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LED and Servo Motor Control Via Bluetooth Based on Android Applications

Iswanto, Joniq Syaftriadi, Anna Nur Nazilah Chamim, Rama Okta Wiyagi, Ramadoni Syahputra

Abstract: ***Remote control is needed to control household appliances and office equipment from a distance by turning them on/off. This control is designed using Bluetooth connected to the circuit using an LED for light control indicator and a servo motor circuit for curtain control connected to the Arduino UNO microcontroller as a minimum system. The Arduino microcontroller is used to process command data from the input of the Android-based Bluetooth signal receiver used as the remote-control button to control the LED and rotate servo motor. This hardware is designed using the Arduino UNO module, LED circuit and servo motor. A serial Bluetooth module was used for communication between the hardware and Android smartphones. Having tested the entire tool system and the Android control application, it was found that the device and the application worked well. However, it is only able to receive the data sent from the Android application, but not able to transfer the data from the system to the Android handset.***

Index Terms*: *android, bluetooth, arduino, microcontroller.

I. INTRODUCTION

The advance of technology in communication continues to develop sophisticatedly and ease almost all communication activities of human life. This is inseparable from companies that create and provide flexibility for mobile phone developers to continuously experiment in creating and processing applications, one of which is the Android mobile operating system. Android makes an open platform available for developers to create applications that can be run in various mobile devices such as smartphones, tablets and others. This quickly increase a number of application program developer communities for Android. One of the examples of Android application is remote control application. Remote control is a controller needed to control equipment from a wide range using wireless technology.

Remote control using wireless technology has been studied by previous researchers. Patel examined research on a new fire extinguisher robot vehicle managed by an android application. The robotic vehicle uses an AVR ATMega-32 Microcontroller carrying water tankers and a pump controlled via wireless communication to splash water [1]. The application of Xbee pro module for managing and observing earthquake locations with a robotic control system was investigated by Adewasti. The tool used Xbee Pro and Arduino microcontroller and as the medium of communication between robot and the remote control. It also used motor driver, DC and servo motors, wireless camera and cellphone as the DC motor drive, camera drive, robot drive, and monitoring device respectively. The results of the research showed that the robot can move and run the commands given from the distance of further than twenty meters indoors, and remain connected to cellphones to monitor earthquake locations [2]. Kuruba investigated surveillance rover for remote areas. using basic modules such as Global for Cellular (GSM) system technology and Dual Tone Multi-Frequency (DTMF) modified and used effectively as a control system [3]. The robotic system for remote hackathon robotics was examined by Korchagin. The system consisted of Troyka Shield and Shield Motor expansion modules, an Arduino UNO board module, two digital line sensors, two Feetech DC-130D gear motors, three Feetech FS90 servo drives and a Sharp GP2Y0A21 infrared proximity sensor [4]. IoT-Based Automatic Electric Monitoring and Remote Load Control Systems Using PIC18F4550 was examined by Islamic Mozumder. Digital energy meters connected to cloud servers through IoT devices. This tool sent the amount of energy consumed by customers connected to the web server [5]. The development of movement-controlled robotic arms was investigated by Jiang. The result of the research found that the robotic arm is completely functional and accurately reacts to the movements of the users. Human users attached two accelerometers on their arms. The accelerometers convey information about position and velocity vectors to the robot arms [6]. Alsibai conducted research on intelligent driver monitoring system utilizing Android applications and embedded systems. This system combined smartphone applications and embedded controllers to build intelligent monitoring and monitoring systems for driver employees. Currently, the smartphone is equipped with many useful built-in sensors.

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***** Correspondence Author
Iswanto*, Department of Electrical Engineering Universitas Muhammadiyah Yogyakarta
Joniq Syaftriadi, Department of Electrical Engineering Universitas Muhammadiyah Yogyakarta
Anna Nur Nazilah Chamim, Department of Electrical Engineering Universitas Muhammadiyah Yogyakarta
Rama Okta Wiyagi, Department of Electrical Engineering Universitas Muhammadiyah Yogyakarta
Ramadoni Syahputra, Department of Electrical Engineering Universitas Muhammadiyah Yogyakarta

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A Bluetooth module exchanges data between smartphones, embedded controllers, and internal and external sensors [7]. Siregar studied remote monitoring system for hydroponic growing media. Hydroponic systems require precision, patience, and regular monitoring. Monitoring system designed with an Electrical Conductivity Sensor, a PH sensor, a light sensor, water and air temperature sensors, GSM/GPRS, Open Garden Shields, Open Garden Hydroponics, and an Arduino Uno microcontroller [8]. Jha's field monitoring using IoT in agriculture was investigated. For good results, a farmer needs to monitor demand from time to time. The proposed monitoring uses an IoT device that will provide live soil moisture, humidity and field temperature for farmers. Arduino microcontrollers with ground sensors, temperature and humidity are used to collect data from those submitted quickly from a long distance field [9].

IoT based agricultural automation was researched by Ahmed. The smart farming system provides information on irrigation water and fertilizer issues and creates a suitable climate for increasing crops produced on agriculture. The agricultural control system uses soil moisture sensors and climate sensors. Irrigation systems, temperature and humidity can be monitored via the internet and automatically and controlled if certain criteria differ from the reference value [10]. IoT based intelligent warehouse management was studied by Sung. This system uses an Arduino and LORA microcontroller as a remote transmitter and receiver. RFID tags were used to provide information and location of goods, while temperature, humidity, infrared and gas sensors were used to monitor the internal condition of the warehouse to make sure the safety of goods [11]. Wireless electrocardiogragphy in monitoring extreme heart rates with global positioning capabilities to localize remote specimens was examined by Landicho. It was a monitoring system using microcontrollers with user remote localization, heartbeat sensors, GPS, and GSM. The result of this integration is that the system is able to monitor a person's Beats per Minute (BPM) pulse involved in an activity and the location of that person. Reflective optical sensors are used as Heart Rate Monitors [12].

Communication technology with android is commonly used with microcontroller devices as one of the control systems. This makes the idea of designing and manufacturing an electronic circuit control such as LED and servo motor controls with an Android smartphone via Bluetooth communication. This device can control the LED or rotate the servo motor remotely without cables.

II. RESEARCH METHOD

The design of LED controllers and long-range servo motors using bluetooth consisting of input blocks, signal processing blocks, and output blocks as shown in the block diagram in figure 1. The figure shows that the system uses Bluetooth to send the data received by the Arduino microcontroller [13]–[16]. A power voltage is used to supply power to the series of the device. The power used is 9V DC via a DC plug/connector on the Arduino module. The input power that enters the Arduino module then passes through the 5V DC regulator circuit contained in the Arduino module so that the power to be used to supply Arduino micro IC and other components is 5V DC. The power for the Bluetooth module, servo motor, LED circuits and LDR sensor is the power from the 5V Arduino module power pin.

The control application on the Android smartphone sends the data to the Arduino module via communication between the Bluetooth smartphone and the serial Bluetooth module. The data received from the Android control application will then be processed in the microcontroller on the Arduino module to be executed into high/ON or low/OFF signal on the LED output and a PWM signal for the servo motor rotary output. The LDR sensor functions as the reader/detector from the ON/OFF of the LED that is controlled. The LED indicator is functioned only as the sign of the reading of the LDR sensor to the controlled LED, which will be ON if the LED output is ON and will be OFF if the LED output is OFF.

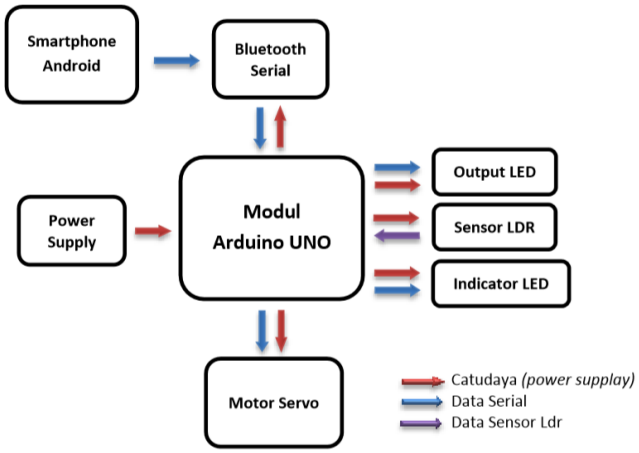

Figure 1. Block diagram of the system

Based on figure 1 of the block diagram, the design of the hardware is made as shown in figure 2. the fiure shows that the power supply is obtained from an adapter circuit with 9V DC output voltage connected to the Arduino module DC plug/connector. While the power supply used to supply Bluetooth, LED, servo and LDR circuit boards are obtained from the 5V Arduino module power pin.

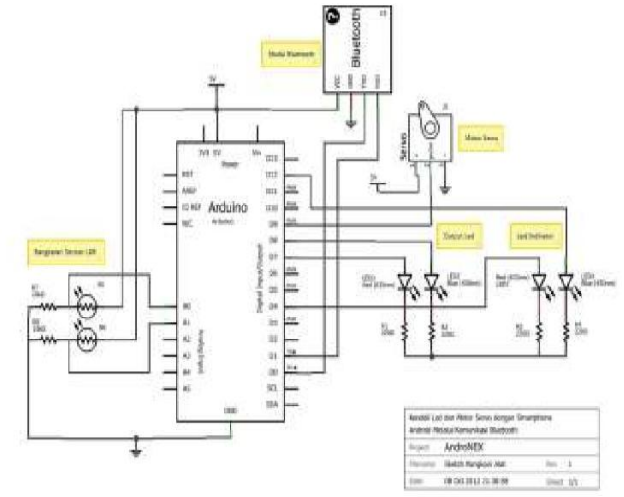

Figure 2. Hardware design

Software design There are 2 software designs created for Android program applications and for Arduino program. Figure 3 shows the flowchart of the Android program, while figure 4 shows the flow diagram of the Arduino program. Figure 4 illustrates how the application program works: Android Start App is to start the program. Initialize Screen & Reset is to do an initialization process on the interface. Bluetooth List is the provision of a Bluetooth place to connect. Bluetooth Select means the selected Bluetooth list will be saved. Bluetooth Connect is the process of connecting between Bluetooth. If the ON 1 button is pressed, the application will send the data 'to' for LED 1 ON. If the OFF 1 button is pressed, it will send the data 'b' to LED 1 OFF. If the ON 2 button is pressed, it will send the data 'c' to LED 2 ON. If the OFF 2 button is pressed, it will send the data 'd' to LED 2 OFF. If the 'Left' button is pressed, it will send the data 'l' to turn the servo to the left at the position of 1800. If the '<0>' button is pressedit will send the data n 'to turn the servo to neutral at the position of 900. If 'Right' button is pressed, it will send the data 'r' to turn the servo to the right at the position of 00. The position of the servo rotation degree in the textbox is in the range from 0 to 180 = val. If the 'Send' button is pressed, it will input value (val). If the 'Disconnect' button is pressed, it will disconnect from the Bluetooth and reset all button functions and displays. If the 'Exit' button is pressed, it will exit the application. End App is ending the program.

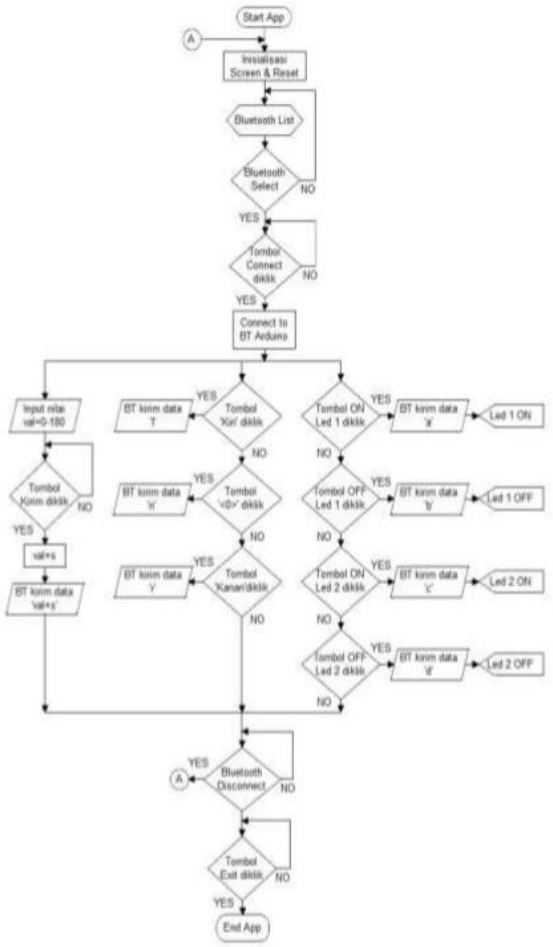

Figure 3. Workflow diagram of Android program

The design of the Arduino program is shown in figure 4. The figure shows the workflow of the program. It is initialized by activating the register of variables, port I/O and serial. Receiving the data; if there is no data received then check the UDR register again. If yes, save the data in the character c. Inputting numbers and converting them to decimal values; If c receives the 'data', set the servo with the val input value then reset the value val = 0 so that it can be input with the new value. If c receives the data 'a', LED 1 and indicator 1 will be ON. If c receives the data "b", LED 1 and indicator 1 will be OFF. If c receives the data 'c', LED 2 and indicator 2 will be ON. If c receives the data 'd', LED 2 and indicator 2 will be OFF. If c receives the data 'r', set the servo to position 00 or to rotate right. If c receives the data 'n', set the servo to the position of 900 or servo neutral position. If c receives the data 'l', set the servo to the position of 1800 or to turn left.

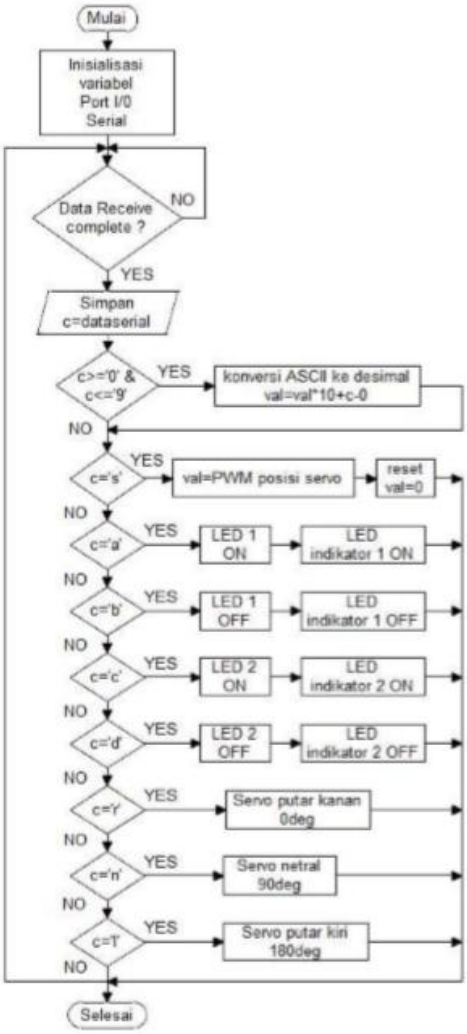

Figure 4. Workflow diagram of Arduino program

III. DISCUSSION

The design of interface control on the smartphone designed in the App-Inventor is shown in Figure 5. It appears that there is a connection and disconnect buttons. The button is used to connect with the LED circuit and servo motor using a Bluetooth connection. The ON and OFF buttons are used to turn on and off the led. While the left and right buttons are used to rotate the servo motor left and right.

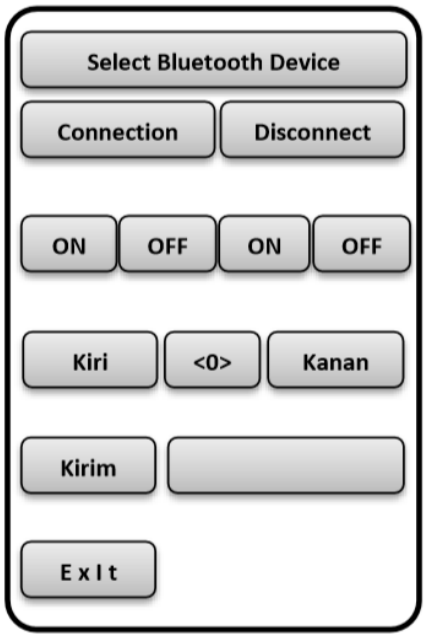

Figure 5. Design of interface control on smartphone

LED control testing

Based on the results of the test on the controlled LED output circuit, the Arduino module pin 7 and 8 produced an output voltage of 80 mV when the LED is OFF and 4.88V when the LED is ON.

Table 1. Android application test with LED circuits

Aplikasi *(jika tombol diklik)*	Led output		Led indikator	
	Led1	Led2	Ind1	Ind2
Tombol ON Led1	On	x	On	X
Tombol OFF Led1	Off	x	Off	X
Tombol ON Led2	x	On	x	On
Tombol OFF Led2	x	Off	x	Off

Servo motor test

The servo motor was tested by giving PWM pulses on pin 9 of the Arduino module (OC1A) using Timer1 16MHz external clock system (Fosc). The reason for using Timer1 because this timer holds 16 bits of data so that a large resolution can be produced. The greater the resolution, the smoother the servo movement. Conversely, if the resolution is small, the servo movement will clog up. The PWM mode used was Phase and Frequency Correct PWM with a pre-scale value (N) of 8.

Table 2. Android application test with servo motors

Aplikasi	Motor Servo		
	0^0	90^0	180^0
Tombol Kiri	x	x	√
Tombol <0>	x	√	x
Tombol Kanan	√	x	x
Tombol Kirim	Sesuai input posisi		

Because the servo motor used a short swivel arm, if the test was performed by giving input values of degree angles that were too small, the movement would be less visible so that the angular changes that occur were not very observable. For example, if it was given give an angle value per 1 degree.

Testing Android applications with devices

Table 3 displays the results of the Android application test on each component. It was found that the performance of the final product can run well in accordance with the design. The applications on Android handsets can be connected to device system and be operated to control the device. The power supply circuit produces a DC output voltage of 9.03. The application can be installed and operated on the Android operating system version 2.3.4 Gingerbread and Android version 4.0 Ice Cream Sandwich.

Table 3. Android application test with servo motors.

Nama komponen	Fungsi	Status
Tombol *Select Bluetooth Device*	Pilih koneksi Bluetooth dengan alat	Berhasil
Tombol *Connection*	Melakukan koneksi dengan alat	Berhasil
Tombol *Disconnect*	Memutuskan koneksi dengan alat	Berhasil
Tombol ON	Menghidupkan Led	Berhasil
Tombol OFF	Mematikan Led	Berhasil
Tombol Kiri	Menggerakkan motor servo ke posisi 180^0	Berhasil
Tombol <0>	Menggerakkan motor servo ke posisi 90^0	Berhasil
Tombol Kanan	Menggerakkan motor servo ke posisi 0^0	Berhasil
Tombol Kirim	Menggerakkan motor servo sesuai input posisi	Berhasil
Textbox	Memberi input posisi putar motor servo	Berhasil
Tombol Exit	Keluar dari aplikasi	Berhasil
Notifikasi Status koneksi dan on/off Led	Menampilkan status koneksi Bluetooth dan On/Off Led pada *screen*	Berhasil

IV. CONCLUSION

The research process has succeeded in creating a system as a tool for sending and receiving data to control the motion of the robot wheels using Bluetooth. The tests were carried out to see the robot's speed. The test result showed that the speed of the robot is average 0.56 m/s in 3 meters, depending on the battery voltage conditions. The pairing can reach 13 meters and the process of sending the data is thriving.

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AUTHORS PROFILE

Iswanto was born in Sleman, Yogyakarta, Indonesia, in 1981. He received the B.S degree and M.Eng degree from Universitas Gadjah Mada, Yogyakarta, Indonesia in 2007 and 2009. Now, he is on Phd Program at Universitas Gadjah Mada. He has been a Lecturer and Researcher in the Electrical Engineering Department at Universitas Muhammadiyah Yogyakarta since 2010. His current research is focused on formation control, path planning and Control UAV.