven segment display which can display only numbers and some of the alphabets. The only disadvantage of LCD over seven

Figure 4: X-Bee Series 1 (802.15.4)

Figure 5: LCD

Figure 6: Relay Module

segment display is that seven segment is robust display and can be visualized from a longer distance as compared to LCD. Here we have used 16 x 2 alphanumeric displays.

Relay

a relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems.

Buzzer

Can make it sound a tone at a frequency set. The buzzer produces sound based on reverse of the piezoelectric effect. Piezo electricity is an effect where certain crystals will change shape when apply electricity to them. By applying an electric signal at the right frequency, the crystal can make sound.

Fan

Connect a 5V Brushless DC Fan to your Arduino to create a nice breeze. If want to move a decent amount of air (and avoid creating electrical noise that will interfere with your other electronics, will need to give its own voltage rail and control it with an NPN transistor.

Figure 7: Buzzer

Figure 8: Fan

Digital temperature humidity sensor (DHT11)

The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermostat to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

SNS-DH11 is an implementation of the popular low-cost DHT11 temperature and humidity sensor. It comes with compatible set of short female-female wires with proper headers to make it even easier to connect to any exposed pins of your main development board.

DHT11 has several features, these are:

- Low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy
- Maximum 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm
- 3 pins with 0.1" spacing
- Three female-female jumper wires in different colors included

SNS-DH11 has three pins: + = Power input VCC pin (connect to a source of voltage in the 3V to 5V DC range); OUT = Data output pin (connect to a chosen digital input pin of your main board); = Digital ground VSS/GND pin (connect to GND of the main board).

Flame Sensor

A flame sensor is a crucial safety component on your gas heating system. During the ignition cycle, gas furnace goes through a process where a spark or a hot surface ignitor will actually ignite the gas. As the gas is ignited, the flame sensor creates a current of electricity. The electricity is calculated in micro amps. If the furnace's control board does not read the proper level of micro amps, the furnace will no longer give the system fuel to avoid an explosion. Over time, if the flame sensor is not cleaned properly, oxidation or carbon buildup can restrict the flame sensor's ability to work properly, which can result in a malfunction of the furnace.

Gas Sensor MQ2

As shown in figure The Grove - Gas Sensor (MQ2) module is useful for gas leakage detecting (in home and industry). It can detect H2, LPG, CH4, CO, Alcohol. Based on its fast response time, Measurements can be taken as soon as possible. Also the sensitivity can be adjusted by the potentiometer.

Features of MQ2cSensor can be as following:

- Wide detecting scope
- Stable and long life
- Fast response and High sensitivity
- Application Ideas
- Gas leakage detecting
- Toys

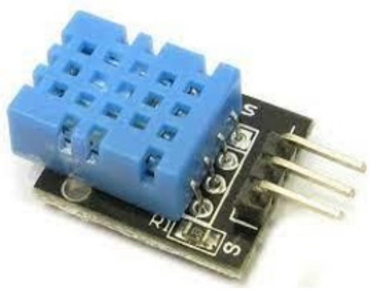

Figure 9: DHT11

Figure 10: Flame Module

Figure 11: MQ2 Sensor

LEDs

A light-emitting diode (LED) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.[5] White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

Software Design

The above detailed description was for the hardware design, the following paragraphs is for software design, that includes Arduino software, Proteus and VSPE.

Arduino program:

The Arduino Uno can be programmed with the Arduino IDE software. The ATmega microcontroller on the Arduino board comes pre-burned with a boot loader that allows user to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. User can also bypass the boot loader and program the microcontroller through the ICSP (In Circuit Serial Programming) header. The Arduino language is implemented in C/ C++ and based in Wiring. When we write an Arduino sketch, we are implicitly making use of the Wiring library, which is included with the Arduino IDE. This allows us to make run able programs by using only two functions setup () function and and loop () function. As mentioned, the Wiring language is inspired by Processing, and the Arduino language structure is inherited from the Processing language, where the equivalent functions are calledsetup (). We need to include both functions in every Arduino program even if we don't need one of them. Let's analyze the structure of a simple Arduino sketch using again the Blink example. Logical Diagram We have a logical diagram for this project. Here android mobile phone works as input signal which start from beginning part. We have got output from electronic devices.

VSPE Software

VSPE is intended to help software engineers and developers to create/debug/test applications that use serial ports. It is able to create various virtual devices to transmit/receive data. Unlike regular serial ports, virtual devices have special capabilities: for example, the same device can be opened more than once by different applications, that can be useful in many cases. With VSPE you are able to share physical serial port data for several applications, expose serial port to local network (via TCP protocol), and create virtual serial port device pairs and so on.

Key features of VSPE Virtual device: connector Virtual device: data splitter Virtual device: pair Mapper device

User mode device: TcpServer User mode device: TcpClient

User mode device: Serial Redirector User mode device: UDP Manager User mode device: Bridge

x86, x86_64 (and arm64 kernel driver) processor architecture support

Figure 12: LEDs

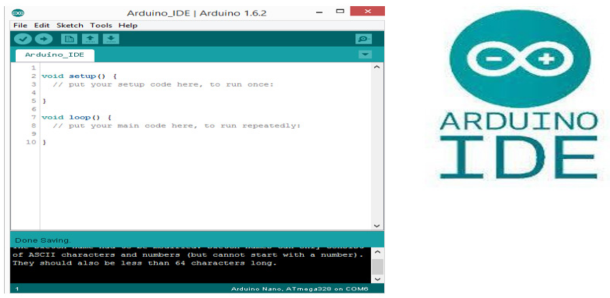

Figure 13: Arduino IDE

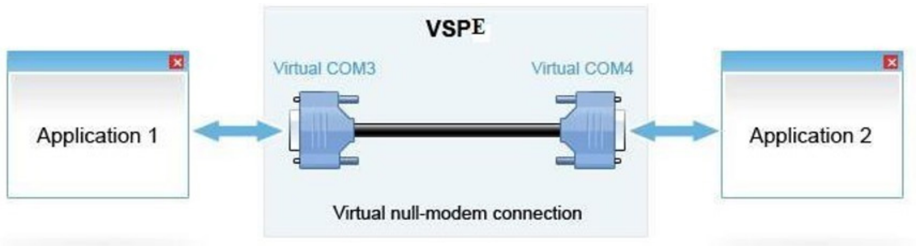

Figure 14:VSPE software

Principle Work of the System

As the flowchart below, system consists of sensors the temperature, flame, gas and humidity. The temperature sensor is used to measure the temperature of the factory where the value of the Sensor is compared with threshold value; this threshold value is defined by the programmer at the time of programming the microcontroller, if it exceeds the provided threshold value.

MATARIALS AND METHODS

The first step in program exclusion is the system initialization, in this step the ESP32 module is connected to internet. If the internet is not connected, then the system try again and again till the connection is established. Then system starts reading data from sensors and decide then if the readings re normal or not, in case of normal readings, the alarm is activated see figure 16 and 17.

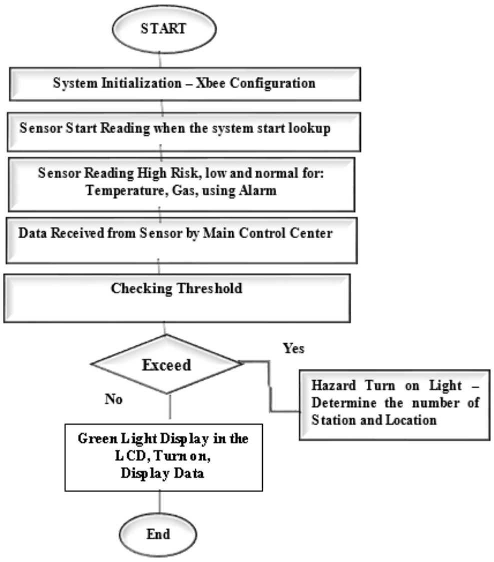

Figure 15: Flow chart

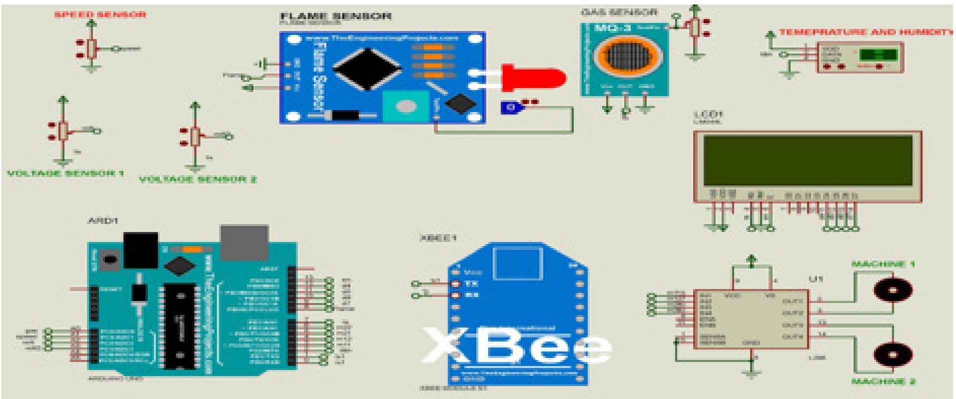

Figure 16: Factory station circuit diagram

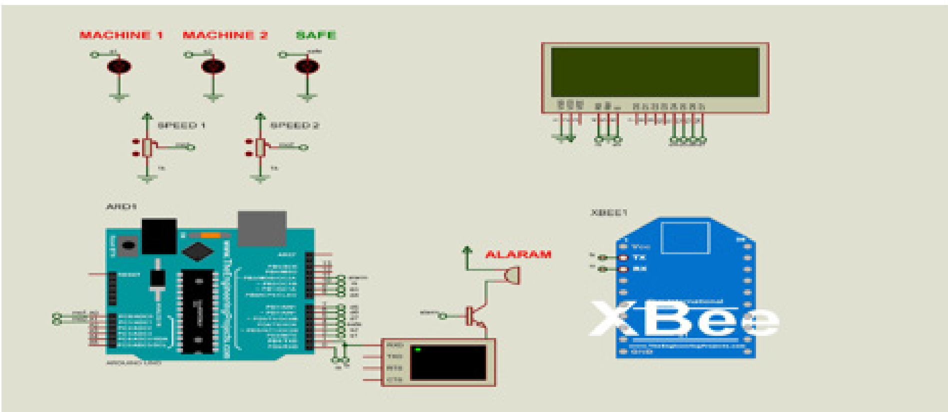

Figure 17:Main station circuit diagram

System Analysis

Parameters and threshold

Table .1 shows the parameters threshold for all sensors of the system, there are seven parameters: gas level %, Flame (1 or 0), temperature C° , voltage1 V, voltage 2 V, humidity % and speed (rpm)). If all parameters are under threshold, so the state is normal or safe and the safe indicator is activated, if any one of the above parameters is abnormal, the state is abnormal and the unsafe indicator is activated.

Table 1: System threshold values

Parameters	Normal	First reading threshold	Second reading threshold	Third reading threshold
Gas %	< 80 %	80 %	90	60
Flame	No	Yes	No	yes
Temperature C°	< 90 C°	90 C°	98 C°	70
Machine 1voltage	< 280 volts	280 volts	290 volts	270 volts
Machine 2 voltage	< 280 volts	280 volt	285 volts	265

Safe State

Figure 18. shows the system response with normal response. The system detects that all sensors (gas, flame and temperature) are normal, there is no fire in the factory. The simulation result is shown in figure 18. In this case the system is working normally that is less than 80 % for gas sensor and less than 90 C for temperature sensor and no flame see Fig 19.

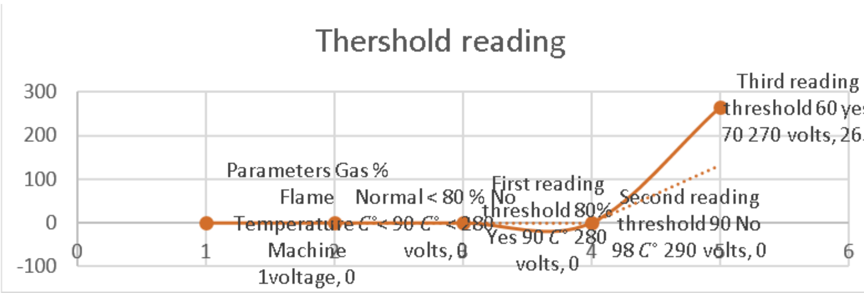

Figure 18: System threshold scan reading value

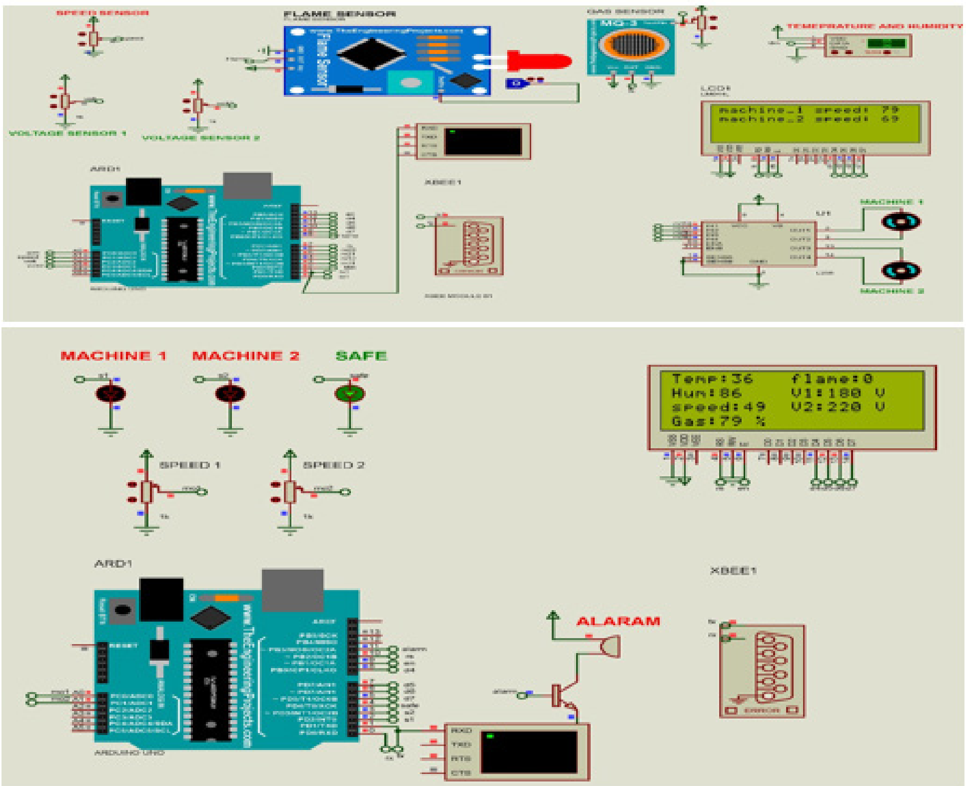

Figure 19. Safe state

The green LED indicates that both machines are safe, if any of the machines aren't safe, the green LED is OFF.

Unsafe state

Figure 19 shows the system response with variation in sensors in the case of up normal reading. There are three cases as follow:

Machine 1 unsafe, Machine 2 unsafe and both Machines unsafe within increase voltages of the threshold.

Machine one unsafe state

The Figure 20. bellow shows unsafe mode for station one, there is overvoltage according to sensor readings. The voltage level is 300 volts as shown in the figure, the red indicator is ON

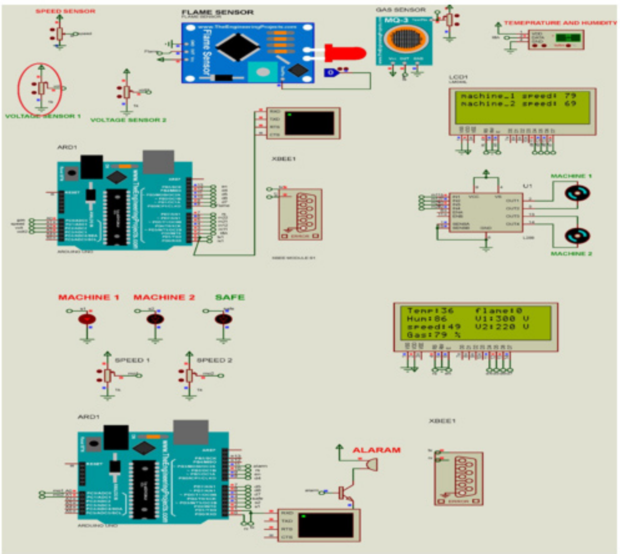

Figure 20: Scenario two machine one unsafe c

Machine two unsafe state

Figure 21. bellow shows unsafe mode for machine two, there is under voltage in machine two according to sensor readings. The voltage level is 300 volts as shown in the figure, the red indicator is ON.

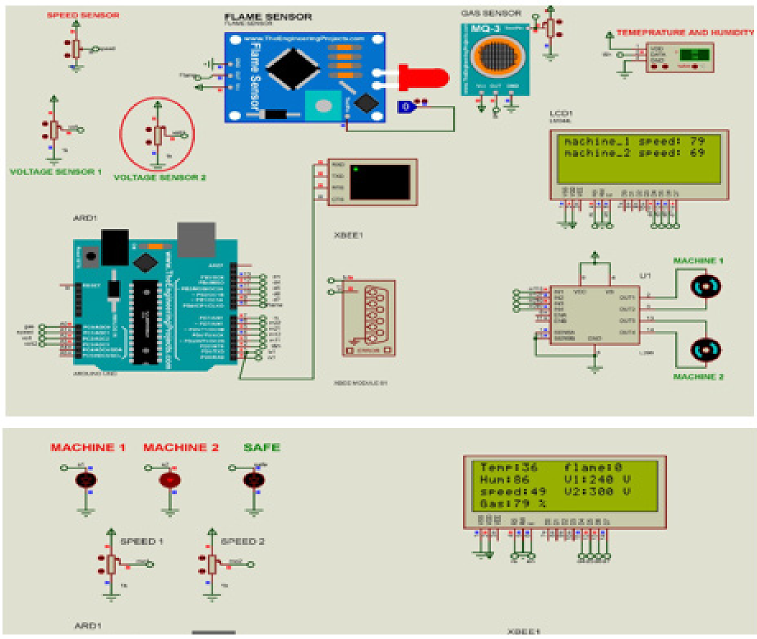

Figure 21: Scenario two station two unsafe case

RESULTS AND DISCUSSIONS

The results shown above presents all scenarios for system of emergency detection, it's important to say that the response of the main station to variation in reading suffers from some delay, that's when station one sends values to station two, there are about 3 to 5 seconds delay before main station responds to this disturbance, this delay because of the Xbee used in this project. Another thing is that when station sends their data at the same time, the main station responds for them respectively, i.e. it responds to the station that sends its data first and the other station waits for main station to finalize the process with the first station.

CONCULSIONS

In this work of research presented, we introduced and described a complete and secured agent cloud-based factory system for remote monitoring and control. One of advantages of the system is, it makes the user aware about risks of each site effectively. The environment of factories is monitored and detected by sensors with real time module provides a complete or total protection into the environment and also the variation monitoring. The inclusion of Xbee into the system have been made because it is said to be the most common mode of wireless senor network (WSN). There are following advantages:

- Accuracy in detecting.
- Convenience for the users.
- Detection for any value change.
- Low in cost.
- Very low power consumption.

Recommendations

Based on the measures while making this study, the listed are the future research which is suggested to:

Develop Intelligent algorithm into programming the microcontroller is highly recommended, Considering the power consumption and provide new devices for sensing, technologies integrated chips can be presented in the developed system.

REFRENCES

Caggiano, A., Segreto, T., & Teti, R. (2016). Cloud Manufacturing Framework for Smart Monitoring of Machining. *Procedia CIRP, 55,* 248-253. https://doi.org/https://doi.org/10.1016/j.procir.2016.08.049

Consortium, I. I. (2017). Architecture Alignment and Interoperability: An Industrial Internet Consortium and Platform Industrie 4.0 Joint Whitepaper. *Industrial Internet Consortium: Needham, MA, USA.*

Esmaeilzadeh, K. (2021). Remote Monitoring and Control of Industrial Equipment Through OPC UA and Cloud Computing. *Master's Thesis.*

Hua, L., Da, X., Jian, Z., & Fuquan, Z. (2016). Design of a State Monitoring System for Equipment based on the Zigbee Wireless Sensor Network. *International Journal of Online Engineering, 12*(6).

Kandala, S. V., Gureja, A., Walchatwar, N., Agrawal, R., Sinha, S., Chaudhari, S., Vaidhyanathan, K., Choppella, V., Bhimalapuram, P., Kandath, H., & Hussain, A. (2025). Engineering End-to-End Remote Labs Using IoT-Based Retrofitting. *IEEE Access, 13,* 1106-1132. https://doi.org/10.1109/ACCESS.2024.3523066

Li, Q., Yang, Y., & Jiang, P. (2023). Remote Monitoring and Maintenance for Equipment and Production Lines on Industrial Internet: A Literature Review. *Machines, 11*(1), 12.

Liu, C., Jiang, P., & Jiang, W. (2020). Web-based digital twin modeling and remote control of cyber-physical production systems. *Robotics and Computer-Integrated Manufacturing, 64,* 101956. https://doi.org/https://doi.org/10.1016/j.rcim.2020.101956

Liu, Y., & Xiao, F. (2021). Intelligent Monitoring System of Residential Environment Based on Cloud Computing and Internet of Things. *IEEE Access, 9*, 58378-58389. https://doi.org/10.1109/ACCESS.2021.3070344

Pereira, J. (2009). Monitoring and Control: Today's Market and Its Evolution till 2020. *Luxembourg: Office for Official Publications of the European Communities.*

Qi, H., Zhao, J., Sun, L., Cang, T., Li, Y., & Wang, X. (2022, 11-13 Nov. 2022). Design of a multi-channel fatigue test monitoring cloud platform based on the Internet of Things. 2022 6th International Symposium on Computer Science and Intelligent Control (ISCSIC),

Salkin, C., Oner, M., Ustundag, A., & Cevikcan, E. (2018). A Conceptual Framework for Industry 4.0. In A. Ustundag & E. Cevikcan (Eds.), *Industry 4.0: Managing The Digital Transformation* (pp. 3-23). Springer International Publishing. https://doi.org/10.1007/978-3-319-57870-5_1

Vanegas-Guillén, O., Parra-Rosero, P., Muñoz-Antón, J. M., Zumba-Gamboa, J., & Dillon, C. (2023). Remote Labs Meet Computational Notebooks: An Architecture for Simplifying the Workflow of Remote Educational Experiments. *IEEE Access, 11,* 132496-132515. https://doi.org/10.1109/ACCESS.2023.3336287

Wang, G., Xu, T., Wang, D., Cheng, P., Shao, C., Feng, F., & Zhou, P. (2024). Cloud-Based Remote Real-Time Monitoring and Control System for Spring Fatigue Testing Machine. *Machines, 12*(7), 462.

Wang, L. (2013). Machine availability monitoring and machining process planning towards Cloud manufacturing. *CIRP Journal of Manufacturing Science and Technology, 6*(4), 263-273. https://doi.org/https://doi.org/10.1016/j.cirpj.2013.07.001

Wang, L., Törngren, M., & Onori, M. (2015). Current status and advancement of cyber-physical systems in manufacturing. *Journal of Manufacturing Systems, 37,* 517-527. https://doi.org/https://doi.org/10.1016/j.jmsy.2015.04.008

Yin, Y., Li, Y., & Zhou, Z. D. (2014). Cloud Manufacturing: definitions, features, modes and core issues. *Applied Mechanics and Materials, 563*, 342-346.