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# Prototype Design of IoT Remote Monitoring System for Industrial Process Using Firebase Realtime Database

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**Abstract**

*Internet of Things is a technology that is currently developing rapidly. IoT is a network that connects various objects combined with electronics, sensors, and software. This technology is widely used in industry to monitor existing processes. Existing monitoring systems such as PLC and SCADA are great tools and software for process monitoring in the industry. However, they are quite expensive to be used by small and medium industries and also require qualified human resources in this field. To overcome this problem, in this paper, we describe the design of the IoT Remote Monitoring System for Industrial Process Using Firebase Realtime Database. The system is designed using ESP32 and sensors with an internal wifi module. The developed system enabled the employee to monitor any process in the industry remotely and in real-time using a progressive web application.*

Keywords: IoT, remote monitoring, real-time database, sensor, PLC



## I. INTRODUCTION

In general, industrial processes are usually monitored and controlled using manual and conventional means so that employees must have full attention. We can also use Programmable Logic Control (PLC) and Supervisory Control And Data Acquisition (SCADA) for this purpose, but this requires very expensive costs and sufficient human resources. Examples of processes or things in the industry that often have to be monitored include liquid temperature, liquid level, motor speed, humidity, calculation of products on a conveyor, water flow, and others. Sensors in the industry are usually connected to a control station or monitor using cables and wireless for continuous and continuous system monitoring. In this case, IoT technology has many advantages for use in the industry, such as low implementation costs, flexibility, high scalability, can be applied using wireless technology, can be easily connected to AI systems, high mobility, and other conveniences that do not exist in


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conventional systems. This advantage is certainly very good for the industry, where currently, the industry's growth is quite large (Xu, He and Li, 2014).

Of course, for industries that are on a lower scale, it will be very burdensome in terms of costs if they have to use a relatively expensive SCADA system. In addition, this system requires supporting equipment made by the manufacturer at a price that is not cheap, of course. To overcome this, this paper proposes and develops an IoT-based real-time industrial environmental monitoring system combined with a Firebase Realtime Database that can be operated by personnel at low cost and other supporting equipment that can be built by yourself using components at affordable prices but remain reliable. To overcome this, this paper proposes and develops an IoT-based real-time industrial environmental monitoring system combined with a Firebase Realtime Database that can be operated by personnel at low cost and other supporting equipment that can be built by yourself using components at affordable prices but remain reliable.

## II. LITERATURE REVIEW

"Internet of Things" or abbreviated as IoT is composed of the words "Internet" and "Things" where "Things" refers to various kinds of devices connected to the internet (Madakam, Ramaswamy, and Tripathi, 2015). Internet of Things (IoT) is a system of computing devices composed of various kinds of mechanical and digital devices, sensors, actuators, animals, or people that are equipped with unique identifiers, and this system has the ability to transfer data over the network without requiring human intervention.

In recent years, IoT, combined with sensors and actuators, has made this technology a new cyber-physical technology, which also includes technologies such as smart networks, virtual power plants, smart homes, smart transportation, and smart cities. (Mocrii, Chen and Musilek, 2018), (Mocrii, Chen, and Musilek, 2018, p. ). IoT technology using network-based microcontrollers is a technology that is cheap enough to be used at this time so that it can be a key component for building smarter systems. But the IoT protocol is like CoAP (Naik, 2017), MQTT (Rouse, 2016), XMPP (Wang *et al.*, 2017) itself is not mature enough, so it still needs to be researched again to find a good protocol. These various IoT protocols have various characteristics with different strengths and limitations (Naik, 2017). Finally, due to technological revolutions around the world, smart technologies are replacing old ones (Jahid and Hossain, 2018), (Jahid *et al.*, 2019).

In the industrial sector, IoT technology is becoming more attractive nowadays. It is expected that by 2020, around 20-50 billion objects will be connected to the internet worldwide (Allhoff and Henschke, 2018), (Jahangir Mohammed, 2016). Although there are many definitions of IoT, the definition relevant to industrial applications is that using smart components such as microcontrollers, sensors, and actuators attached to ordinary objects can make ordinary systems smarter.

### II.1. Three definitions of IoT that are quite a relevant include:

IoT is "a group of infrastructure, which connects various objects and allows management, data mining, and access to the resulting data" where these various objects are "sensors and/or actuators that perform specific functions that can communicate with other equipment" (Dorsemaine *et al.*, 2015).

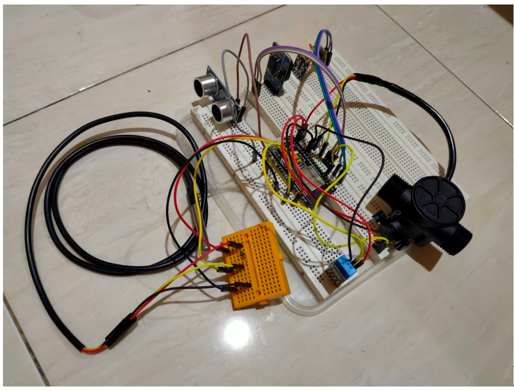
IoT itself is an extension of network connectivity and computing capabilities of objects, equipment, sensors, and other objects that may not have previously been considered computable objects. These "smart objects" then require less human intervention to generate, exchange, and consume data; These objects have a connection feature to a remote server whose job is to collect data, analyze and organize it. (Fortino *et al.*, 2016);

IoT itself represents a scenario where each object has sensors and is able to communicate with other objects and is able to make the system in its environment work automatically. (Hossain, Jahid, and Rahman, 2018). In related research conducted by Febrian Prayoga (Prayoga, 2016) entitled "Designing Class Announcement Application Prototype Using Firebase Cloud Message Technology on Android" discusses making applications for class announcements in real-time with a case study of the Faculty of Technology and Information, Satya Wacana Christian University, Salatiga using the Waterfall method. This application will later be used to send announcements to students taking certain classes in the form of push notifications using FCM technology.

The National Institute of Standards and Technology (NIST), Information Technology Laboratory, provides two notes on the notion of cloud computing. First, cloud computing is still a growth paradigm. Definitions, use cases, underlying technology, problems, risks, and benefits will continue to be refined through debate by both the public and private sectors. The definitions, attributes, and characteristics will evolve and change over time. Second, the cloud computing industry is a large ecosystem with many models, vendors, and market shares. This definition attempts to cover all various cloud approaches (Rittinghouse and Ransome, 2016). From these two notes, NIST provides a definition of cloud computing is a model to allow convenient, on-demand network access to share a configured computing resource (for example, networks, servers, storage, applications, and services) that can be quickly provided and released with minimal management effort or service provider interaction. The cloud computing model drives availability and consists of five characteristics, three service models, and four deployment models.

Firebase Cloud Messaging is designed to provide a connection to an Android device via notification message. The FCM is reliable, with 98% accuracy of messages sent to connected devices at speeds of 500ms or less, and is also large-scale, with an infrastructure that generates over a trillion messages per week. Firebase Cloud Messaging offers a variety of methods for providing easy control (Moroney, 2017).

# III. RESEARCH METHODOLOGY

This section describes the methodology, which represents the backbone of this work as it determines the selection of methods for the Remote Monitoring System Prototype for Industrial Process Using IoT and Firebase Realtime Database system design and development as well as the perspective applied for results analysis and the system performance evaluation. The prototype of the proposed system is shown in Figure 1, which consists of ESP32 microcontroller, temperature sensor DS18B20, humidity sensor DHT11, pressure sensor MPX2050DP, KY-008 laser sensor, flow sensor, and ultrasonic sensor.

Temperature sensors are used to measure the temperature of liquids involved in industrial processes, for example, in the process of boilers, boilers, reactors, cooling systems, and heat exchangers. The data from this sensor will be retrieved by ESP32 and then sent to Firebase. The data line from this temperature sensor is connected to the IO15 port of the ESP32. Moisture sensors are very important for industries related to the manufacturing process of food, beverage, medicine, the process of preservation. The data line from the humidity sensor is connected to the IO16 port of the ESP32. The pressure sensor will be used to measure the pressure that often exists in the industry, such as gas pressure in a tube, water pressure in a container, air pressure in an enclosed space, and pressure in a venturi tube. The data line from this pressure sensor is connected to the IO17 and IO18 ports of the ESP32.

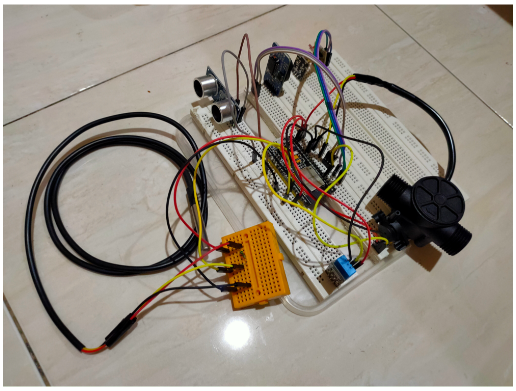


*Figure 1: System prototype*

The laser sensor is here combined with a laser light source. These two objects are placed a certain distance apart and then used to detect an object that is walking on the conveyor belt. The purpose of

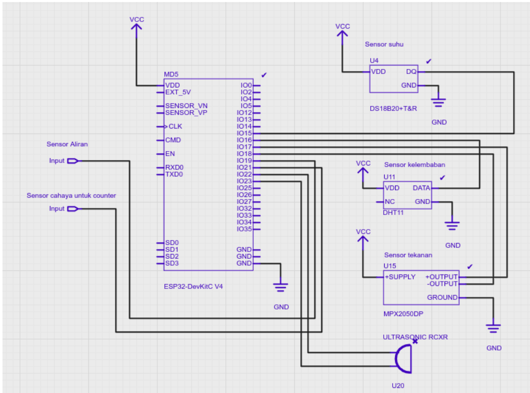


*Figure 2: Proposed system circuit diagram*

using this sensor is to count the number of items passing through the sensor. The data line from this laser sensor is connected to the IO21 port of the ESP32

Flow sensors are used to detect whether in a fluid pipe used in the industry, there is a flow or not. This is very important to be applied in industry to ensure the smooth running of a production process, for example. The data line from this flow sensor is connected to the IO19 port of the ESP32. The ultrasonic sensor is here used to measure the height of the liquid in a tank or pond. The data path from this ultrasonic sensor is connected to the IO22 and IO23 ports of the ESP32.

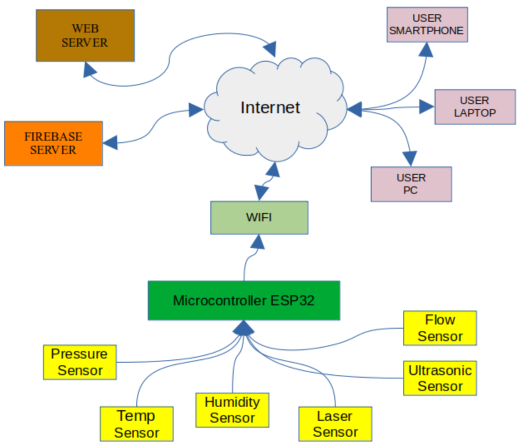
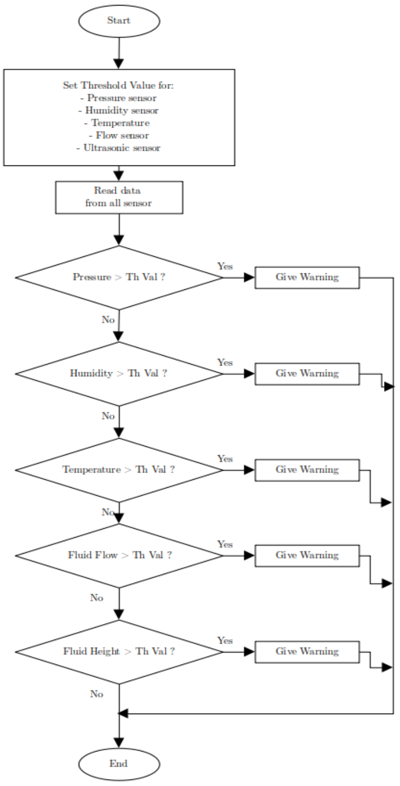



*Figure 3: Proposed system architecture*

Furthermore, a progressive web application is made to monitor the condition of all sensors used. This application gets all sensor data from the Firebase Realtime Database, which is sent using push messaging techniques. The data entered in the application is then processed to check whether it matches the threshold value for each sensor. If it doesn't match, the application will issue an alarm




to get the user's attention.

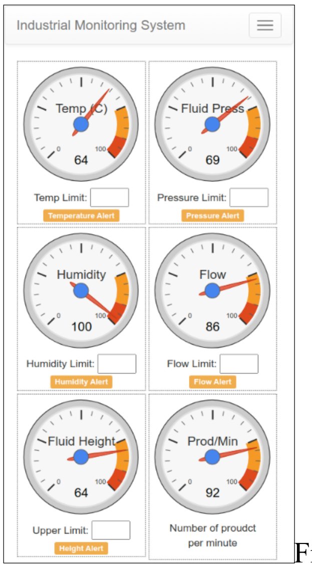
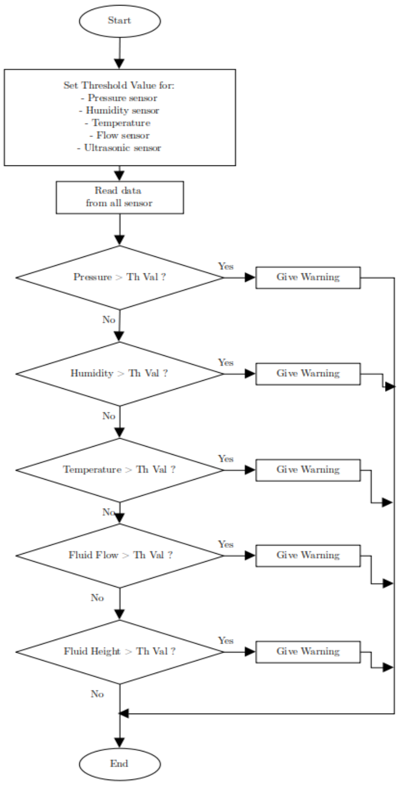



Figure 4 is the flowchart of the system operation, while Figure 5 is the interface design of the proposed progressive web application. In the application interface, you can see six gauges that will be used to display real-time sensor data. Below each gauge is a textbox, which is used to enter the threshold value for the corresponding sensor.



Start
Set Threshold Value for:
- Pressure sensor
- Humidity sensor
- Temperature
- Flow sensor
- Ultrasonic sensor
Read data
from all sensor
Pressure > Th Val ?
Yes
Give Warning
No
Humidity > Th Val ?
Yes
Give Warning
No
Temperature > Th Val ?
Yes
Give Warning
No
Fluid Flow > Th Val ?
Yes
Give Warning
No
Fluid Height > Th Val ?
Yes
Give Warning
No
End

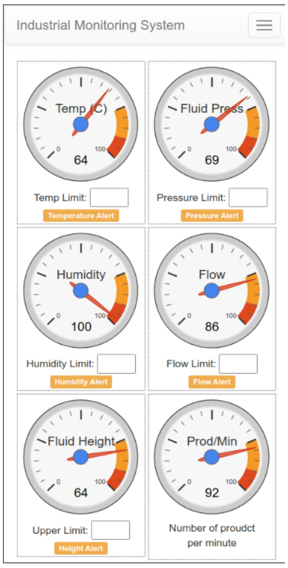



*Figure 5: Proposed Application GUI*

### III.1. Mathematical Model

Let

S ≡ {USER, CONN, SERSOR, RDB, THV, GET(), SET()}

It is the main function containing all the set involved in the proposed system where,

- **USER** is the set of all users of the proposed system.
- **CONN** is the set of connections to the proposed system.
- **SENSOR** is the set of sensors in the proposed system, such as temperature sensor, humidity sensor, pressure sensor, flow sensor, laser sensor, and ultrasonic sensor.
- **RDB** is the set of the real-time database for storing data from all sensors.
- **THV** is the set of threshold values used in the sensor.
- **GET()** is the function for getting the data from each individual sensor.
- **SET()** is the function for setting the threshold values for alarm processing.

## IV.RESULT AND DISCUSSION

Berikut ini adalah data ujicoba yang telah berhasil diambil oleh sensor iot, dikirim melalui jaringan internet dan masuk ke dalam database realtime Firebase:

*Table 1: Temperature Data*

| Primary Key | Temp |
|---|---|
| -MHaoLouux411vJpVz2y | 28.69 |
| -MHaoNF1k0S8lQlNU1Da | 28.69 |
| -MHaoOhl1H9SFOgqnlSu | 28.62 |
| -MHaoQ7qvocPz_2lUmXf | 28.69 |
| -MHaoRYrDVTclEwIluRE | 28.69 |
| -MHaoT-haUBIEwxfXYP2 | 28.69 |
| -MHaoURS7v21bzLXOSoa | 28.75 |
| -MHaoVtCIwqLb50LEobd | 28.69 |
| -MHaoXIbCyaYOi-qlFA_ | 28.62 |
| -MHaoYhk181EtMojIdaW | 28.69 |
| -MHao_6zj4UShXmSpkae | 28.69 |
| -MHaoaZ9K_U2-aAfghZA | 28.69 |

The proposed system can be used in various industries such as the chemical industry, metallurgy industry, food processing, oil processing industry, and others. In these various industries, there are many processes that need to be monitored using sensors in real-time; data is stored in a cloud-based real-time database so that employees can easily access them from anywhere and at any time. In addition, data in cloud storage can be prepared for future computing needs.

Challenges to overcome: the addition of sensors in industrial environments and in monitoring applications needs to be done automatically without the need for an employee who masters the technical details, the data obtained from the sensor will eventually become a Big Data database, so it is necessary to create a computation system using ML for the data for decision-making purposes so that useful and high-value information is obtained.

## V. CONCLUSION

Previously, industrial process monitoring used standalone tools and sensors and then increased using SCADA. To ease monitoring work, IoT-based sensors are used where monitoring data is sent to employees/users in real-time using a progressive web application combined with the Firebase Realtime Database, and the data is stored in cloud storage. For this reason, we propose to create an industrial process monitoring system using IoT sensors using Firebase Realtime Database technology.

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