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IDENTIFICATION WATER LEVEL MONITORING SYSTEM AND PERSON DETECTION IN BATHROOM USING IOT CONNET APPLICATION

[1]**Muliadi***

[1] Informatics and Computer Engineering Education, Universitas Negeri Makassar, Indonesia
* Corresponding author: muliadi744@unm.ac.id

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ABSTRACT

This Uncontrolled and excessive use of water can lead to the scarcity of clean water supplies, considering that the world's fresh water supply is only about 3%. An example of uncontrolled water use is when a tap user forgets to close the tap so this causes water waste. Therefore, a tool is needed that can solve these problems. This research aims to develop an IoT-based system that is able to monitor water levels and detect the presence of a person in the bathroom automatically to reduce water waste and increase user comfort. The system utilizes HC-SR04 ultrasonic sensors to measure the water level in the bathtub and PIR sensors to detect motion as an indicator of the presence of people. The data from the sensors is processed by the ESP32 microcontroller and forwarded to the IoT Connect application, which allows users to monitor the water volume and presence in the bathroom in real-time. The system also features a solenoid valve that automatically opens and closes the water flow according to the data from the sensor, as well as an LED as a visual indicator. Test results show that the system is able to accurately monitor water levels and detect the presence of a person, as well as provide automatic control of water flow to prevent wastage. With the integration of the IoT Connect app, the system offers a practical and innovative solution for bathroom water management.

Keywords: IOT Connect, Selenoid Valve, Water Level Monitoring, ESP32;

1. Introduction

Water is an important part of life and is the source of human life [1]. Uncontrolled and excessive use of water can lead to the scarcity of clean water supply, considering that the world's fresh water supply is only about 3% [2]. This situation can worsen if awareness of the wise use of water is not immediately increased [3]. One example that often occurs is forgetting to close the faucet after use in the bathroom or closing it imperfectly, resulting in wasted water [4]. In addition, another problem is the lack of information regarding the presence of people in the bathroom, which can result in inconvenience for the next user. Therefore, a technology-based solution that is able to monitor water conditions and the presence of people in the bathroom is needed to overcome these problems.

Several studies have developed IoT-based systems to monitor water conditions and the presence of a person in the bathroom. One study utilized PIR sensors and ultrasonic sensors connected to a microcontroller to monitor the water level in the bathtub and the presence of users in the bathroom. Data from the sensors is processed by the microcontroller and generates a response through actuators such as lights and solenoid valves, which are then relayed to the user via a Wi-Fi network [5]. Another study used NodeMCU controlled through the C programming language in the Arduino IDE to control and monitor the water level in the tank through a smartphone device connected to the microcontroller system [6]. In addition, there is research that applies the IoT-based Wemos D1 R1 to stop the flow of water automatically when the bathtub is full, with the help of ultrasonic sensors connected to the microcontroller [7].

Based on relevant research, it can be seen that Internet of Things (IoT) technology has great potential in providing innovative solutions to various daily problems, including water management [8]. However, it can be seen that there is no research that discusses water meter monitoring as well as detecting a person in an IoT-integrated bathroom. Therefore, in this research, an IoT-based system is developed that automatically monitors the water level in the bathtub and detects the presence of users in the bathroom to optimize water usage. As an innovation compared to previous research, this system uses the IoT Connect application as a communication medium between a smartphone and an ESP32 board with Arduino IDE support. This prototype enables remote monitoring and efficient water flow control, so it is expected to be a more practical solution in water management and increased user comfort in the bathroom.

2. Materials and Methods

The manufacturing flow of this water monitoring and person detection system in the bathroom consists of two main components, namely hardware and software. In the hardware part, this system uses various components, including Esp32 board, HC-SR04 ultrasonic sensor, PIR (Passive Infrared) sensor, relay, solenoid valve, and LED indicator. The Esp32 serves as the main microcontroller that processes data from the sensors and sends it to the IoT Connect application via a Wi-Fi connection. The HC-SR04 ultrasonic sensor is used to measure the water level in the bathtub by emitting sound waves and calculating the reflection time as a distance determinant, while the PIR sensor detects movement to determine the presence of someone in the bathroom. Relay components and solenoid valves regulate the flow of water automatically according to the data obtained from the sensors. The system also uses a 12V power supply that is regulated to 5V through stepdown to meet the power needs of the device. In addition, three LEDs are used as visual indicators, displaying the status of the bathroom, such as the presence of people and the water level that has reached the limit. The hardware flowchart can be seen in Figure 1.

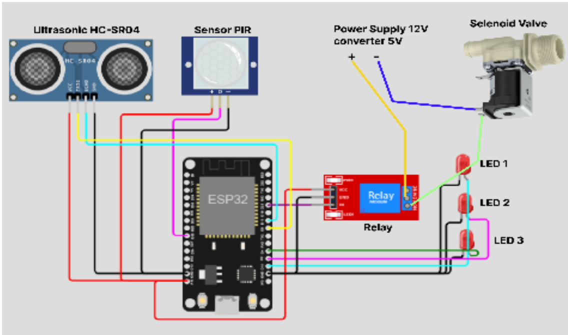

Figure 1. System Hardware Circuit Flow

In figure 1 above, it shows how each component is connected to each other. The ultrasonic and PIR sensors are connected to the esp32 via predefined VCC, GND, Trigger, Echo, and OUT pins, while relays and LEDs are connected to provide control and status visualization. In the software part, the IoT Connect application is used as a link between the esp32 and the user's smartphone, which allows real-time monitoring of sensor data and remote control of the solenoid valve. The flowchart of this monitoring system can be seen in Figure 2.

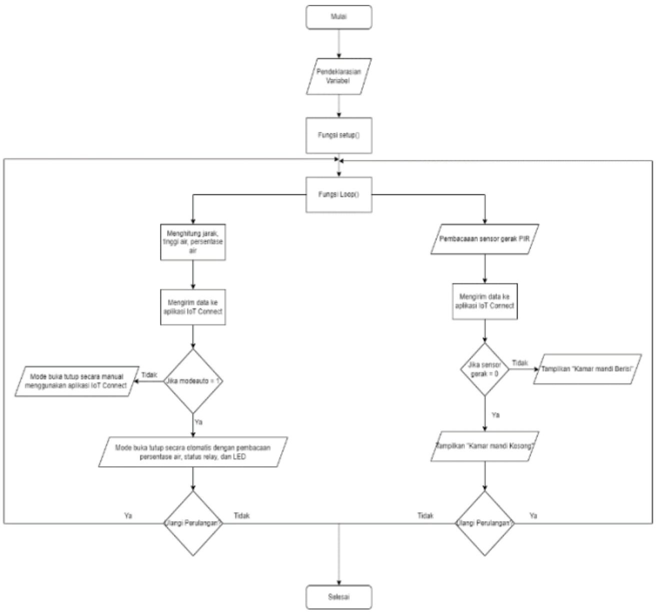

Figure 2. System Software Flowchart

In Figure 2 above, the software workflow begins with a flowchart design that organizes the process of capturing data from sensors, sending data to the IoT Connect application, and the control response sent back to the esp32. Programming is done using the Arduino IDE with the C language, where Esp32 is set to periodically read sensor data, process it, and then send the data to Firebase as an intermediary between Esp32 and the IoT Connect application. This process is facilitated by the FirebaseESP32 Library to integrate Firebase in sending and receiving data. The program code can be seen as follows:

```
#include <WiFi.h>
#include "FirebaseESP32.h"
#define WIFI_SSID "Awasko"
#define WIFI_PASSWORD "123454321"
#define FIREBASE_HOST "iotconnect-7a197-default-rtdb.firebaseio.com/"
#define FIREBASE_AUTH "mXIwoo1VVLfU8AkDxO5Nzvof1hj6W3wW6R7Nt3Tb"
#define s_pir 26

const int trigPin = 5;
const int echoPin = 18;
const int relaypin = 21;
const int ledultra = 15;
const int ledkosong = 2;
const int ledberisi = 4;
const int tinggi_tangki = 30;
//define sound speed in cm/uS
#define SOUND_SPEED 0.034
#define CM_TO_INCH 0.393701

long duration;
float distanceCm;
//float distanceInch;

FirebaseData data4;
FirebaseAuth auth;
FirebaseConfig config;
void printResult(FirebaseData &data);

int modebuka;
int modetutup;
int modeauto;

void setup() {
  Serial.begin(115200); // Starts the serial communication
  pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
  pinMode(echoPin, INPUT); // Sets the echoPin as an Input
   pinMode(s_pir, INPUT);
    pinMode(relaypin, OUTPUT);
    pinMode (ledultra, OUTPUT);
    pinMode (ledkosong, OUTPUT);
    pinMode (ledberisi, OUTPUT);
    WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print("Connecting to WiFi");
  while (WiFi.status() != WL_CONNECTED) {
    Serial.print(".");
    delay(1000);
  }
  Serial.println();
  Serial.println("WiFi connected");
  config.host=FIREBASE_HOST;
  config.signer.tokens.legacy_token=FIREBASE_AUTH;
  Firebase.reconnectWiFi(true);
  Firebase.begin(&config, &auth);
}
```

```
void loop() {
  // Clears the trigPin
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10 micro seconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  bool state_pir = digitalRead (s_pir);
  Serial.println(state_pir);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);

  // Calculate the distance
  distanceCm = duration * SOUND_SPEED/2;
  int tinggi_air = tinggi_tangki - distanceCm;
  float persentase_air = (float)tinggi_air / tinggi_tangki*100;
  String volume = String(persentase_air, 1);
  Firebase.setString(data4, "/proyek/Risvan/sensor/tinggiair", volume);

  // Convert to inches
// distanceInch = distanceCm * CM_TO_INCH;

  // Prints the distance in the Serial Monitor
  Serial.print("persentase air (%): ");
  Serial.println(persentase_air);
//  Serial.print("Distance (inch): ");
//  Serial.println(distanceInch);

if (state_pir == 0){
     Serial.println("Kamar Mandi Kosong");
     digitalWrite(ledkosong, HIGH);
     digitalWrite(ledberisi, LOW);
     Firebase.setString(data4, "/proyek/Risvan/sensor/gerakan", "WC Kosong");
  }
  else {
     Serial.println("Kamar Mandi Berisi");
     digitalWrite(ledberisi, HIGH);
     digitalWrite(ledkosong, LOW);
     Firebase.setString(data4, "/proyek/Risvan/sensor/gerakan", "Ada Orang");
  };

  if(modeauto==1){
    if (persentase_air >= 80){
      digitalWrite(relaypin, LOW);
      digitalWrite(ledultra, HIGH);
    } else if (persentase_air <= 80 && persentase_air >= 30){
      digitalWrite (ledultra, LOW);
    }else if (persentase_air <= 30) {
     digitalWrite(relaypin, HIGH);
     digitalWrite(ledultra, LOW);
    }
  }else if(modebuka==1){
    digitalWrite(relaypin, HIGH);
  }else{
    digitalWrite(relaypin, LOW);
  }
```

```
Firebase.getInt(data4, "/proyek/Risvan/saklar/modebuka");
      modebuka = data4.intData();
  Firebase.getInt(data4, "/proyek/Risvan/saklar/modetutup");
      modetutup = data4.intData();
  Firebase.getInt(data4, "/proyek/Risvan/saklar/modeauto");
      modeauto = data4.intData();
// delay(1000);
}
```

The data collection process in this system takes place every one second for the ultrasonic sensor, where the measurement results are converted into a percentage of the water level in the tank. Meanwhile, the PIR sensor monitors movement every 500 milliseconds to detect the presence of people. The data generated by these two sensors is sent to Firebase whenever there is a significant change in the water level or movement status, and then displayed in real-time on the IoT Connect app. Users can monitor the water condition in the bathroom and the status of the empty or occupied bathroom and set the water flow control as needed.

3. Results and Discussion

After the design process, the implementation of the entire hardware system is assembled to monitor the amount of water and movement in the bathroom. Can be seen in Figure 3 which is the result of the system implementation. There is a PIR sensor for motion detection and an Ultrasonic sensor as a water volume meter.

Figure 3: Inside view of the system

Figure 4. Water and motion monitoring system

The system is also equipped with a control system through the IoT *Connect* application. The display can be seen in Figure 4, where the *user* can control the desired mode either *auto* or manual. There is also a display of water level conditions, which displays the percentage of water volume and detects the movement of a person.

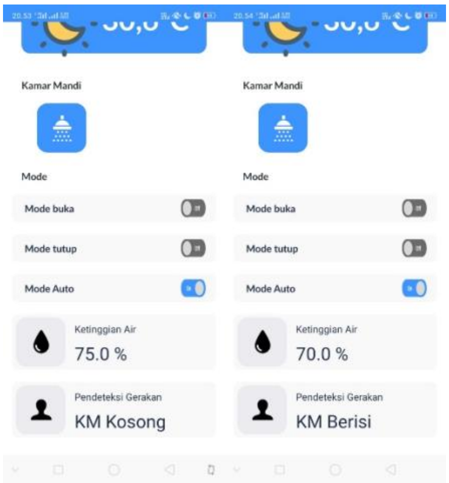

Figure 5. Control application

a. Component Testing

Testing is carried out on two sensors used in this system, namely the PIR sensor and ultrasonic sensor:

Table 1. PIR Sensor Testing

No	Movement	Description
1	Present	Successful
5	Nor Present	Successful

Table 2. Ultrasonic Sensor Testing

No	Water Level	Status	System	Description
1	30%	Empty	On	Successful
2	40%	Empty	On	Successful
3	50%	Empty	On	Successful
4	60%	Empty	On	Successful
5	75%	Empty	Off	Successful
6	70%	Filled	Off	Successful
7	60%	Filled	Off	Successful
8	50%	Filled	Off	Successful
9	40%	Filled	Off	Successful
10	30%	Filled	On	Successful

Table 2 shows the testing of this system, basically the system is divided into two states. When the water is 30% filled, the system will fill the water tank up to 70% and will automatically stop at that height. In addition, from an empty state (30%), water will continue to fill either in a state of 40%, 50%, 60%, or even 70%. However, it is different if the water was previously in a fully filled state (70%), then the water will continue to turn off both in a state of 60%, 50%, and 40%. Until it reaches 30% again. This system is also equipped with an LED if the water is turned on then the blue LED will turn off, otherwise if the water is off then the LED will light up.

Table 3. LED Testing

No	LED	Status	Description
1	Blue	On	Successful
2	Blue	Off	Successful
3	Orange	On	Successful
4	Orange	Off	Successful
5	White	On	Successful
6	White	Off	Successful

Table 3 describes the display on the LEDs in the 3rd system The LEDs used successfully display the various functions desired. When the blue LED is on, the water is full, so there is no water flow. Conversely, if the blue LED is off then the water is being filled. Furthermore, the orange and white LEDs have the same function to display the PIR sensor, where if the white LED is on the orange LED automatically turns off which explains that no movement is detected. Conversely, if the orange LED is on, the white LED automatically turns off which explains that motion is detected.

4. Conclusions

Based on the results obtained, it can be concluded that this research successfully developed a water level monitoring system and detecting the presence of a person in an IoT-based bathroom by utilizing PIR sensors and ultrasonic sensors. Integration with the IoT Connect application allows users to monitor water volume and detect the presence of people in the bathroom in real-time, while providing automatic control of water flow to reduce waste. The system provides a more practical solution in water management and improves user comfort in the bathroom. With the implementation of integrated sensors and automatic settings, the system is not only effective in preventing water wastage but also has the potential to be further developed with additional features, such as water usage pattern analysis.

References

[1] M. Iman Wahyudi and Rifki Abdul Aziz, "Keran Air Wudhu Otomatis Menggunakan Sensor Infrared Sebagai Upaya Meminimalisasi Pemborosan Air," *J. Appl. Comput. Sci. Technol.*, vol. 3, no. 1, pp. 151–156, Jun. 2022, doi: 10.52158/jacost.v3i1.296.

[2] T. M. Hazbi and A. Ma'arif, "Design an Automatic Water Tank Filling Tool Using NodeMCU Based on the Internet of Things," vol. 5, no. 1, 2023.

[3] S. Suhardi, "Keran Air Otomatis Pada Bak Mandi Berbasis Arduino Uno Menggunakan Sensor Ultrasonic," *ALGORITMA J. ILMU Komput. DAN Inform.*, vol. 3, no. 1, p. 48, Apr. 2019, doi: 10.30829/algoritma.v3i1.4438.

[4] A. R. Pramudya, A. Alfeto, and C. Cristianti, "Penggunaan Keran Air Otomatis dalam Penghematan Air," *Ultima Comput. J. Sist. Komput.*, vol. 12, no. 1, pp. 17–22, Jul. 2020, doi: 10.31937/sk.v12i1.1612.

[5] M. O. Prasetio, A. Setiawan, R. D. Gunawan, and Z. Abidin, "Sistem Pengendali Air Tower Rumah Tangga Berbasis Android," *J. Tek. Dan Sist. Komput.*, vol. 1, no. 2, pp. 53–58, Dec. 2020, doi: 10.33365/jtikom.v1i2.45.

[6] R. Hasrul, H. A. Adnan, A. D. Bhaswara, M. A. Atsir, and R. M. Utomo, "Rancang Bangun Prototipe WC Pintar Berbasis Wemos D1R1 Yang Terhubung Pada Android," vol. 5, no. 2, 2021.

[7] H. Irawan and A. R. Kardian, "Rancang Bangun Sistem Cerdas Kamar Mandi Otomatis Berbasis Internet of Things," *J. Ilm. Komputasi*, vol. 19, no. 3, Sep. 2020, doi: 10.32409/jikstik.19.3.61.

[8] A. Achmad, I. S. Areni, E. Palantei, A. D. Achmad, and - Muliadi, "IoT Network of Sensor Array for Intrusion Detection and Diagnosis of Electrical Systems," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 12, no. 2, p. 446, Apr. 2022, doi: 10.18517/ijaseit.12.2.13656.

[9] A. J. Purwanto, D. Darlis, and A. Hartaman, "Perancangan dan Implementasi Smart Bathroom Berbasis IoT," *EProceedings Appl. Sci.*, vol. 5, no. 2, Agustus 2019.