

Design and Construction of a Self-Balancing Robot Using Long Range Control Based on NRF24L01

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Abstract- At first, robots were created to replace routine human work, requiring a high level of precision, and also to replace humans in dangerous situations. Robots that have the ability to maintain self-balance are called Self Balancing Robots. The Self Balancing Robot is the result of the development of an inverted pendulum model which is positioned on top of a wheeled train. The robot is controlled using a remote control using NRF 24L01 which can be controlled remotely. And to find out the situation in running the robot which is controlled from the remote using To detect the tilt angle of the robot, the MPU6050 sensor is used which is a module that integrates three sensors, namely the gyroscope and accelerometer on three different axes.

Keywords— Self Balancing Robot, Sensor MPU6050, NRF24L01.

I. INTRODUCTION

In the 21st century, technology has experienced rapid development, especially in the field of wireless communication (wireless). The use of robots today has covered various aspects and jobs previously performed by humans. This technology has completely changed the way we live. Therefore, it takes innovative thinking to take advantage of equipment and make people's work easier in the future. Likewise, the field of computer systems requires automating everything that can reduce human labor and make everything practical and economical. At present, advances in robotics technology have succeeded in improving the quality and quantity of production in various industries. An approach to advance robot intelligence to add sensors, control methods, and provide artificial intelligence (artificial intelligence) on the robot. One example is a two-wheeled balancing robot that can utilize such technology to achieve a higher level of intelligence [1]. Balance Robot is one type of robot that is able to stand upright premises using two wheels on both sides, balance robot has characteristics with fast dynamics, unstable, and nonlinear [2]. The first balancing robot system was announced by Dean Kamen in 2001 as the SEGWAY, known as the "first self-propelled electric Transporter".

In a previous study by [3] the only main focus of this robot is to maintain the position and balance of the robot perpendicular to the Earth's surface on a flat plane. This can be achieved by applying the proportional Integral derivative (PID) control method.

Based on some of the reasons above, the researchers tried to create and design a Self Balancing robot that can be controlled by remote using Arduino UNO, MPU 6050 sensor that contains a gyroscope to balance the robot, and NRF24L01 transceiver that can be controlled remotely used to connect the Self Balancing robot control, so that the robot can move as expected author. Therefore the author made the title "design of Self Balancing robot using Long Range using NRF24L01"

II. METHOD

A. Hardware

Sourced several reasons above, the inventor tried to make and design a Self-Balancing robot that can be controlled by remote using Arduino UNO, MPU 6050 sensor contained gyroscope to balance the robot, and NRF24L01 transceiver that can be controlled remotely used to connect the robot Self-Balancing control, so that the robot can move as expected author.

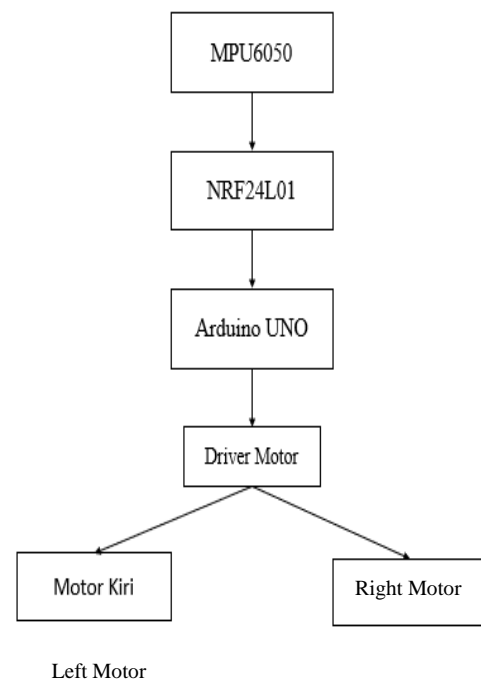


Fig 1. Block diagram

The block Diagram depicted above can be described the function of each component as follows:

1. Sensor MPU6050
Serving as an input to the robot to adjust the robot's balance, the MPU6050 has built-in accelerometer and Gyroscope sensors.
2. Sensor NRF24L01
As the control center of the entire system and manages the signals sent by the sensors to determine whether a fire really occurred. If true, Arduino uno will send a fire signal to the buzzer and GSM SIM module to be continued to the number that has been connected to this tool.

3. Arduino Uno
Serves for long-distance or wireless communication using 2.4 GHz RF waves commonly applied in the scientific, industrial, and medical fields. Used as a connecting device from remote to robot balancing
4. Driver Motor
As a DC motor speed regulator that drives the robot and is connected to the Arduino UNO.
5. Left right stepper motor
Actuators are widely used in robotic applications for running robots.

B. Product Design

The product design of this Self Balancing robot consists of several components such as MPU6050 sensor, motor driver, stepper motor, Arduino UNO, lippo 12V battery.



Fig 2. Product design

C. Wiring Diagram

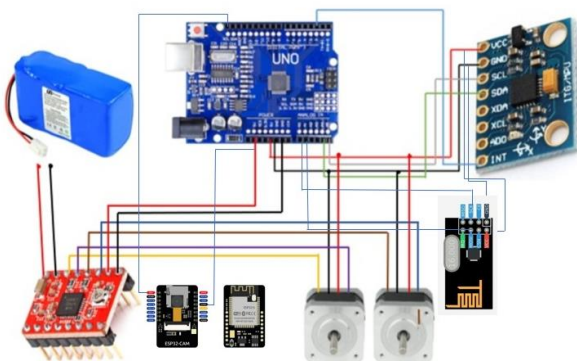


Fig 3. Wiring Diagram

D. Product Test

Product testing is done to evaluate what tools that have been designed can function equally well and meet the desired requirements. Here are some examples of product testing that will be conducted by researchers:

- a. Testing distance of Self Balancing robot

Distance testing is done with the author stationary in one place and then move the robot to walk in open space or closed obstacles/walls

- b. Transportable load testing Self balancing robot

The load test was carried out in a manner almost similar to the first Test but this time it was only tested within a predetermined distance.

- c. Gyroscope sensor testing

This test is done to find out how the sensor responds to a certain slope.

E. Variables and Operational Definitions of Variables

A variable is a value or element that can change or make changes to other elements. This value can change according to the object or the will of the creator himself. In this study used several variables to determine the value of some of the components used, namely:

1. Independent variable

The independent variable in this study is a data taken from the robot balancing test. Free Variable in testing the maximum distance traveled robot balancing in open space is the data input distance robot balancing in open space free variable that can be in testing distance robot balancing in a closed space is the data input distance robot balancing in a closed room, and the free variable of the carrying capacity of the robot balancing is a load data (grams) that can be transported balancing robot.

2. Dependent variable

The dependent variable in this study is a data taken from the robot balancing test. Bound variables of the maximum distance testing robot balancing open space is the Output of the results of the maximum distance in the open space, the variable of the maximum distance testing robot balancing in a closed space is the Output of the results of the maximum distance balancing robot in a closed room. And the dependent variable of the load balancing robot is the Output of the load balancing robot successfully tested.

F. Data Analysis Methods

The method used by the author to analyze the data is the comparative method, where the comparative method is a study that compares the presence of one or more variables in two different samples or at different times.

Previously, research has created a balancing robot that focuses only on maintaining the position of the robot in equilibrium and perpendicular to the Earth's surface in a flat plane using the proportional Integral derivative (PID) control method. Currently, the author has developed a new balancing robot that can be controlled remotely with the title "design of Self Balancing Robot using long Range Control based NRF24L01".

III. RESULTS AND DISCUSSION

A. Results and Product Evaluation

The results and evaluation aims to determine whether the product can be used or there is still something that needs to be improved, so that the presentation of data in the tool can be done optimally.

B. Presentation Of Data

Based on the experiments conducted, the analysis of the data obtained produce some data as follows :

1) Testing distance of Self Balancing robot

Done in order to determine the extent to which Self-Balancing Robot can be controlled by the author in an open room or with a closed room in the form of a wall.

TABLE I. OPEN SPACE TESTING

No.	Distance Covered by Open Space	Connected	Not Connected
1.	5 Meters	Connected	
2.	10 Meters	Connected	
3.	15 Meters	Connected	
4.	20 Meters	Connected	
5.	25 Meters	Connected	

TABLE II. ENCLOSED SPACE TESTING

No.	Distance Covered by Closed Space	Connected	Not Connected
1.	5 Meters	Connected	
2.	10 Meters	Connected	
3.	15 Meters		Not Connected
4.	20 Meters		Not Connected
5.	25 Meters		Not Connected

2) Load testing Self balancing robot

The load test is performed in order to determine the maximum weight that can be transported by the robot by maintaining its balance.

TABLE III. LOAD TESTING

No.	Weight (grams)	Balanced	Unbalanced
1.	30 grams	Balanced	
2.	60 grams	Balanced	
3.	90 grams	Balanced	
4.	120 grams	Balanced	
5.	150 grams		Unbalanced

3) Gyroscope sensor testing

Testing of the MPU6050 sensor was carried out using a serial monitor in the Arduino IDE application. The purpose of this test is to observe the response of the sensor to a given slope. Using serial monitor, data from the MPU6050 sensor can be monitored and analyzed in real-time to understand how the sensor responds to tilt changes. Gyroscope Sensor produces an output in the form of analog voltage values to be read by the microcontroller. To read the slope of the balancing robot, the analog voltage value of this sensor will be converted into a digital value through the process of Analog to Digital Converter (ADC). The ADC process converts analog signals into digital values that can be processed and used by the microcontroller to measure the tilt of the robot and take appropriate measures to maintain balance.

TABLE IV. GYROSCOPE SENSOR TESTING

No.	Corner Starting Point	Gyroscope ADC Sensor Value	Error
1.	0	282	282
2.	30	302	22

3.	60	316	256
4.	90	350	260
5.	120	378	258
6.	150	402	252
7.	180	420	240

C. Data Analysis

Based on Table 4 can be described as follows diagram :

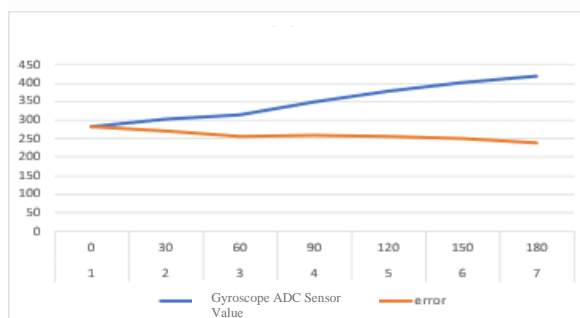


Fig. 4. Graphic image of gyroscope sensor ADC

In the picture there is a data display where the results of the data taken on the gyroscope testing is used to drive a stepper motor, to make commands in running the stepper motor on the Self Balancing robot.

D. Discussion

After doing some testing as above, the author can explain based on Table 1 the success rate of Self Balancing Robot reaches 90% because Self Balancing robot is able to control in open space from the author's position with a maximum distance of 25 meters, but if the distance exceeds 25 meters the robot cannot be controlled by the user. While in Table 2 the success rate of Self-Balancing robot is controlled in a closed room / obstacle in the form of a robot WALL can be controlled only 10 meters from the position of the author, and in Table 4.3 on the load test that can be carried Self Balancing Robot in order to remain balanced when moved by the author through the joystick controller of 120 grams, if the load exceeds 120 grams of the robot will not be balanced after doing some testing as above, the author can some data such as the system can read the Gyroscope sensor when there is a slope of more than 0°. While the balancing robot will work based on a stepper motor, if the control reads the movement of the joystick module, then the stepper motor will move in the direction of the joystick. In general, the robot balancing control system using gyroscope sensor consists of input, process and output. Part enter (input) of this system is a change in the degree of inclination, part of the process of this system is Arduino uno by using a PC/computer. The output part is used by the stepper motor to control the balancing robot.

IV. CONCLUSION

Based on the results of the design of Self Balancing Robot that has been designed by the author, it can be concluded:

1. The author managed to design a Self-Balancing Robot driven by remote control.

2. MPU6050 Sensor and Arduino successfully designed as a Self-Balancing Robot controller, NRF24L01 capable of being used for connecting between robots with remote control, and stepper motors as robot actuators

V. REFERENCES

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