Electric Control Equipment Based on Arduino Relay

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Abstract. Many accidents caused by the use of control systems which is not in accordance with the standards, both in the home and in the building. This study aims to create an Arduino Relay based control device (according to the application design and electrical installation design), which can control and secure electrical devices (TV, rice cooker, reservoir, lamp, and electric safety). The system control is contained in a building/house, to avoid the danger of short circuit and fire, as well as saving on the use of electrical energy. Research shows that the control equipment has functioned properly, so it can secure and control all the electrical devices contained in a building/house, either from close range or remotely using a smartphone.

Keywords: Arduino Relay, control device, electrical devices, control equipment

1. Introduction
Nowadays, technology advancement has contributed to human welfare. The people use many electrical devices for comfort and convenience in household activities. However, many incidents of building fire due to incorrect electrical installation [1]. There have been many accidents and losses caused by improper installation and control of electricity. Generally, the electrical installation in the house is assembled by Nasional Electrical Company and not being a private domain. In Indonesia, the standard for installing electrical installations has been contained in the General Regulation of Electrical Installation. Unfortunately, there are still many detelictions about the installation. Carelessness in the installation and control of electrical installations can be fatal consequences. For example, many houses burned due to an electrical short circuit has the potential to propagate the fire to the surrounding buildings. There has been a lot of news on media about fires occurred due to electricity.

One of the security systems for the use of electronic devices in households is Arduino Relay-based Control [2]. This tool uses a microcontroller as a brain equipped with smartphone technology. One of the usability of Arduino Relay as safety and controller of electrical devices is using the close range and remotely depends on consumer desires.

Arduino is an open source electronic kit specifically designed to make everyone easier in developing electronic devices that can interact with various sensors and controllers. Arduino DueMilanove is an ATMega 328 microcontroller board [3]. This microcontroller board has 14 digital input/output pins (6 of them can be used as PWM outputs), 6 analog inputs, 16MHz crystal oscillators, USB connections, and ICSP headers.
Arduino is a microcontroller board based on ATmega328. The Arduino has 14 input/output pins where 6 pins can be used as PWM outputs, 6 analog inputs, a 16 MHz crystal oscillator, USB connection, power jack, ICSP head, and reset button. Arduino is able to support micro-controllers; can be connected to a computer using a USB cable. Arduino can be given power via USB connection or power supply. The power automatically inhibits the entry of electricity. The power supply can use a DC adapter or battery. The adapter can be connected to a striking adapter jack on the input supply port connection. Arduino board can be operated using an external supply of 6-20 volts. If the supply is less than 7V, sometimes 5V pins will supply less than 5 volts, and the board can become unstable. If using more than 12 V, the voltage in the regulator can become exhausted and cause damage to the board. Voltage recommendations are from 7 to 12 volts.

The input voltage to the Arduino board use voltage from the outside (as mentioned 5 volts from a USB connection or regulated voltage). Users can provide voltage through this pin, or if the supply voltage uses a power jack, it can be access to this pin. Power supply regulation is used to power the microcontroller and other components on the board. 5V can go through Vin using a regulator on the board, or supply by USB or other 5V regulation supply. 3.3 volt supply is obtained by the FTDI chip on the board. The maximum current is 50mA. The Pin Ground serves as a ground line on Arduino. ATmega328 has 32 KB of flash memory for storing code. Also, 2 Kb for bootloaders and ATmega328 has 2 Kb for SRAM.

Every 14 digital pins on an Arduino can be used as input or output, using the pin Mode, digital Write, and digital Read. Input/output is operated at 5 volts. Each pin can produce or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) 20-50 ms. Some pins have the following functions: Serial: 0 (RX) and 1 (TX). Used to receive (RX) and send (TX) TTL serial data. This pin is connected to the corresponding pin from the USB FTDI to the TTL serial chip. External interrupts on pins 2 and 3. This pin can be configured to trigger an interact in low value, rising or falling edge, or change in value. PWM 3, 5, 6, 9, 10 and 11 functions support 8-bit PWM output with analogWrite function. SPI 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK) are SPI communication support pins, which still support hardware, which is not included in the Arduino language. The 13 LED will be connected pin 13. When the pin is HIGH, the LED is on, when the LOW pin, the LED turns off.

One of the Arduino complement is a relay. The relay is a simple electronic circuit and is composed of Switch, Electromagnetic field (wire coil) and Iron shaft. This component start to work when the electric current flows through the coil, then makes the surrounding magnetic field change the position of the switch to produce a larger electric current. The main point of this simple component is its minimal form can produce a larger current. This simple component in its development was used as a basic component of various electronic devices, vehicle lights, electronic networks, television, radio, even in the 1930s, it was used as a basic computing device whose existence is now replaced by microprocessors such as Intel Corp. and AMD. The advantages of the relay are to control the current and the desired electrical voltage and to maximize the amount of voltage until it reaches its maximum limit. Relays are also widely used for controlling machines that work sequentially before microprocessor technology is available, for example in injection molding machines, blow molding, and on conveyor belts [4] (Figure 1).

Figure 1. Relay
The other component to activate the controlling system is a smartphone. Smartphones are advanced technology which combined with PDA, and mobile phones. New technologies that resemble Personal Digital Assistant (PDA), which has a variety of functions and ease of accessing the internet [5]. The sophistication of smartphones compared to cellular phones lies in the formidable operation system, high processing speed, cutting-edge multimedia device, the best internet connection, and touchscreen. According to Brusco [6], the smartphone is a mobile phone that has functions such as computerized systems, messaging (e-mail), internet access and has a wide range of applications as a means to find information such as health, sports, money and a wide range of topics.

Arduino Complementary is the router. The router is one of the computer network hardware used to divide the protocol to other network members [7]. The function of routers, in general, is as a liaison between two or more networks to pass data from one network to another network. But the router is different from Switch because Switch is only used to connect multiple computers and form a LAN (local area network). While the router is used to connect between one LAN with another LAN.

![Router and modem](image)

**Figure 2.** Router and modem

2. Research Method
This type of research is product design which is designing and making Arduino Relay-Based Electric Control Devices. The material used in this research are Board House set, Saclar Push-On 4 set, Conduit Cable 1 set, Lamp 4 pcs, Arduino set, Ethernet Shield, USB cable, jumper wire, relay set, smartphone, multimeter Digital, amperemeter Digital, MCB, jack connector, Adaptor, Screw Shield. The Access Point TP-Link MR-3020 is a tool used in this research. Data collection techniques used are interview techniques with electrical installation experts, library techniques, direct measurement techniques, and documentation techniques

3. Result and Discussion
3.1 Design of Electrical Installation
Design Electrical installations used are based; PUl '2011, SPLN, and LMK regulations which apply in Indonesia. The design used safety MCB 4A, which serves to secure the entire installation of electrical devices in the building/house if there is a short circuit, which can be controlled automatically via a smartphone. The contact box function, Electric Lights and Safety used in the Building must be controlled by the Relay contained in the Control Panel. Sonic is used to control the reservoirs. The controlling system was directly from Arduino, through a relay board inside the panel. The lowest level of water will activate the pump automatically to fill the reservoir, and vice versa if the water in the reservoir is full then the engine will automatically stop (off) [8]. Design drawings Electrical installations can be seen in Figure 3.
3.2 Test of Control System

3.2.1. Using the Local Network

Figure 4 shows the access point used as a media liaison between the smartphone and Arduino Relay acting as a server. The smartphone functions as a controller and sends instructions to Arduino through a website-based application with an address/local IP address of 192.168.100.102 whose function is to control/power an electrical device. The workings of this control device are through instructions from the Arduino device which is forwarded to the relay board, which is then sent to the Switch, KKB, and electrical safeguards (MCB), according to the customer's wishes [7].
3.2.2. Using the Internet Network

![Control using the internet network](image)

**Figure 5.** Control using the internet network

Figure 5 describes the development of a local connection as controlling system through an internet connection. The function of the modem or router is connecting local and internet connections to give users a chance to monitor and control the electrical device. The user must be connected to the internet and access the address "http://www.peneliti-kontrol gedyus.com" on the user's smartphone. The website page will appear and used as a remote to send instructions to the Arduino relay whose function is to control electrical equipment in a building or house.

3.3 Application of system

The testing of controlling system by facilitating five contact box. The first testing in the Electric Traps and television and the results the information in Table 1.

| Contact Box | Smart Phone Status | Information                      |
|-------------|--------------------|----------------------------------|
| ON          | ON                 | TV On, with working voltage, 220V|
| OFF         | OFF                | TV Off, because working Voltage = 0 Volt|

Table 1 shows that when the ON button on the Smartphone is pressed, then the TV that installed on the contact box 1 will light up. It indicated that contact box position is functioning (ON). Conversely, when the OFF button is pressed, the TV will turn off or indicated that the position of contact box is not functioning (OFF). Table 2 shows the result of testing by using a rice cooker and contact box 2.

| Contact Box 2 | Smart Phone Status | Information                                      |
|---------------|--------------------|--------------------------------------------------|
| ON            | ON                 | Rice Cooker Functional, with working voltage, 220V|
| OFF           | OFF                | Rice Cooker Not functional, because working Voltage = 0 Volt|

Table 2 shows that if the ON button of the Smartphone is pressed the rice cooker was function by voltage source from contact box 2. The device can be used to cook rice, with a working voltage of 220 Volts. Conversely, when the OFF button of the Smartphone is pressed, the Rice Cooker is Off, because the voltage source of the contact box is equal to 0 Volts (no voltage supply from PLN). The
third testing was using a water pump and contact box 3. The information about the testing result shows in Table 3.

### Table 3. Testing for a reservoir with sources from contact box 3

| Contact Box | Smartphone Status | Information |
|-------------|-------------------|-------------|
| ON          | ON                | The Water Pump Engine works with a normal working voltage of 220 V, with a controlled level of the water level. |
| OFF         | OFF               | Water Pump Machine OFF, because there is no supply voltage (V = 0 volts) |

Table 3 shows that when the ON button of the Smartphone is pressed, it appears that the Reservoir is filled with Water. On the contrary, if the OFF button is pressed, the flow of water that fills the Reservoir is stopped. The condition caused by the voltage on contact box 3 is not present or 0 Volts. If the ON button on the Smartphone is pressed again means that the Reservoir engine will function and fill the reservoir. If the tank is in full condition, the water pump will stop automatically and work again if the water in the reservoir has arrived at the lowest level (according to settings). The forth testing was using electric light and contact box 4. The information about the testing result shows in Table 4.

### Table 4. Testing for electric lights

| Saclar | Manual | Smartphone | Lamp      | Information |
|--------|--------|------------|-----------|-------------|
| 1      | ON     | ON         | Lamp 1. ON| Working Voltage 220 Volt. |
|        | OFF    | OFF        | Lamp 1. OFF| Working Voltage 0 Volt. |
| 2      | ON     | ON         | Lamp 2. ON| Working Voltage 220 Volt. |
|        | OFF    | OFF        | Lamp 2. OFF| Working Voltage 0 Volt. |
| 3      | ON     | ON         | Lamp 3. ON| Working Voltage 220 Volt. |
|        | OFF    | OFF        | Lamp 3.OFF| Working Voltage 0 Volt. |
| 4      | ON     | ON         | Lamp 4. ON| Working Voltage 220 Volt. |
|        | OFF    | OFF        | Lamp 4. OFF| Working Voltage 0 Volt. |

Testing the control device on the electrical device of a building/house lives either manually through the switch buttons, or automatically using a smartphone, has functioned perfectly. In Table 4 it can be seen that when lamp number 1 is turned on manually through the Switch button, the Smartphone is also lit (ON). Conversely, if the button on the Smartphone is pressed to turn the light off, the automatic position on the manual switch is also OFF. When the Switch ON 2 position is for lamp number 2, the Switch position on the Smartphone is also ON. Conversely, when the Switch button on the Smartphone for lamp 2 is OFF, it will automatically switch OFF. The same applies to lights 3 and 4. Especially for testing Safety Devices (MCB/ELCB), when the ON button of the Smartphone is enabled, all electrical devices in the building/house can be used/functioned, according to the designation electrical equipment that will be used, with a working voltage of PLN is 220 Volts. Conversely, if the OFF button on the Smartphone is pressed, then all electrical devices in the building/house cannot be used, because there is no electricity voltage from the PLN. Table 5 shows the function of a device to control MCB.
Table 5. Tests on installed electrical safety

| MCB/ELCB Status | Smart Phone Status | Information |
|-----------------|--------------------|-------------|
| ON              | ON                 | All electrical devices can be operated with 220 volts working voltage |
| OFF             | OFF                | There is no power supply from a power source (PLN), which means that all electrical devices cannot operate because of the working voltage of PLN = 0 volts. |

Table 5 shows that smartphone and device can be used to control the MCB. When the smartphone status is ON position, All electrical devices can be operated with 220 volts working voltage. Conversely, the OFF status of the smartphone will stop the power supply of power to the MCB.

The microcontroller system can be used as a controller of electrical appliances in the household and can prevent fires due to misuse. The use of a smartphone with the help of the router makes it easier for users to control electronic devices remotely. The microcontroller as part of a smart home system not only as fire prevention but also serves as an electrical efficiency control. The Arduino-based smart home energy efficiency system can control energy consumption from the use of electronic equipment at home.

4. Conclusion

Software Arduino Relay-based electric control devices are functioning properly; this is evidenced by the functioning of all control systems both on the security system, and for various controlled electrical devices. Electric control devices based on Arduino Relays that have been made to control TVs, rice cookers, reservoirs, electric lights, and electrical safeguards, have functioned well, this has been proven in research trials. Interface and Arduino Relay-based control system application has been functioning properly and can control the electrical devices contained in a building or residence.

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