Gyroscope Controlled Robot

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***Abstract*— This paper presents the development and implementation of a gyroscope-controlled robot using an ESP32 microcontroller, DC motors, and a smartphone. The system utilizes the gyroscope in a smartphone to provide intuitive control over the robot's movements. By tilting the smartphone, users can direct the robot to move forward, backward, left, or right. The ESP32, chosen for its integrated WiFi and Bluetooth capabilities, communicates with the smartphone and processes the control signals. DC motors powered by a 18650 lithium-ion battery and controlled by an L298N driver, enable precise and efficient movement. Performance tests on different surfaces demonstrate the system's reliability and responsiveness. This research offers an innovative, user-friendly control solution for mobile robotics, leveraging readily available smartphone technology.**

Keywords*— gyroscope control, ESP32, DC motors, smartphone, mobile robotics, intuitive control

I. INTRODUCTION

The advancement of robotics technology is progressing rapidly in line with the increasing demand for more intelligent and efficient automation systems. One crucial aspect in the development of robots is the control system that enables robots to move and interact with their environment autonomously and adaptively. In this context, the use of a gyroscope as a control tool has become an intriguing research focus because it offers intuitive and accurate control based on the device's orientation.

Gyroscopes, which are commonly integrated into smartphones, are capable of detecting rotation and orientation with high accuracy. They are accurate enough for angular motion tracking in mobile biofeedback applications . This has led to the idea of using them as a tool for controlling robots. Using a smartphone as a robot controller not only enhances interactivity but also leverages existing, easily accessible technology for users. In this study, we developed a robot controlled using a gyroscope from a smartphone.

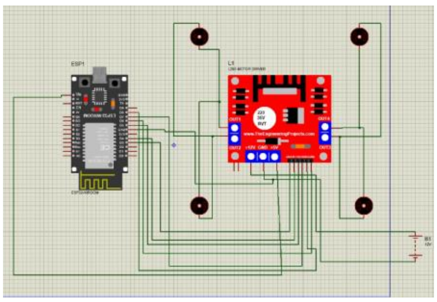
In the development of this robot, we chose to use the ESP32 microcontroller. The ESP32 has become a popular choice in IoT and robotics applications due to its various advantages over similar microcontrollers such as Arduino or Freescale microcontrollers. The ESP32 has a 32-bit buffer that allows for faster and more efficient data processing. Additionally, the ESP32 is equipped with integrated WiFi and Bluetooth capabilities, making it a versatile and cost-effective choice for robotic control applications[1]. DC motors are used as the main actuators in this robot because of their ability to provide high torque at low revolutions per minute (RPM)[2]. These motors are particularly suitable for robotic applications that require well-controlled speed, such as our robot car project. By using DC motors, we can achieve the desired speed for the robot vehicle.

The robot is powered by a 18650 battery, which is a type of rechargeable lithium-ion battery. This battery was chosen for its high energy density and efficient recharging capabilities[3]. The use of this battery ensures that the robot can operate for a long period of time without the need for frequent battery replacements or recharging. To control the motors, we used the L298N motor driver. This is a DC motor driver module used to control the speed and direction of DC motors[4]. The driver offers accurate and reliable control over DC motors, allowing the robot to move according to the instructions given by the control system. The use of a gyroscope on a smartphone to control the direction of the robot offers various advantages, including ease of use and high interactivity. Users can control the direction of the robot's movement simply by tilting their smartphone, which is translated by the system into movement commands for the robot. This control method is not only intuitive but also enhances the user experience in operating the robot[5].

This research aims to explore the effectiveness of gyroscope-based control in mobile robot control and test the system's performance under various operating conditions. We also evaluate the system's reliability and responsiveness in dealing with rapid orientation changes and varying terrain conditions. This study contributes to the field of mobile robotics by offering an innovative and user-friendly control solution. The results of this research are expected to serve as a basis for further development in smarter and more adaptive robot control systems.

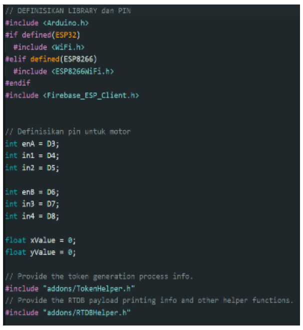
II. REALISASI

A. Schematic

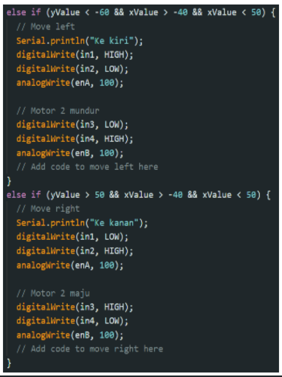


This schematic illustrates the control circuit for a robot using the ESP32 microcontroller and the L298N motor driver. The ESP32 functions as the main controller of the system, with several of its digital pins connected to the L298N motor driver. The L298N module is used to control two DC motors independently through its two channels (Channel A and Channel B). The control pins on the L298N (IN1, IN2, IN3, and IN4) are connected to the digital pins of the ESP32, allowing the ESP32 to send control signals that will regulate the motor's direction of rotation. Additionally, the ENA and ENB pins on the L298N may be connected to the PWM pins of the ESP32 to control motor speed using pulse-width modulation (PWM). The ground (GND) of the ESP32 and the L298N must be connected together to ensure a common voltage reference. The DC motors are connected to the outputs of the L298N, allowing them to be driven according to the control signals provided by the ESP32.

B. Code



```
// DEFINISIKAN LIBRARY dan PIN
#include <Arduino.h>
#if defined(ESP32)
  #include <WiFi.h>
#elif defined(ESP8266)
  #include <ESP8266WiFi.h>
#endif
#include <Firebase_ESP_Client.h>


// Definisikan pin untuk motor
int enA = D3;
int in1 = D4;
int in2 = D5;

int enB = D6;
int in3 = D7;
int in4 = D8;

float xValue = 0;
float yValue = 0;

// Provide the token generation process info.
#include "addons/TokenHelper.h"
// Provide the RTDB payload printing info and other helper functions.
#include "addons/RTDBHelper.h"
```



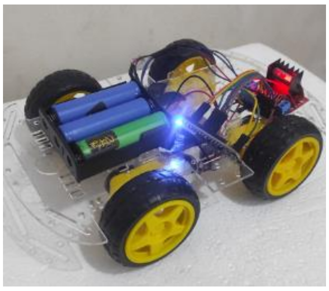
```
else if (yValue < -60 && xValue > -40 && xValue < 50) {
  // Move left
  Serial.println("Ke kiri");
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);
  analogWrite(enA, 100);

  // Motor 2 mundur
  digitalWrite(in3, LOW);
  digitalWrite(in4, HIGH);
  analogWrite(enB, 100);
  // Add code to move left here
}
else if (yValue > 50 && xValue > -40 && xValue < 50) {
  // Move right
  Serial.println("Ke kanan");
  digitalWrite(in1, LOW);
  digitalWrite(in2, HIGH);
  analogWrite(enA, 100);

  // Motor 2 maju
  digitalWrite(in3, HIGH);
  digitalWrite(in4, LOW);
  analogWrite(enB, 100);
  // Add code to move right here
}
```

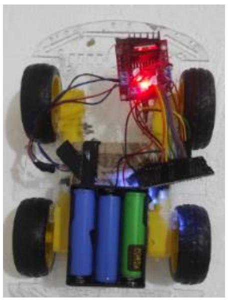
```
// Sign up
if (Firebase.signUp(&config, &auth, "", "")){
  Serial.println("ok");
  signupOK = true;
} else {
  Serial.printf("%s\n", config.signer.signupError.message.c_str());
}

// Assign the callback function for the long running token generation task
config.token_status_callback = tokenStatusCallback; // see addons/TokenHelper.h

Firebase.begin(&config, &auth);
Firebase.reconnectWiFi(true);

// Set pin modes for motor
pinMode(enA, OUTPUT);
pinMode(enB, OUTPUT);
pinMode(in1, OUTPUT);
pinMode(in2, OUTPUT);
pinMode(in3, OUTPUT);
pinMode(in4, OUTPUT);


oid loop() {
if (Firebase.ready() && signupOK) {
  if (Firebase.RTDB.getString(&fbdo, "DHT11/X")) {
    String xStr = fbdo.stringData();
```

```
if (xValue < -40 && yValue > -60 && yValue < 50) {
  // Move forward
  Serial.println("Maju");
  digitalWrite(in1, LOW);
  digitalWrite(in2, HIGH);
  analogWrite(enA, 100);

  // Motor 2 maju
  digitalWrite(in3, LOW);
  digitalWrite(in4, HIGH);
  analogWrite(enB, 100);
  // Add code to move forward here
}
else if (xValue > 50  && yValue > -60 && yValue < 50) {
  // Move backward
  Serial.println("Mundur");
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);
  analogWrite(enA, 100);

  // Motor 2 mundur
  digitalWrite(in3, HIGH);
  digitalWrite(in4, LOW);
  analogWrite(enB, 100);
  // Add code to move backward here
}
```

The code above functions to include necessary libraries and define the pins according to their input and output functions. It then controls the movement of the robot based on the X and Y values obtained from the gyroscope with the following rules: If the X value is less than -40 and the Y value is between -60 and 50, the robot will move forward; if the X value is greater than 50 and the Y value is between -60 and 50, the robot will move backward; if the Y value is less than -60 and the X value is between -40 and 50, the robot will move to the left; and if the Y value is greater than 50 and the X value is between -40 and 50, the robot will move to the right.

III. TESTING





Testing was conducted to evaluate the performance of the robot control system developed using a smartphone gyroscope as the control tool. This testing involved several stages, including basic functionality testing, system responsiveness testing, and performance testing under different conditions.

A. Basic Functionality Testing

Objective: Ensure that all system components function as expected.

Steps:

- Assemble the robot according to the planned design.
- Ensure all components are correctly connected and functioning.
- Perform simple trials to ensure the robot can be controlled using the smartphone gyroscope..

B. *Performance Testing Under Different Conditions*

Objective: Assess reliability and stability under different conditions.

Steps:

- Prepare various types of surfaces (ceramic floor and carpet surface).
- Operate the robot on each surface.
- Observe and record the robot's performance on different terrains..

IV. TEST RESULTS

A. Test Result

The basic functionality tests show that all system components function well. The robot can move according to the commands given through the smartphone gyroscope. There were no connectivity issues between the smartphone and the robot.

B. Performance Testing Results Under different conditions

- Ceramic Floor: The robot moves stably.
- Carpet Surface: The robot struggles to move.

C. Test Result Analysis

The testing shows that the robot control system using the smartphone gyroscope as the control tool works well and is responsive. The system operates satisfactorily on ceramic floors. However, on carpeted areas, the robot requires improvements in its power source, as it has difficulty moving.

Link Testing Results: https://drive.google.com/drive/folders/1z5UC0KbwxNM3YBjUn39UZd-nDxzJmXnj?usp=sharing

V. CONCLUSION

This research successfully developed an innovative robot control system using a gyroscope on a smartphone as the main control tool. The developed system involves the use of ESP32 as the microcontroller, DC gearbox motors as the main actuators, 18650 batteries as the power source, and L298N driver to control the motors. The use of the gyroscope from the smartphone allows intuitive and responsive control, giving users the ability to control the robot by simply tilting their smartphone. The results show that this system is not only easy to use but also highly effective in providing accurate and stable control of the robot. Testing the system in various operating conditions demonstrates that gyroscope-based control can cope with rapid orientation changes and adapt to various terrains, making it highly suitable for robotic applications that require flexibility and agility.

The success in using ESP32 as the microcontroller demonstrates the device's great potential in IoT and robotics applications, especially due to its ability to integrate various sensors and communication modules. Additionally, the use of DC gearbox motors has proven to provide optimal performance in terms of torque and speed, which is crucial for various robotic applications.

The use of 18650 batteries as a power source also demonstrates high efficiency in supporting the robot's operation over a long period. Meanwhile, the L298N driver has proven reliable in controlling the speed and direction of the DC motors, making it a key component in this control system. This study contributes significantly to the field of mobile robotics by offering an innovative and user-friendly control solution. By leveraging existing technologies such as the gyroscope on smartphones, this research paves the way for the development of smarter robot control systems that are more accessible to the general public. Furthermore, the success of this research demonstrates that the combination of the ESP32 microcontroller, DC gearbox motors, 18650 batteries, and L298N driver can serve as a strong foundation for further developments in robotic systems. Overall, this research not only proves the effectiveness of gyroscope-based control but also shows the great potential of integrating these technologies.

The results of this research are expected to serve as a reference for other researchers and developers in developing more advanced and adaptive robot control systems, which can contribute to the advancement of robotics and automation technology.

However, this research also has some limitations that need to be considered. For example, the performance of the system under extreme environmental conditions has not been thoroughly tested. Therefore, further research is needed to test and improve the system's resilience in various operating conditions. Additionally, integration with other technologies such as artificial intelligence and machine learning could be the next step in developing smarter and autonomous robot control systems. In conclusion, this research emphasizes the importance of innovation in robotic control and demonstrates how existing technologies can be leveraged to create efficient, effective, and user-friendly systems. Focusing on the use of the gyroscope from a smartphone, ESP32, DC gearbox motors, 18650 batteries, and L298N driver, this research offers insights and practical solutions that can be adopted and further developed for various robotic applications in the future

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