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Development of Prototype System Design with the Application of Renewable Technology

Diah Widiastuti
Machine Engineering, National University. Jakarta, 12520
diahwidiastuti712@gmail.com

Titi Ratnasari*
Electrical Engineering, PLN Institute of Technology. Jakarta, 11750
titi.ratnasari@itpln.ac.id
**Corresponding author*

Intan Ratna Sari Yanti
Electrical Engineering, PLN Institute of Technology. Jakarta, 11750
intan.ratnasari@itpln.ac.id

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***Abstract*—**The development of a system designed in such a way as to become a security that makes everyone feel the need to ensure the security of everything that includes himself, both from his activities, and the assets he owns. The magnitude of the value of an asset owned, which encourages everyone to implement an effective and efficient security system as protection. One of them is in Locker cabinets which generally still use a manual locking system. The purpose of this research is to design a locker cabinet door security system by utilizing the Arduino Uno R3-based keypad and E-KTP. This system uses an RFID Reader with a frequency of 13.56 MHz and an ATMega328 Microcontroller which acts as a controller or circuit controller and is tested with hardware and software testing to determine the performance between software and hardware on the device. The result of this research is that the RFID Reader can detect E-KTP with a maximum distance of 2.5 cm and the solenoid will lock back after 3 seconds. Utilization of Renewable Energy is currently a priority in carrying out technology development, one of which is the use of solar energy with solar panels as electrical energy. This research is to support efforts to develop energy-based technology that is converted with various supporting components and system authentication designed using the use of control security systems both in terms of administration and information technology based on population data and uncontrolled system prototypes.

***Keywords*—** Cabinets, RFID, Microcontroller ATMega328, Arduino, E-KTP, Renewable Energy

I. INTRODUCTION

The importance of security, making everyone feel the need for security guarantees against everything that includes him, both from his activities, and the assets he has. However, security issues are still common anywhere and in many ways. One of them can happen in the locker cabinet. Personal access security such as those mentioned in locking lockers generally only applies a manual security system and it is easy to break into it. So that with the development of technology, a personal access security system is created that uses electronic systems and is more automatic with a more guaranteed level of security (Syafii et al, 2018). Security systems can be done by using electronic devices as an innovation to create a sophisticated security system tool. One of them, Automatic Identification (Auto-ID) technology by utilizing E-KTP as an RFID Tag Card (Muttaqin et al, 2023); (Nurria, 2022). E-KTP is an Identity Card (KTP) that is made electronically and is included in the type of smart card that can be utilized in various things such as health services, access tokens, passports, and others (Akhariana and Irmawati, 2019). E-KTP can be used as an RFID tag because it contains a chip that stores a unique ID number (Saputro and Wibawanto, 2016). One of the technologies that help design a modern and efficient locker security system is RFID (Radio Frequency Identification) technology. Radio Frequency Identification (RFID) is a technology that automatically identifies an object by transmitting and receiving data that is utilizing from radio frequencies (Setiawan and Kurniawan, 2015). The data transmitted in the form of a unique information code and cannot be duplicated so that it is safer to use it and the level to safe is more secure (Yoanda, 2017).

II. LITERATURE REVIEW

A. *Solar Panel*

Utilization of solar power generation systems (PLTS) can be a solution in the face of the threat of the electricity crisis. Power generation systems that use solar panels or also known as solar panels become an environmentally friendly energy source. Solar panels are a system that can be used to convert sunlight energy into electrical energy using a principle called the photovoltaic effect (Rohana and Zulfikar, 2018).

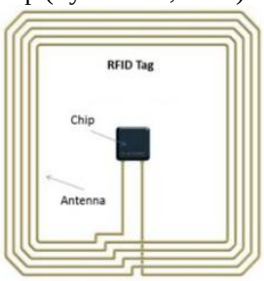
A solar panel is a device consisting of solar cells that converts the photo energy of light into electricity. They are called the sun's upper sun or "sole" because the Sun is the strongest light source that can be harnessed (Junaldy et al, 2019). Solar panels are often called photovoltaic cells, photovoltaics can be interpreted as "light electricity". "Solar cells or PV cells rely on the potovoltaic effect to absorb the Sun's energy and cause currents to flow between two opposing charged layers" (Ramadani, 2020).

B. Radio Frequency Identification (RFID)

RFID is an object identification method that uses radio waves. The identification process is carried out by an RFID reader and an RFID transponder (RFID Tag) (Djamal, 2014). An RFID tag is attached to an object or an object to be identified. Each RFID tag has a unique identification number of data. RFID is used to describe a system capable of transmitting an object's identity data wirelessly using radio waves (Daniel, 2017). RFID is included in Automatic Identification (Auto-ID) technology (Yudhanto and Azis, 2019). Nowadays the automatic identification system is becoming very popular in various industries such as services, purchases, manufactur and other technologies included in Auto-ID are barcodes (Yudhanto and Azis, 2019), optical character readers and biometric technology. An RFID tag is attached to an object or an object to be identified. Each RFID tag has a unique identification number of data, so the RFID no tag has the same ID number. Barcode labels everywhere are the originators of the revolution of automatic identification systems (Lubis et al, 2020). Although barcodes are very cheap, there are disadvantages in terms of low storage and the lack of the ability to be reprogrammed. The technically optimal solution is to utilize a silicon chip as a storage medium which is then adopted in RFID systems (Simarmata et al, 2021).

C. RFID Tag

The basic function of an RFID tag is to store data and transmit data to an RFID reader. Basically, tags consist of electronic chips and antennas (see Picture 1.) that are packaged in a single package to form a tag or packaging label. Generally, chips contain information data stored in memory on the chip (Syafii et al, 2018).



Picture 1. RFID Tag

RFID tags are divided into two:

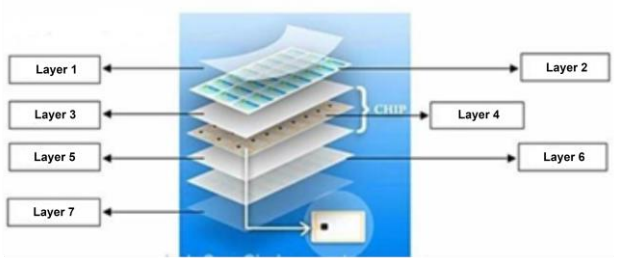
1. Active Tag: a signal with power from the battery. In general, RFID does not continuous signals. To save battery life, RFID will only emit its signal if there is a trigger signal that is in accordance with the procedures for delivery and reception. These trigger signals are usually placed into one on a transmitter or receiver (Reader/Antenna)
2. Passive Tag: This tag has no battery. The signal is sent by the reader/antenna received by the RFID tag, then the circuit in the tag using the signal energy sends the data to the antenna/reader back. Therefore, the signal is weak in its range.

One form of passive tag is an electronic identity card or electronic -KTP (E-KTP). Identity Card (KTP) made electronically, in the sense that both in terms of physical and use functions computerized.

E-KTP refers to the ISO 14443 A/B standard working well in the temperature range between -25^0c to 70^0c and with an operational frequency range of 13.56 MHz ± 7 KHz. E-KTP has a SAM (Secure Access Module) of 4 bytes UID's (Unique identifier) in a combination range of 10 digits (Puasandi, 2014).

D. Advantages of E-KTP as a Passive Tag

Thin chip physical materials such as paper are dominated by silicone and plastic types, not heat resistant, corrosion, wet or damp. The E-KTP chip use a contactless interface that meets iso 14443 A/B standards. E-KTP is made of PETG material, a kind of thermoplastic polymer, which is arranged in 7 layers (Syafii et al, 2018), as shown in Picture 2.



Picture 2. E-KTP Model from PTEG Material

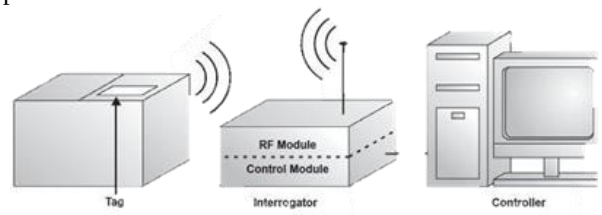
Thin chip physical materials such as paper are dominated by silicone and plastic types, are not heat resistant, corrosion, wet or damp and can be damaged by broken, torn and other types of physical damage. E-KTP itself technically has the advantage of:

1. E-KTP chips are protected, one of them, with a two-way authentication mechanism, which is a mechanism to recognize each other between E-KTP chip with RFID reader, where the chip must be able to recognize the RFID reader the RFID reader must be able to recognize the chip after going through this authentication mechanism then the data stored in the new chip can be read by the RFID reader.
2. The RFID reader must produce a high-frequency radio field to provide a power supply that matches the needs of the-KTP chip, where the radio field will be modulated for communication purposes.
3. The range of large radio frequency magnetic fields generated by RFID readers follows the provisions in ISO/IEC 14443, which is between 1.5 A/m to 7.5 A/m. While the frequency of modulation of the amplitude of the magnetic field, which is used to transmit data to the E-KTP chip, is 13.56 MHz.

The chip embedded in this card allows it to perform various computational processes that magnetic stripe-based cards cannot. With this capability, chip cards can run a variety of algorithms and security protocols that are quite complex (Simarmata et al, 2022).

E. System RFID

An RFID system uses cordless radio communication technology to identify an object. There are three basic components for an RFID (Daniel, 2017), as shown in picture 3.



Picture 3. Basic Blog RFID System can work

System to work, as shown in Picture 3:

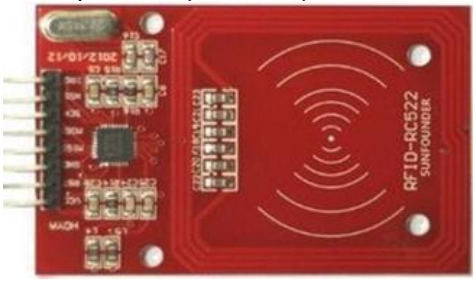
1. RFID tags (transponders) consisting of semiconductor chips, antennas and sometimes battery tags.
2. RFID reader: an electronic module and equipped with an antenna to read RFID tag data.

A controller (as a host): that run's an RFID control system

F. Reader MIFARE RC522 RFID

An RFID reader is a link between application software and an antenna that will radiate radio waves to an RFID tag. Radio waves transmitted by the antenna propagate in the surrounding room. As a result, data can move wirelessly to an RFID tag that is adjacent to the antenna. One of the RFID readers to detect RFID code on E-KTP is the MIFARE RC 522 Reader, this reader specifically detects RFID tags with a frequency of 13.35 kHz. E-KTP compatible RFID readers both use the ISO 14443 A/B standard. MIFARE RC522 RFID Reader Module is a Philips MFRC522 IC-based module that can read RFID with easy use and low price, because this module already contains the components needed by MFRC522 to be able to work This module can be used directly by the MCU using an SPI interface, with a voltage supply of 3.3 Volt DC (Mulyanto and Kushermanto, 2017).

Picture 4 show the MFRC522, that is a product of NXP that uses a fully integrated 13.56 MHz noncontact communication card chip for reading and writing. MFRC522 matches all variants of MIFARE Mini, MIFARE 1K, MIFARE 4K, MIFARE Ultralight, MIFARE DESFire EV1and MIFARE Plus RF identification protocols (Eko, 2019).



Picture 4. Physical Shape of The Mfrc522 RFID Reader Module

Specifications of the MIFARE RC522 Reader RFID module:

1. Chipset: MFRC522 Contactless Reader/Writer IC.
2. Frequency: 13,56 MHz.
3. Card reading distance: < = 50mm.
4. Protocol Access: SPI (Serial Peripheral Interface) @ 10 Mbps.
5. Transmission speed RF: 424 kbps (Two-way / bi-directional) / 848 kbps (unidirectional).
6. Supports cards MIFARE Classic S50 / S70, Ultra-Light, and DESFire.
7. Power Supply: 3,3 Volt DC.
8. Current Consumption: 13-26 mA at the time of the read/write operation, < 80µA when standby mode.
9. Operating temperature -20°C s.d. +80°C
10. Dimension: 40 x 50 mm

G. RFID Control System

An RFID control system is a control system to access electronically to break down limitations on conventionally working mechanical keys. A wide variety of permissions can be used to replace mechanical keys. For example, when accessing a door, if access to open the door is approved then the door will open at an automatically specified time and the transaction will be recorded by the system. When access is denied, the door will remain locked and attempts to access it will also be recorded. The system can also sound an alarm if the door is incorrectly accessed.

H. Working Frequency of RFID

Radio frequencies used by tags to send and receive signals have implications on performance, distance, operation, tag read speed and frequency RFID data used by RFID systems:

1. Band LF (Low Frequency) with a frequency range of 125 KHz – 134 KHz with a short distance usage, approximately 50 cm is used for identification systems that only require short distances.
2. Band HW (High Frequency) Operating at a frequency of 13.56 KHz with readings up to approximately 3 m, this frequency is suitable for reading on RFID tags and is also widely used for matching items in industrial warehouses, buildings or tracking that require a reading speed of 10 to 100 RFID Tags / second.
3. Band UHF (Ultra High Frequency) about 915 MHz with a reading range of up to about 9 m. UHF tags can be read at speeds of up to 1000 Tags/second. It is usually widely used for tracking goods in truck containers.
4. Microwaves of 2.4 GHz with a longer reading distance (10 m) at this frequency experience more reflection of waves and objects around them and can interfere with the RFID reader's ability to communicate with RFID tags.

I. Arduino (Arduino)

Arduino is an electronic kit or open-source electronic circuit board in which there is a main component, a microcontroller chip with AVR type from the Atmel company. The microcontroller itself is a chip or IC

(Integrated Circuit) that can be programmed using a computer (Septryanti and Fitriyanti, 2017).

The purpose of embedding the program in a microcontroller is so that the electronic circuit can provide input, process the input, and then produce the output as desired. So, the microcontroller serves as the 'brain' that controls the input and output of an electronic circuit. In general, Arduino consists of two parts (Widiana et al, 2019).

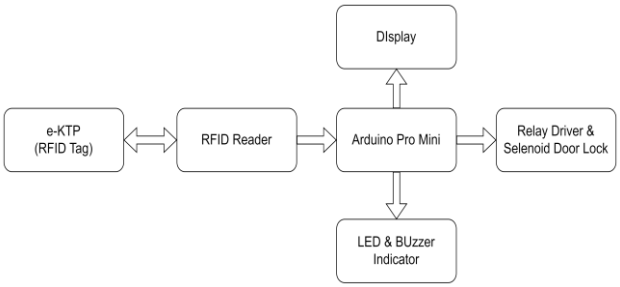
1. Hardware in the form of an open source input/output (I/O) board.
2. Software Arduino is also open source, including Arduino IDE software to write programs on the computer then transferred to Arduino.

III. METHODOLOGY

A. *Working System Flow Diagram*

1. Start: The first step to operating the device is to provide voltage to the system or circuit.
2. Initialization of Arduino Pro Mini: Once the system is active the Arduino Pro Mini will perform its function as a control of all inputs and outputs. Arduino Pro Mini enables RFID and LCD readers. Once active, the LCD will display the writing to paste the E-KTP.
3. Scene E-KTP to RFID Reader: The RFID reader will read the data on E-KTP through electromagnetic wave emission. The data read by the RFID reader will be forwarded to the Arduino Pro Mini to be validated with the ID adjustment listed on the Arduino Pro Mini memory.
4. If the data sent by the RFID reader is registered, the Arduino Pro Mini will carry out the next instruction that is to register the E-KTP code that you want to register or pass the registration process. If the E-KTP code corresponds to the Arduino e-prom memory then Arduino will activate the green LED Indicator, buzzer, relay driver and solenoid so that the locker will open in accordance with locker code 1 or locker 2 that has been registered.
5. Solenoid off After 10 seconds then the Arduino Pro Mini will instruct the relay to active low, and solenoid (Off) lock will be closed.
6. If the affixed E-KTP is not registered on memory, then the red LED lights up and the buzzer will sound, as a sign that the affixed E-KTP is not recognized.
7. Completed: All locking and opening processes will return to the initialization position of AT mega 328 (Looping).

Seen some intersection relationships in the radio frequency identification application system in the security locker. The Arduino Pro Mini is the main part that serves as the main controller of the CPU (Central Processing Unit). RFID tags and RFID readers (RFID tag readers) As input or input data to the Arduino Pro Mini which will be processed for access to a locker. While the output or output of the system is an explanation of the flow diagram of the working system of the locker security system program. To make it easier to conduct research can be seen in picture 5.



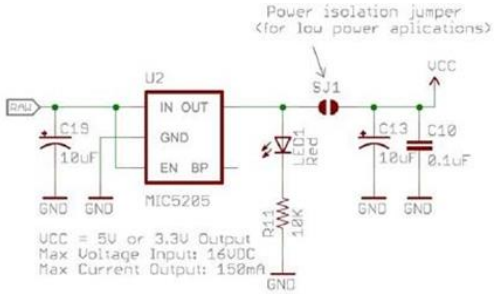
Picture 5. Working System Flow Diagram

1. Start: The first step to operating the device is to provide voltage to the system or circuit.
2. Initialization of Arduino Pro Mini: Once the system is active the Arduino Pro Mini will perform its function as an LCD display (Liquid Crystal Display), LED, Buzzer, and a solenoid as an electronic digital key. In this final task will be described one by one the locker security system with Radio Frequency Identification (RFID) technology.

IV. RESULT AND DISCUSSION

A. *Arduino Pro Mini Series*

Picture 6 shows, this circuit serves as the control center of the entire existing system. The circuit has become a module with an IC regulator for Arduino power supply and IC for communication between Arduino pro mini to PC.

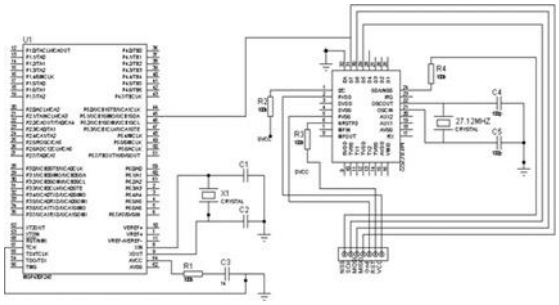


Picture 6. Arduino Pro Mini Minimum System

The main component of this overall circuit is the AT Mega 328 microcontroller IC. It is in this IC that all programs are filled, so that the circuit can run as desired.

B. *Reader Module Network RFID*

As shown in picture 7, this RFID reader module serves to read the data or ID number on the E-KTP which then sends the data to the Arduino Pro Mini. Installation of RFID reader module components with Arduino Pro Mini port can be seen in table 1 and table 2.



Picture 7. Schematic Modul Reader RFID RC522

Table 1. RFID Reader Module Specification

#	Parameter	Description
1.	*Supports Card*	ISO/IEC14443A/MIFARE
2.	*Frequency*	13.56 MHz
3.	VDDA (Working Voltage)	2.5 – 3.6 Volt
4.	IDDA (Workflow)	10 Ma

Table 2. RFID Reader Pin Connection to Arduino Promini

#	Name	Arduino Pro Mini Pin
1.	NSS	Digital Pin 10
2.	MOSI	Digital Pin 11
3.	MISO	Digital Pin 12
4.	SCK	Digital Pin 13
5.	RST	Digital Pin 9
6.	GND	GND
7.	VCC	3.3 Volt DC

Arduino Pro Mini will carry out the instructions that have been given, if the code is appropriate, it will automatically activate the relay so that the Solenoid is active and open the door, but if the code or ID number is not appropriate then the solenoid inactive relay will (Off) and the door does not open.

C. RFID Tag Code Reading Results

This test was conducted by using an RC522 RFID reader, 4 E-KTP, 4 white card type tags and 4 key chain type tags to test the data and compare the data whether file from the RFID reader can read information or not. Next, the data is processed on Arduino. Data from RFID module tests is shown in Table 3.

Table 3. RFID Tag Code Reading Results

#	RFID *e*- KTP Code	*RFID Tag*
1.	C7167021	*e*-KTP 1
2.	C7167046	*e*-KTP 2
3.	C7167032	*e*-KTP 3
4.	45F42055	*e*-KTP 4
5.	162101663	*White Card* 1
6.	163254871	*White Card* 2
7.	161432022	*White Card* 3
8.	167895829	*White Card* 4
9.	331561985	*key chain* 1
10.	3343452767	*key chain* 2
11.	3377822291	*key chain* 3
12.	3355369397	*key chain 4*

V. CONCLUSION

The locker security system with the use of radio frequency identification (RFID) technology on E-KTP for safety, can conclude that after doing 66 Arduino pro mini-E-prom testing combinations, the data storage system is still stable and cannot be interfered with if given access to other types of RFID tags. The data recognition process is so sensitive that the design of these security tools is more secure. Furthermore, this tool has been tested capable of recording more than 2 locker users, namely as many as 15 locker users and Effective read distance key chain type tag with a success rate of 100% read distance ≤ 2.5 cm for E-KTP user's effective read distance with a success rate of 100% is ≤ 3.5 cm and RFID white card tag type with a success rate of 100% read distance ≤ 5 cm, white card tag is the furthest read distance between E-KTP and key chain according to RC522 RFID reader data sheet. Eventually the three types of RFID tags after being tested the reading distance is different because the antenna design of each tag is different, affecting the distance of operation of its work.

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