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Prototipe Sistem Pemantauan dan Peringatan Dini Gangguan Aliran Air PDAM berbasis Arduino, Firebase Realtime DB, dan Android

A Prototype of Monitoring and Early Warning System of Public Water Flow Interference based on Arduino, Firebase Realtime DB, and Android

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Abstrak – Mayoritas penduduk menggunakan air bersih yang bersumber dari pipa PDAM (Perusahaan Daerah Air Minum Indonesia) untuk memenuhi kebutuhan sehari-hari. Namun pemanfaatan air bersih terkadang tidak lancar karena pasokan air dari hulu tersendat atau karena gangguan pada jaringan perpipaan PDAM. Gangguan yang sering terjadi secara perlahan ini menyebabkan aktivitas rutin masyarakat seperti mandi atau memasak terhenti karena air bersih merupakan kebutuhan pokok. Oleh karena itu, diperlukan suatu sistem untuk memberikan peringatan dini ketika pasokan air PDAM mulai bermasalah sehingga masyarakat dapat melakukan antisipasi awal. Penelitian ini merancang prototipe sistem peringatan dini menggunakan sensor aliran air berbasis Arduino yang mencatat data debit aliran air pada pipa PDAM dan dikirim ke *Firebase Realtime Database* sehingga dapat dipantau secara *real-time* melalui aplikasi *Android*. Pengujian sistem dilakukan dengan pengujian *black-box*, yaitu kami memeriksa semua fungsi sistem ini, terutama pada pengiriman notifikasi peringatan ketika debit aliran air berada pada tingkat yang rendah. Berdasarkan hasil pengujian, dapat disimpulkan bahwa semua fungsional berjalan dengan baik pada situasi normal, mulai dari pencatatan debit aliran air sampai pengiriman peringatan ke aplikasi Android. Namun, ketika koneksi internet bermasalah, proses perekaman debit air menjadi terhambat. Diperlukan metode tambahan untuk mengantisipasi data dari Arduino yang tidak bisa dikirimkan ke server.

Kata Kunci: pemantauan, peringatan dini, gangguan air, Arduino, Android, PDAM

Abstract *– – The majority of the population uses clean water sourced from the PDAM (Indonesian Regional Water Supply Company) pipeline to meet their daily needs. However, clean water utilization is sometimes not smooth because the upstream's water supply is stalled or the PDAM pipeline disrupted. This disruption that often occurs slowly causes routine community activities, such as bathing or cooking, become stop because clean water is a basic need. Thus, a system is needed to provide early warning when the PDAM water supply starts to have problems so that the community can make initial anticipation. This study designed a prototype of an early warning system using an Arduino-based water flow sensor that records water flow discharge data on the PDAM pipeline and sent to the Firebase Realtime Database to be monitored in real-time through an Android application. The system testing is done by black-box testing, i.e. we check all functions of this system, mainly on sending a warning notification when the water flow debt is at a low rate. Based on the test results, it can be concluded that all functions work well in normal situations, from recording water flow to sending warnings to the Android application. However, when the internet connection has problems, the process of recording the water discharge becomes disturbed. An additional method is needed to anticipate data from Arduino that cannot be sent to the server.*

Keywords: *monitoring, warning, water discharge, Arduino, Android, PDAM*

INTRODUCTION

Freshwater from the PDAM (Indonesian Regional Water Supply Company) pipeline is the primary need of most of the population in urban areas. Considering its position as the interests of many people's lives, PDAM is expected to provide excellent service, especially in providing sufficient water debit for all household needs.

In a normal situation, PDAM water discharge can meet the daily needs of its customers. However, there are times when the water flow of the PDAM decreases and even dies or doesn't flow at all. This condition is caused by water supplies from the upstream (rivers, reservoirs, or lakes) running low or PDAM pipeline disruption (Ulum, 2019). This frequent disruption causes routine community activities, such as bathing or cooking, to stop because clean water is a basic need

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(Fazri, 2017). Thus, a system is needed to provide an automatic early warning when the PDAM water supply starts to have problems so that the community can anticipate early and also provide notification when the water discharge returns to normal.

Based on those problems, this research will design a prototype of the PDAM water flow disturbance monitoring and early warning system. To record the water flow, an Arduino will be used because this device is cheap and easy to be used, and can integrate with many useful sensors. Certain Arduino models even have Wi-Fi modules so that they can simply send water flow data to the cloud server through the Internet. The stored data then can be accessed by an Android application to help users either in monitoring the water flow or getting early warning notifications. The system prototype that has been built will be tested using simulation; that is, when the water debit in the simulated main pipeline is gradually reduced, the system will automatically give a warning to the user. In the end, users can prepare themselves earlier, such as accommodating the remaining water discharge in the tub and saving money when there is a PDAM water disruption.

To facilitate further discussion, we showed some studies related to the public water monitoring system. We reviewed and compared them to this research to know the novelty of this study.

Research from (Pratama, Piarsa, & Wibawa, 2020) implemented an IoT-based integrated PDAM prepaid system that will increase the performance efficiency of the PDAM company. When the system runs automatically and is supported by a water meter equipped with IoT technology, PDAM officers do not need to come to the customer's house every month. However, this system does not provide notifications so that customers do not know when PDAM water stops flowing. The research from (Suharjono, Rahayu, & Afwah, 2016) made a design for creating a new water meter measuring device connected to the IoT so that water use by PDAM users in Semarang can be seen directly through an application. However, this system does not provide notifications, so the customers do not know when PDAM water stops flowing.

On the other hand, the study from (Widayaka & Jauhari, 2020) showed a flowmeter sensor trial in a case where a pipe from a water line suddenly leaks so that the officer can be given direct notification. Another study (Zakaria, Zakaria, & Taufik, 2019) made an IoT prototype to monitor customers' water debit. It aims to simplify monitoring of customers' water usage, provide more accurate water usage data, and make it possible to control the water discharge remotely. But, those studies do not provide notifications for the customers.

Based on the research gap described above, this research makes an early warning system of public water flow interference using a real-time database and Android services. Thus, the PDAM customer can know when the water flow of the PDAM decreases and can anticipate early.

METHODOLOGY

We conduct four stages to build a system that can solve the research problems. The steps are analyzing requirement, creating an overview of the system, developing modules, and formulating a testing scenario.

Requirement Analysis

Interviews with 10 Denpasar residents who subscribe to PDAM were held to know what they need to anticipate the water disruption. All interviewees stated that they required early information about the disruption so that they could prepare other scenarios pretty well for the anticipation. Based on the requirement, this research developed a prototype that could send an early warning to all people.

System overview

The system prototype to be built is an interconnected system as shown in figure 1. This system consists of an Android smartphone-based application as a medium for interaction for users, a cloud server for processing and storing data online, and an Arduino device with a water flow sensor to record debit data. The Arduino device and sensors will be placed on the PDAM pipe, while users who use an Android smartphone can be anywhere to monitor the development of water discharge conditions and get notifications when the water flow decreases.

We do not use regular database management to speed up the server and Android user's data synchronization process. Still, we take advantage of third parties' real-time database services, namely *Google Firebase* (Moroney, 2017b). Using this scheme, the system automatically fast loads the Arduino module's new data in the Android application (Wiratno & Hastuti, 2017).

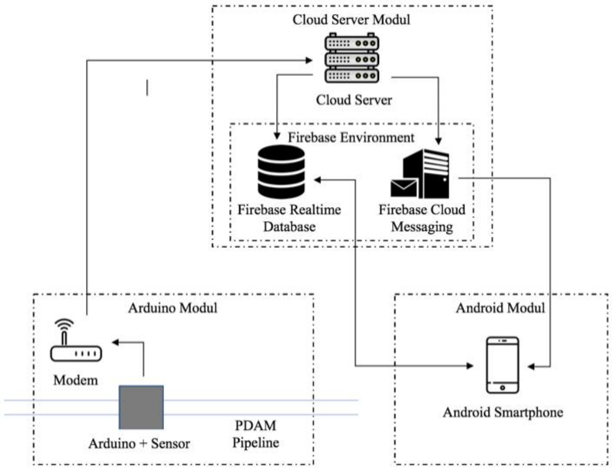

Figure 1 System overview

Modules Design

Based on the system overview, three modules construct it: the Arduino module, Cloud Server module, and Android Module. So, in this stage, we design each module as Figure 2.

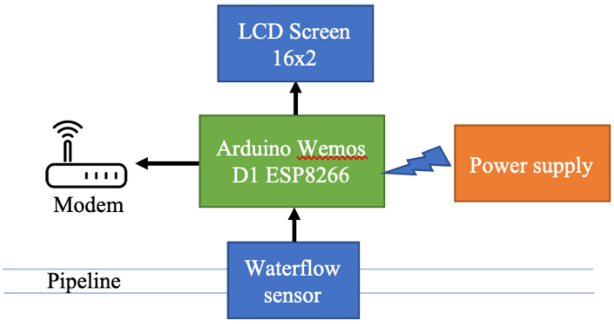

Figure 2 Arduino module scheme

1. Arduino Module

This first module works for gathering real-time water flow data from the PDAM pipe as shown in figure 2. We used *Arduino Wemos D1 ESP8266* that has been integrated with a Wi-Fi module so that this microcontroller can send data to the cloud server through a wireless modem installed near it. A water flow sensor of type *YF-S201* was installed and connected to an Arduino pin to know the water debt. Furthermore, this module added LCD Screen sized 16x2 set as the information screen. To make the Arduino module works appropriately, we input source code into *Wemos D1 ESP8266* through USB Cable. The code has workflow as shown in figure 3.

First, we set up some Arduino pins for the water flow sensor and LCD screen. We also configure the Wi-Fi name and password so that this module can automatically connect to the nearest wireless modem when turned on. Next, on the loop block, we set the code for watching data from the water flow sensor by using utilizing a digital pin with an interrupts feature. After converted to a liter per second, the data is printed into the LCD screen and sent to the cloud server. Last, we set the delay process for 1 second for the next loop to avoid the Arduino crashes.

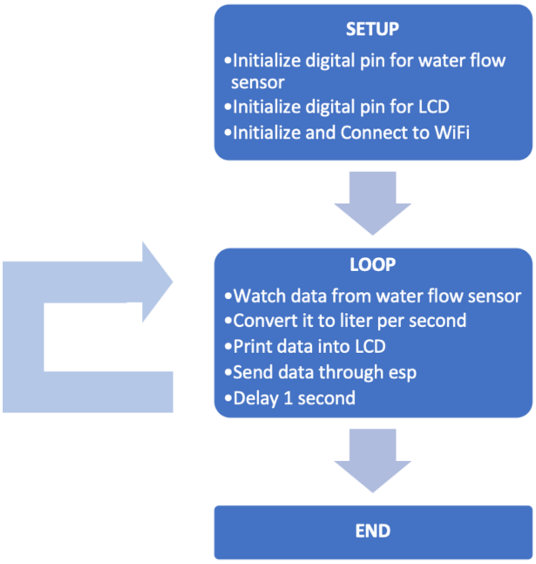

Figure 3 Arduino workflow

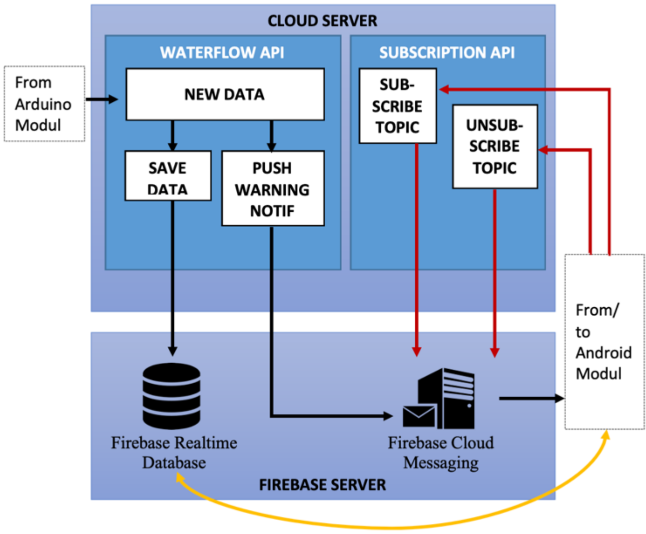

Figure 4 Cloud server workflow

2. Cloud Server Module

This second module works for storing the water flow data into a real-time database as shown in figure 4. According to several cloud services providing database saving, we choose Firebase, owned by Google Services. The main advantage is the real-time database can be synchronized in real-time to every connected Android application (Ohyver, Moniaga, Sungkawa, Subagyo, & Chandra, 2019).

Apart from using the real-time database, we also develop a server application in a PHP environment for processing the data sent by the Arduino module. The water flow data received is initially checked whether its value is below a specific limit. If yes, after saving the value into a real-time database, the server sends an order to *Firebase Cloud Messaging* for pushing warning notification to all Android users. Besides, we create a *Subscription class* to handle the Android users who want to receive the notice. If they're going to subscribe, their data, such as the *Firebase* registration token, will be registered in the water monitoring topic in *Firebase Cloud Messaging* (Moroney, 2017a). Therefore, when the cloud server wants to push a warning to the users, the *Firebase* system will only send the notification to the Android tokens that have been registered in the water monitoring topic (Mokar, Fageeri, & Fattoh, 2019).

3. Android Module

The last module helps the user monitor the PDAM water flow and receive notifications when the water flow decreases. Also, the user can set whether they want to activate the message or not. If yes, the Android application will request a token from Firebase Cloud Messaging. After obtained successfully, the token will be sent to the cloud server to be registered in the Firebase water monitoring topic. To be more clear, see figure 5.

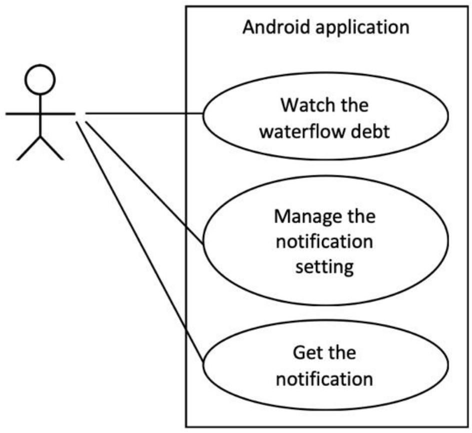

Figure 5 The Android use case diagram

RESULT AND DISCUSSION

Based on the design above, we successfully implemented and tested a system within the results as follows.

Prototype Result

The development results of a prototype monitoring system and early warning of water flow disturbances in PDAM are in the form of three integrated sub-systems or modules. The three modules are the Arduino module, the cloud server module, and the Android module. First, the prototype Arduino module that was successfully developed has the form as shown in figure 6. We used *Asus Power Bank* as the power supply simulation of this module. Besides, we connected the water flow sensor to a garden hose as the PDAM pipe simulation. The garden hose is connected to tap water that has been installed in the house so that we can control the water flowing in the hose.

Next, the real-time database and Android application results can be seen in figure 7 and figure 8. In the Firebase real-time database, we only saved the date and the value of each water flow data. The data is stored in JSON format. While in the Android application, we showed the chart of water flow progress on the main screen. When the water flow is below the limit, the application will push a warning notification in the title bar.

Figure 6 Arduino prototype result

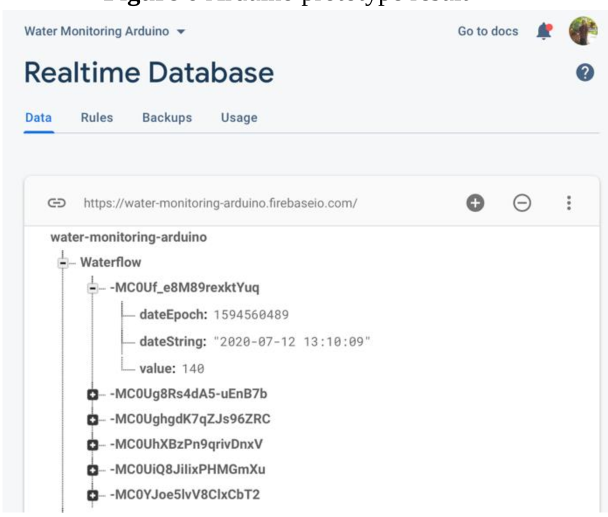

Figure 7 Real-time database server result

Testing Result

System testing is carried out in the black box to determine whether the system's components have run according to the specified flow. The following is a scenario and black box test results sorted by system process flow. We tested started from Arduino was turned on, and recorded the water flow until the Android user received a warning notification when the water flow is below a specific limit. We used the garden hose and the tap water to simulate the disruption in the PDAM pipeline network.

Table 1 Blackbox testing results

Module	**Process name**	**Expected result**	**Testing result**
Arduino	Start	LCD shows welcoming statements	Run
Arduino	Connecting to Wi-Fi	LCD prints "Arduino is successfully connected to Wi-Fi."	Run
Arduino	Recording the water flow	LCD prints the rate of water discharge per second	Run
Arduino	Sending data to the cloud server	Cloud server receives the data	Run
Cloud Server	Storing data to Firebase Realtime Database	Data is stored in Firebase Realtime Database	Run
Cloud Server	Pushing notification to devices by sending data to Firebase Cloud Messaging	The Android device receives a notification about the low rate of water discharge	Run
Android	Opening home page	The Android device shows a graph of the water flow rate per second	Run
Android	Setting notification up	Firebase Cloud Messaging stores user subscription options	Run

Of the eight black-box test scenarios above (table 1), the system prototype successfully executed all of them. There was no error or stuck while the testing was conducted. The update of the water flow chart in the Android application was run smoothly. But, there was one thing to be concerned about: the system performance was very dependent on the internet network's stability. This means that if the internet has a problem, the Arduino module connection will run slowly so that all water flow data cannot be successfully sent to the cloud server.

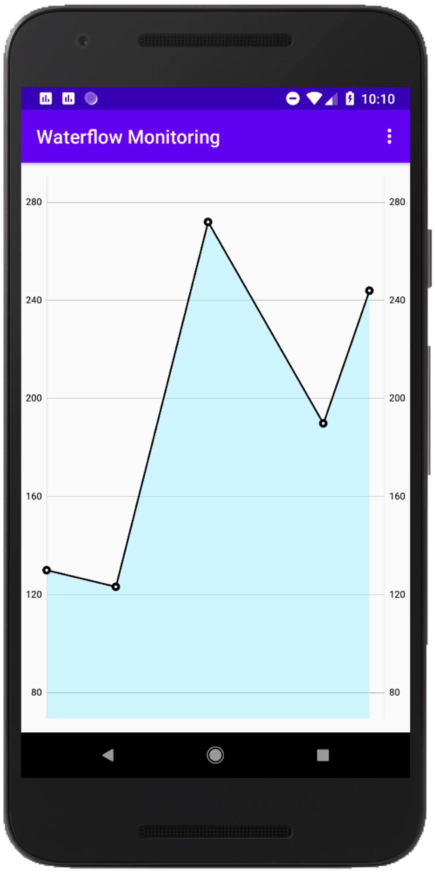

Figure 8 Android result

CONCLUSION AND FUTURE STUDY

Based on the results and discussion that has been presented, this research has succeeded in developing an early version of the PDAM water flow disturbance monitoring and warning system prototype, which consists of the Arduino module, the Cloud Server module, and the Android module. The test results show that all system functionality is running well. Several notes can be used as material for further prototype development; namely, the system prototype has not considered the problematic internet network, and the *WeMos D1* board device sometimes errors in running the *YF-S201* type water flow sensor so that other devices and sensors can be considered for use.

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