iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** XI **Month of publication:** November 2023

DOI: https://doi.org/10.22214/ijraset.2023.56838

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XI Nov 2023- Available at www.ijraset.com

Development of IOT based System for Process Control Loop

Hrucha G. Nagre, Srushti M. Patil, Hrutvij A. Patil, Mohit C. Patil
Department of Multidisciplinary Engineering (DOME) Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India

Abstract: The development of IOT based System for Process Control Loop paper describes the smart process control laboratory where the industrial internet of things (IIOT) concept is applied using a trainer kit at lab scale. Level control trainer implementation and outcomes are discussed along with a case study. The PID control algorithm is used to regulate the tank's water level. IIOT, an emerging technology today, added automation and control to the IoT platform, allowing for remote monitoring and control of sensors and actuators. This illustration focuses primarily on home automation and incorporates mobile devices. The system requirements and device difficulties are discussed. The software platform selected is Kodular, which allows mobile devices to communicate with the process computer using the application data dashboard.
Keywords: IIOT, Process control loop, Arduino IDE, Kodular app creator, Firebase

I. INTRODUCTION

The number of control loops used in industry is growing continuously and there are problems in keeping them working at a satisfactory level. Industrial automation has undergone a revolutionary change as a result of the Internet of Things (IoT) quick development of sophisticated control systems. An IoT-based control system offers many advantages, including increased monitoring, intelligent decision-making, and improved overall system performance, in a multi-process control environment where various interconnected control loops operate simultaneously. This introduction outlines the process involved in developing an IoT-based control system for multi-process control loops. According to numerous studies, the performance of feedback controllers in the process industry is unsatisfactory. Poor performance may be caused by both their design and the upkeep of control loops. If maintenance problems are not taken into consideration, a loop that once functioned well is likely to deteriorate over time. The degradation of control loop performance can be attributed to a number of factors, such as faulty machinery, friction or stiction in valves, incorrect valve dimensioning, input saturation, changes in dead time, an inappropriate control structure or algorithm, improper controller tuning or changes in disturbance characteristics, poor sampling time selection, interactions with other loops, etc.

Industrial control systems are engineered and designed to provide control, process monitoring, and functions in manufacturing facilities. trial control systems use control loop systems to ensure that the desired processes and functions are carried out. Control loop systems made up of a number of parts, use programmable software to control a variety of variables in industrial processes in order to increase manufacturing output. The control loop system's individual parts cooperate to manage the industrial process. Machines, instruments, and other equipment used in industrial or manufacturing processes are monitored and controlled by control loop systems.

The system runs the hardware parts and software control operations required to monitor and modify the factors affecting each process. As a process management tool intended to keep the process variable at a desired set point at each step, think of control loop systems. Process variables are a group of programmable parameters used to monitor and regulate a process to keep the output within a predetermined range or quantity. Instrumentation and components of the control loop measure the variable first, react to it, and then control the variable to keep it within a predetermined range.

The Android application utilizes a real-time database (Firebase) for interpreting the sensor data. Google Firebase is a Google-backed application development software used for creating, managing, and modifying data generated from any Android/IOS application, web services, IoT sensors, and hardware. Next is Kodular, which provides the best way to make apps with a simple interface and code, there are many components and options, and also the material design. So, we have designed a Android Application using Kodular.io. using the Firebase Host. Whenever we turn ON/OFF the switches from the App the changes will be updated in the Firebase database.

II. LITERATURE REVIEW

1) N. Vatanskia, S-L. Jämsä-Jounelaa, A. Rantalac, T. Harjub: “Control Loop Performance measure in Evaluation of Process Economics”: For maintenance purposes, control loop performance measures have been developed. When the number of control loops in the plant is high (>200), the benefits of using these methods are greatest. Because of the simplicity of the algorithms and the complexity of the connections between physical properties and economics, the indices cannot be directly transformed into economic values in most cases. However, economic benefits can be realized over time. These advantages should be assessed using plant-wide process economic evaluation algorithms. The use of control loop performance measures is proposed as a strategy for analyzing control loop economics. Test results from industry that support the first step of the strategy are presented. It is anticipated that the strategy may prove useful in conveying control quality in a common language understood by operators, engineers, and management.
2) Keck Voon Ling, Kiah Mok Goh: “The Rapid Development of a Closed-Loop Control System.” This paper provides a brief overview of automatic control loop performance evaluation. The methods for rapidly deploying closed-loop control systems are presented in this paper. A flexible real-time embedded platform is built on reconfigurable computing technologies, on which control blocks comprised of optimized control algorithms are installed. Control blocks are used to create a set of tools aimed at shortening the development cycle of embedded control systems. In comparison to traditional methods, the tools allow controller developers to construct required controllers much faster and with greater flexibility.
3) Dr. B.D Jadhav, Pradeep.R. Jadhav “Industrial Control Process system using IOT”: In this process control system, sensors send data from a given input to the Raspberry Pi, which is then transmitted via the Thingspeak cloud. The data provided by the cloud is visualized and monitored in a graphical user interface using the QT designer tool. This process is used to achieve a level of consistency, economy, and safety in production that would be impossible to achieve solely through human manual control. The current process system is widely used in industries such as oil refining, pulp and paper production, chemical processing, and power plants.
4) Alpesh Patel, Rohit Singh, Jignesh Patel, Harsh K Kapadiya: “Industrial Internet of Things based Smart Process Control Laboratory: A Case Study on Level Control system”: This paper describes a smart process control laboratory in which the industrial Internet of things (IIOT) concept is implemented on a laboratory-scale trainer kit. The implementation and results of a level control trainer case study are discussed. The PID control algorithm is used to regulate the level of water in the tank. Today, IIoT is an emerging technology that has brought control and automation to the IoT platform, i.e., remote control and monitoring of sensors and actuators. This example is primarily for home automation, where mobile devices play a role. The device challenges and system requirements are discussed. The software platform chosen is NI LabVIEW through which the application data dashboard is used in mobile devices to communicate with the process computer.

III. METHODOLOGY/EXPERIMENTAL

Tools and Technologies used for the Development of IOT-based systems for process control loops are Arduino IDE, Firebase, Controllers, converters, etc.

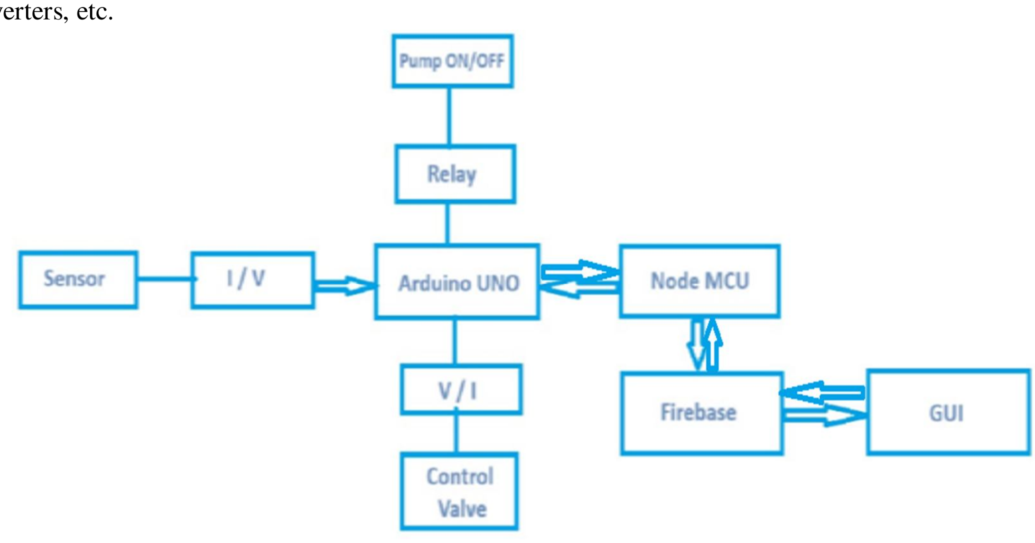


Fig.01: Block diagram of the system

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XI Nov 2023- Available at www.ijraset.com

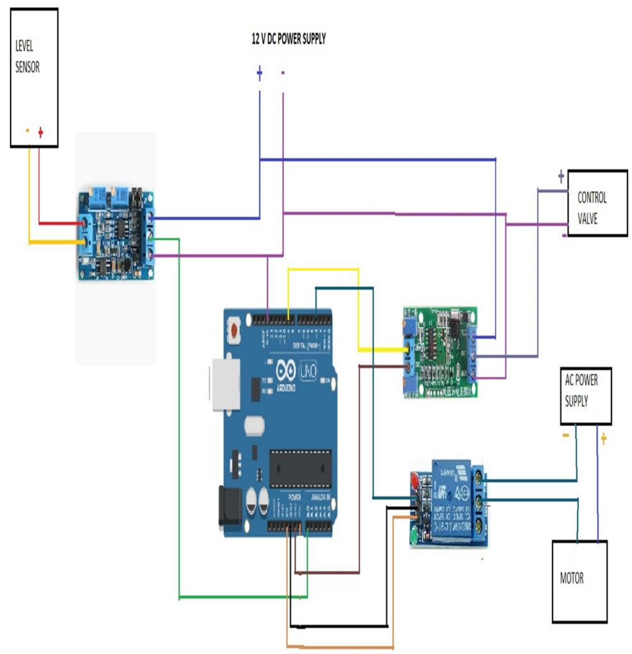


Fig.02: Circuit diagram of the system

A. Tools used

1) *ESP8266:* ESP8266 is a versatile and widely used Wi-Fi-enabled microcontroller module that has gained significant popularity in the field of IoT (Internet of Things) development. It offers a cost-effective solution for integrating Wi-Fi connectivity into various projects, making it an ideal choice for creating smart devices, home automation systems, sensor networks, and more. The ESP8266 module, developed by Espressif Systems, is based on the ESP8266EX chip and supports the use of the Arduino IDE and various programming languages.
2) *Arduino UNO:* The Arduino Uno is built around the Atmega328P microcontroller, which provides a good balance between processing power and versatility. It operates at 5V and has 14 digital input/output pins, among which 6 can be used as PWM (Pulse Width Modulation) outputs, and 6 are dedicated analog inputs.
3) *I-to-V convertor:* I-to-V converters operate based on the principle of Ohm's law, which states that the voltage across a resistor is proportional to the current flowing through it. In the case of an I-to-V converter, the input current is passed through a feedback resistor, and the resulting voltage drop across the resistor is the output voltage.
4) *V-to-I convertor:* V-to-I converters operate based on the relationship between voltage and current in a circuit. They convert a voltage input into a proportional current output using various configurations, such as transconductance amplifiers, operational amplifiers (op-amps), or dedicated integrated circuits.

B. Technology used

1) *Arduino IDE:* The Arduino IDE (Integrated Development Environment) is a software platform specifically designed for programming and developing projects with Arduino boards. It provides an easy-to-use interface that simplifies the process of writing, compiling, and uploading code to Arduino microcontrollers.
2) *Google-Firebase:* Firebase is also an app development software enabling developers to develop apps, it also provides the developers various tools enabling them to track analytics, report, and fix app crashes. It also has authentication and real-time cloud database services which were used in our proposed system. Data from different sensors is stored in a cloud database which also makes the system more cost-effective.
3) *Kodular App Creator:* Kodular allows you to create Android apps with a block-type editor. Kodular provides various modules to create apps and their components without the need of coding. Kodular was used for creating the app to receive real-time data from the sensors of the system and to notify the user in case of rare, damaging events.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XI Nov 2023- Available at www.ijraset.com

Fig.03: Control Valve

Fig.04: Water tank

IV. RESULT AND DISCUSSION

The IoT-based control system is anticipated to provide real-time monitoring and control capabilities for multiple processes within the control loop, involving data collection, analysis, and dynamic adjustment of control parameters. Through IoT integration, the control system aims to optimize process operations, leading to increased efficiency, minimized downtime, and improved overall productivity.

The system is expected to enable remote access and management of the control loop, empowering operators and managers to monitor and control processes from remote locations for enhanced operational flexibility and responsiveness. The IoT-enabled system is projected to gather and analyze data from various sensors and actuators, offering valuable insights into process behavior, anomalies, and trends. This analytical approach supports informed decision-making for process enhancements. The IoT-based control system is expected to optimize energy consumption within the control loop, contributing to improved sustainability and cost savings. Integrating IoT devices such as sensors, actuators, and communication modules within the control loop facilitates seamless data exchange and communication between processes and the central control system.

By achieving these expected outcomes and effectively implementing the discussed aspects, an IoT-based control system for a multi-process control loop can significantly boost operational efficiency, decrease costs, and pave the way for a more sustainable and data-driven approach to industrial control and automation.

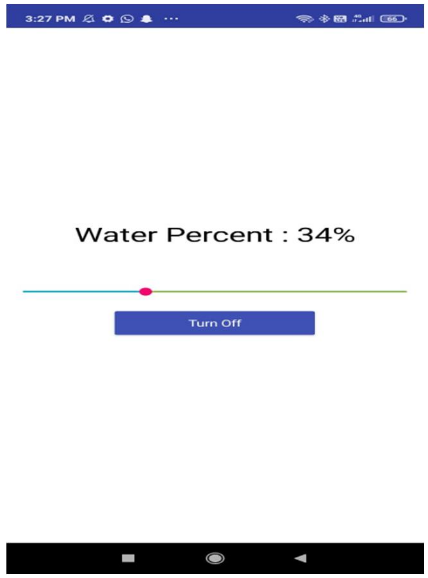


Fig.06: Kodular App Interface

V. CONCLUSION

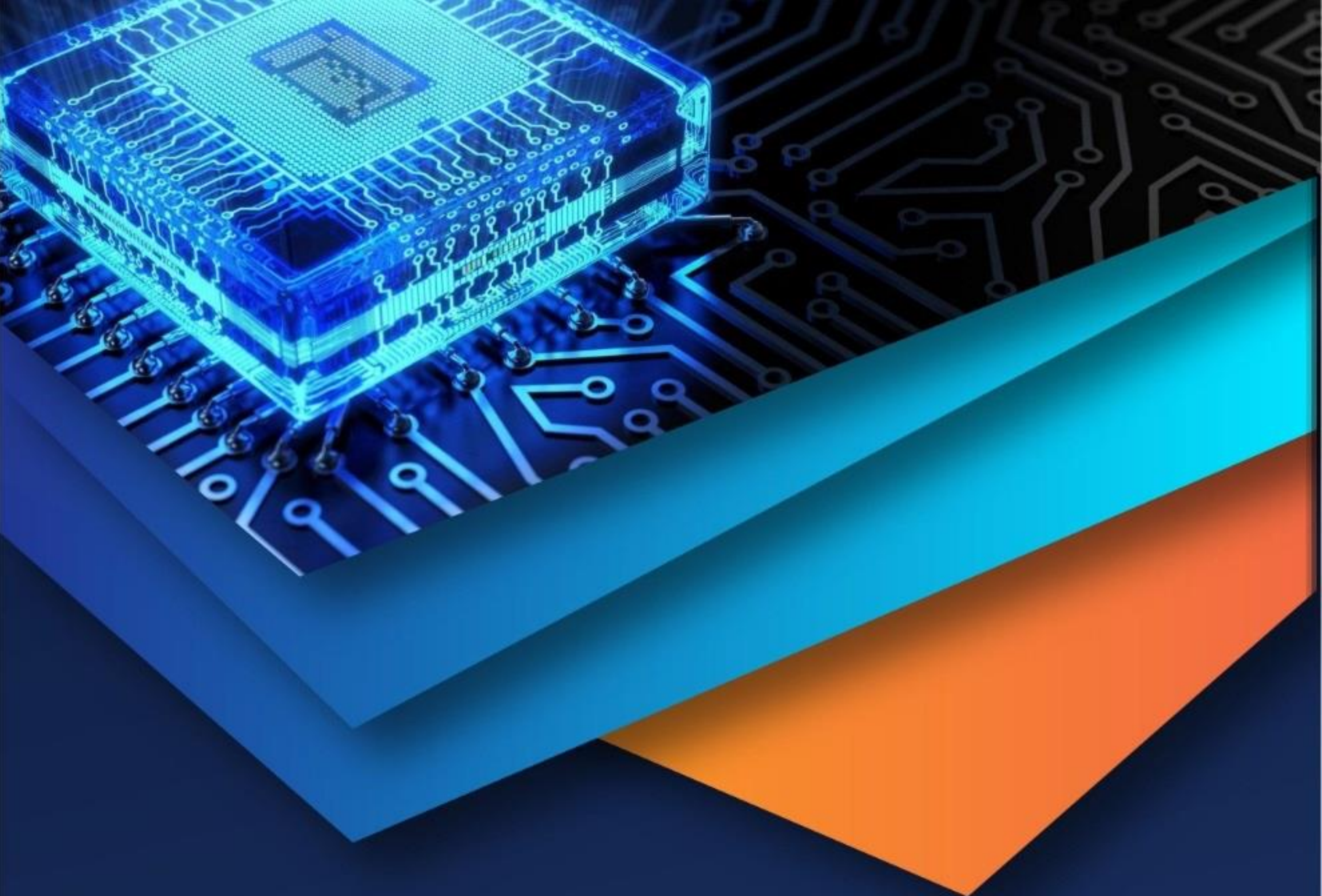
Control loops are important for maintaining the stability of a system, and for consistently producing the desired outcome of a process. Hence, we have proposed a system in which the user will have remote access and control over the specific parameters in the process control loop. The project involves using IoT devices like the ESP8266 to control the process control loop from a distance without having to physically be present near the loop. The components include an ESP8266, Arduino Uno, I/V convertor, V/I converter, a battery, etc. We have developed an app using Kodular.io and Google Firebase. The Android application utilizes a real-time database (Firebase) for interpreting the sensor data Thus, we have developed a system that provides remote access to the control system, allowing operators and decision-makers to monitor and control processes from anywhere, at any time.

VI. FUTURE SCOPE

Developing a cloud-based architecture for the IoT-based system will provide several advantages. It will enable remote access to the system, facilitate data storage and retrieval, and support centralized control and monitoring. Moreover, cloud-based deployment can leverage the benefits of scalability, reliability, and security provided by established cloud service providers. The IoT-based system should be further customized to address the specific requirements of different industries. This customization can include industry-specific process models, control algorithms, and user interfaces tailored to the unique needs and challenges of each sector. This system will focus on energy efficiency and sustainability aspects. By integrating energy monitoring and optimization features, the system can identify energy-intensive processes, suggest improvements, and enable efficient resource utilization.

REFERENCES

[1] N. Vatanskia, S-L. Jämsä-Jounelaa, A. Rantalac, T. Harjub: “Control Loop Performance measure in Evaluation of Process Economics” published in 16th IFAC Triennial World Congress, 2005, Prague
[2] Keck Voon Ling, Kiah Mok Goh: “The Rapid Development of a Closed-Loop Control System.” April 2005.
[3] Dr. B.D Jadhav, Pradeep.R. Jadhav “Industrial Control Process system using IOT”, April 2018.
[4] Alpesh Patel, Rohit Singh, Jignesh Patel, Harsh K Kapadiya: “Industrial Internet of Things based Smart Process Control Laboratory: A Case Study on level Control system” January 2018.



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY