



Implementation of Vibration Sensor and Pin Lock using Keypad for Charity Box Security

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ABSTRACT

Security is a state in which people or things feel safe from ominous or unsettling hazards, which will then cause them to feel at ease and comfortable. There are many ways to achieve security, one of which is via utilizing and deploying technology. The use of security technology has advanced quickly in recent years, from low-tech to high-tech techniques. By using Arduino as a circuit controller to process input from a vibrating sensor and 4x4 keypad, output to a solenoid as a charity box lock, and a buzzer that serves as an alarm in case of theft, technological or automated methods can reduce charity box theft and also increase the security of charity box locks. The charity box security system tool is made to prevent the theft of charity boxes, which frequently happens in mosques. If someone tries to steal the charity box, an alarm will go off, and you need a pin that has been programmed on an Arduino Ide and stored in EEPROM to open the charity box cover, so this tool can stop charity box theft in mosques.

INTRODUCTION

Whenever people or things feel safe from ominous or unsettling hazards, they will feel peaceful and at ease. This condition is known as security. One method of achieving security is by utilizing and deploying technology. The use of security technology has advanced very quickly in recent years, from low-tech to high-tech techniques. All techniques call for the use of a key as validation in terms of security. This key will be referred to as the Password in the future.

The essential tool is Arduino Uno, which will serve as a controller for the complete circuit, including input, process, and output. Tools that can control automatically and can save passwords that have been entered into the program are required to run all of these circuits. The keypad will be used as the input password to unlock the donation box and the sensor will be used as a vibration detector if the donation box is forced open to produce the needed output. The solenoid, which serves as a lock for donation boxes, is then turned on and off by a relay that doubles as a switch and operates with a voltage of 5 volts. The buzzer also serves as an output, and if the vibration measured by the vibration sensor is louder than 4 dB, the buzzer will ring.

Other people have conducted many studies related to security systems, including Home Security Systems Using RFID, PIR Sensors, and Microcontroller-Based GSM Modules [1]. Design and build an anti-theft charity box using a microcontroller-based SMS Gateway [2]. Design and build a home security system based on Arduino Mega 2560 [3]. Design and build an IOT-based motorcycle security system [4]. Design of a digital locking system on a microcontroller-based motor paddock [5]. And the application of vibration sensors has also been carried out in many other studies such as the use of vibration sensors to Anticipate Earthquakes [6]. Development of an Earthquake Vibration Monitoring System Prototype Using the SW-420 Sensor Module [7]. Use of sensor networks to monitor cracks in buildings based on the Internet of Things [8]. And the application of key-based security with a keypad has also been carried out a lot, among others Automatic door design with Arduino AT MEGA 328-based Keypad [9]. Design and build a room safety prototype with pin code input and microcontroller-based multi-sensors [10]. The garage door security system prototype uses a keypad with a microcontroller-based sensor [11]. Arduino Uno Microcontroller-Based Cash Storage Box [12]. Prototype of Smart Door Lock Using Multi-Sensor Based on Arduino System [13].

LITERATURE REVIEW

Arduino Uno

The Arduino Uno is an ATmega328-based microcontroller board with 14 input pins for digital output, 6 of which can be used as PWM outputs, and 6 input pins for analog input. It also contains a USB port, a 16 MHz crystal oscillator, a power socket, and a reset button. The microcontroller can only be used with these pins connected to a computer through a USB cable or voltage sources such as an AC-DC adapter or battery. Additionally, researchers have used

Arduino, including [14][15][16][17].



Figure 1. Arduino Uno R3

Vibration Sensor

A Vibration Sensor is a measuring tool that can measure vibrations on an object. Later, the resulting data will be used for the benefit of an experiment or to anticipate if something unexpected happens.



Figure 2. Vibration Sensor SW-420

Buzzer

In general, it can be defined as a warning or notification sound in terms of a buzzer. It can also be described as a message when there is a decrease or failure in the data communication signal or there is damage to equipment, a reduction in the performance of this message to warn the operator or administrator that there is a problem.



Figure 3. Buzzer

Solenoid door lock

Solenoid Door Lock is one of the automatic locking solenoids that functions precisely as a solenoid for door locks. This door lock solenoid requires a supply voltage of 12V, and the working system of this door lock solenoid is NC (Normally Close). The solenoid valve will be pulled if there is voltage and vice versa the solenoid valve will extend if there is no voltage.



Figure 4. Solenoid door lock

Keypad

A keypad is a series of buttons that are arranged or can be called (a pad) which usually consists of letters of the alphabet (A-Z) to type sentences, there are also numbers and other special symbols. in use 4x4 keypad.



Figure 5. Matrix Keypad 4x4

METHOD

Tools and materials

The tools and materials needed in the Design of a Charity Box Security Tool Using an SW-420 Vibration Sensor and a 4x4 Matrix Keypad connected using Arduino Uno R3 consist of hardware and software including:

Hardware

The hardware used in this research method is as follows:

Table 1. Hardware

No	Name	Tool Function	Specification (Version)
1	Arduino Uno	As a controller of the components in the tool design	R3
2	Vibration Sensor	As a vibration detector and meter	SW-420
3	Buzzer Active	As a notifying Alarm	3-6 Volt
4	Keypad	As a pin access	Matrix 4X4
5	Solenoid lockdoor	As a door lock	9-12 Volt

Software

The specifications of the software used in this study are:

Table 2. Software

No	Name	Tool Function	Specification (Version)
1	Arduino Id	It uploads programs for the Arduino Uno-based keypad vibration sensor and keypad commands.	Version 1.85
2	Fritzing	Used to simulate a series of Charity Box Security tool designs Using Vibration Sensors and Arduino Uno Based Matrix Keypads.	Version .0.9.0b.32.pc

Schematic Design / Block diagram

This design was made to simplify the process of designing a tool to make a technology-based safety box for charity. The following is a system design as shown in Figure 5.

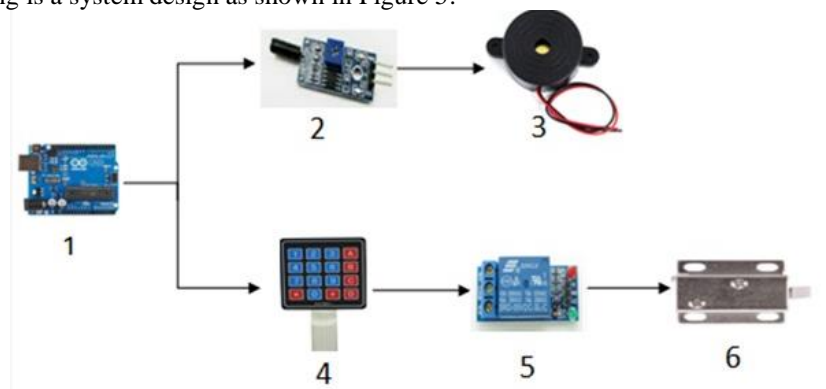


Figure 6. Tool Design Diagram

Information:

1. Arduino Uno as a component controller

2. Vibration Sensor to detect vibration
3. Buzzer as Alarm
4. Keypad access opens the charity box
5. Relay 5 Volt as a switch
6. Solenoid Lock the door as a charity box lock

System Design Diagram

The buzzer will sound, the vibration sensor will detect vibrations in the charity box, and Arduino will control all input from the 4X4 keypad as a means of entering passwords and also processing the output with the on and off solenoid. If pulses detected by the sensor are higher than 4 Hz, the buzzer, which serves as an alarm, will be active, making it easier to know that an unidentified person is carrying the charity box. In the interim, you must enter a pin code that the charity box's keeper alone knows to unlock the box. The charity box will immediately open when the pin access code is received, and if the pin code is entered incorrectly three times, access will be denied for five minutes.

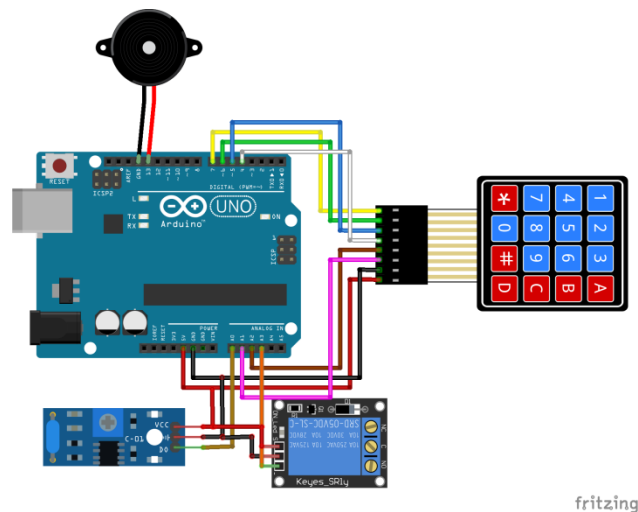


Figure 7. System Design Diagram

Function:

1. Input Section

The input section consists of an SW-420 vibration sensor which functions to detect vibrations that occur in the charity box and a keypad to unlock the Solenoid Door Lock.

2. Control Section

The control section consists of Arduino Uno R3 which functions as a controller for the entire circuit so that the circuit can work optimally.

3. Process Section

The process part consists of reading the vibration height by the vibration sensor and reading whether the password input by the keypad is correct or not.

4. Output Section

The output section consists of a buzzer that functions to provide notification when a charity box is detected to vibrate beyond the rules and reads whether the password entered on the keypad is correct or not so that the Solenoid Door Lock can be opened.

Flowchart

When the tool starts to move, Arduino will control all components connected to it, then the vibration sensor will detect vibrations in the charity box, if the vibration detected by the sensor is above 4 Hz then the buzzer which functions as an alarm will active, making it easier to find out that an unknown person was carrying the charity box. Meanwhile, to open the charity box, you must enter a pin code that the keeper only knows of the charity box. When the pin access code is received, the charity box will open automatically and if the pin code is incorrect 3 times, access to enter the pin will be blocked for 5 minutes.

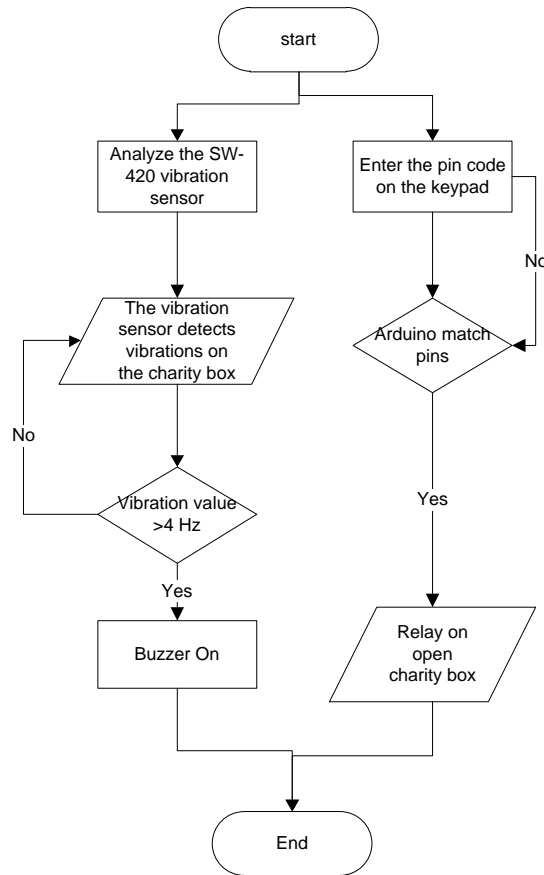


Figure 8. Flowchart

RESULTS AND DISCUSSION

Results of the Charity Box Security Tool Design Series

This charity box is designed to avoid theft that often occurs, especially in mosques, the series of charity box designs include, among others:

Matrix And Arduino Keypad Circuit

Digital pins 1,2,3,4 are connected to Arduino pins 4,5,6,7 and digital keypad pins 5,6,7,8 are connected to Arduino pins 8,9,10,11. As shown in Figure 10 below.

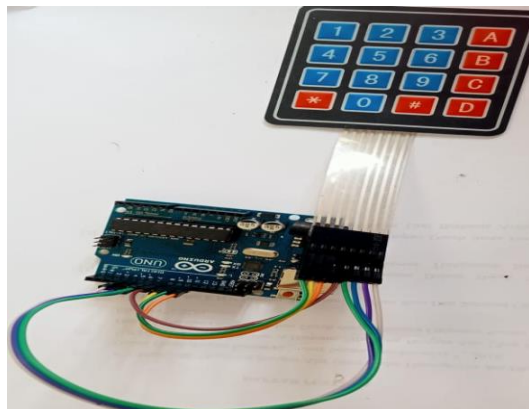


Figure 10. Matrix Keypad and Arduino

Arduino and Relay Circuit

The Vcc pin on the relay is connected to the Arduino 5V pin, the relay Ground pin is connected to the Arduino Ground pin, and the relay Out pin is connected to Arduino pin 12. Like Figure 11.

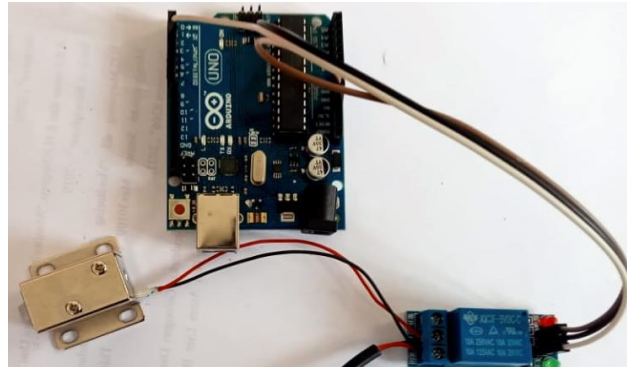


Figure 11. Relays and Arduino

The Whole Range of Tools

All components are connected, Arduino will control all components connected to it, then the vibration sensor will detect vibrations in the charity box, if the vibration detected by the sensor is above 4 Hz then the buzzer which functions as an alarm will be active. making it easier to know that an unknown person is carrying the charity box. Meanwhile, to open the charity box, you must enter a pin code that the keeper only knows of the charity box. When the pin access code is received, the charity box will open automatically and if the pin code is incorrect 3 times, access to enter the pin will be blocked for 5 minutes, as shown in Figure 12.

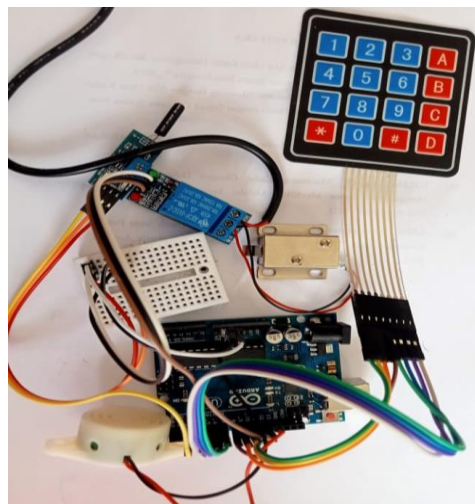


Figure 12. Overall results of the tool

Tool testing procedures

After the system has been created, it is necessary to test the system. the vibration sensor will detect vibrations in the charity box, if the vibration detected by the sensor is above 4 dB then the buzzer that functions as an alarm will be active, making it easier to know that an unknown person is carrying the charity box. Meanwhile, to open the charity box, you must enter a pin code that the keeper only knows of the charity box. When the pin access code is received, the charity box will open automatically and if the pin code is incorrect 3 times, access to enter the pin will be blocked for 5 minutes. Where the author will conduct research 10 times to find out the performance of the charity box security device.



Table 3. Vibration Sensor Reading Test

Testing	Testing Time	Vibration Sensor Readings	Buzzer status	
			On	Off
First	Noon 11:22	> 4 Hz	√	
Second	Afternoon 11:40	> 4 Hz	√	
Third	Noon 12:22	< 4 Hz		√
Fourth	Evening 08: 20	< 4 Hz		√
Fifth	Evening 08: 50	> 4 Hz	√	
Sixth	Evening 09: 20	< 4 Hz		√
Seventh	Evening 09: 30	< 4 Hz	√	
Eighth	Morning 09:25	> 4 Hz		√
Ninth	Morning 10:15	< 4 Hz		√
Tenth	Morning 10:30	> 4 Hz	√	

Where the first research was carried out 10 times, then when the vibration sensor detects vibrations above 4 Hz, the alarm sounds automatic, making it easier to find out that someone wants to bring the charity box. For testing the vibration sensor, it can be tested directly using the program that has been created and uploaded to Arduino, no comparison is needed with decibel meters. So on, because the sensor is designed and produced as sensitive as possible so that every vibration detected by the existing magnet at the end of the sensor is processed faster, and the program that has been made is also included for setting the sensor vibration, namely the Hz unit, where the Hz unit can be changed depending on what kind of tool you want to apply. And for the vibration value of the device, it can be set in the Arduino Ide program so that it can be used as needed.

```

COM6
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frekuensiGetar=0
frekuensiGetar=1
frekuensiGetar=0
frekuensiGetar=1
frekuensiGetar=0
frekuensiGetar=8
alarm aktif
frekuensiGetar=0

```

Figure 13. Monitor serial display

When the tool is turned on, the value of the vibration sensor reading = 0, and the vibration sensor starts to calculate vibrations when the charity box starts to vibrate. If the vibration detected by the sensor is > 4 Hz, the alarm will be active.

The serial monitor is to display the results read by the sensor and if the vibration value read by the sensor is above 4dB then an alarm will sound automatic, making it easier to know that someone wants to bring the charity box. And for the vibration value of the tool, it can be set in the Arduino Ide program so that it can be used as needed.

Table 4. Tests for unlocking passwords

Testing	Enter pins	Charity box closing status	
		Open	Not Open
First	1234	√	
Second	4321		√
Third	1234	√	
Fourth	1234	√	
Fifth	1344		√
Sixth	1234	√	
Seventh	5435		√
Eighth	1234	√	
Ninth	2543		√
Tenth	1234	√	

Tests are carried out on the keypad to find out if the pin entered is correct or incorrect, if the pin is entered correctly then the charity box cover will open and if the password is entered incorrectly 3 times then the pin will be blocked for 30 seconds. Meanwhile, opening the cover of a charity box takes 1.30 seconds.

Tool Test Results

The charity box security system is designed as a charity box to facilitate the research process for the tool. The charity box security system tool is designed for security to avoid the theft of charity boxes that often occurs in mosques, if an unknown person wants to steal the charity box, an alarm will sound, and opening the charity box cover requires a password in the form of a pre-defined pin. set in the program.



View of the tool



Front view of the tool

View of the left side of the tool

Figure 14. Tool overall result



CONCLUSIONS

After designing and designing a series of charity box security devices using the SW-420 vibration sensor and Selenoid Door Lock based on Arduino Uno and then testing the tools, both testing in the form of each series and the overall sensor readings, it can be concluded:

1. If the vibration sensor detects vibration above 4 Hz, an alarm will sound
2. To open the cover of the charity box requires a pin that has been programmed on the Arduino Ide and stored in the EEPROM

REFERENCES

- [1] A. Mubarak, I. Sofyan, A. A. Rismayadi, and I. Najiyah, "Sistem Keamanan Rumah Menggunakan RFID Sensor PIR," *Informatika*, vol. 5, no. 1, pp. 137–144, 2018.
- [2] S. D., "Rancang bangun kotak amal anti maling menggunakan sms gateway berbasis mikrokontroler," *Sustain.*, vol. 11, no. 1, pp. 1–14, 2019.
- [3] A. S. Ramadhan and L. B. Handoko, "Rancang Bangun Sistem Keamanan Rumah Berbasis Arduino Mega 2560," *Techno.COM*, vol. 15, no. 2, pp. 117–124, 2015.
- [4] A. Tri Wibowo, I. Salamah, and A. Taqwa, "Rancang Bangun Sistem Keamanan Sepeda Motor Berbasis Iot (Internet of Things)," *J. Fasilkom*, vol. 10, no. 2, pp. 103–112, 2020, doi: 10.37859/jf.v10i2.2083.
- [5] J. T. Tilarsa, I. Nina, and P. Is, "DIGITAL PADA PADDOCK MOTOR BERBASIS MIKROKONTROLLER Bina Darma Conference on Engineering Science," pp. 84–95.
- [6] H. Alam, B. S. Kusuma, and M. A. Prayogi, "Penggunaan Sensor Vibration Sebagai Antisipasi Gempa Bumi," *JET (Journal Electr. ...)*, vol. 5, no. 2, pp. 43–52, 2020, [Online]. Available: <https://www.jurnal.uisu.ac.id/index.php/jet/article/view/2879%0Ahttps://www.jurnal.uisu.ac.id/index.php/jet/article/download/2879/1912>.
- [7] J. F. Saputra, M. Rosmiati, and M. I. Sari, "Pembangunan Prototype Sistem Monitoring Getaran Gempa Menggunakan Sensor Module SW-420," *eProceedings Appl. Sci.*, vol. 4, no. 2442–5826, p. 2055, 2018, [Online]. Available: <https://openlibrarypublications.telkomuniversity.ac.id/index.php/appliedscience/article/view/7170>.
- [8] M. ASRI, S. HAISAH, and S. A. HULUKATI, "Penggunaan Jaringan Sensor Untuk Memonitoring Keretakan Pada Bangunan Berbasis Internet of Things," *J. INSTEK (Informatika Sains dan Teknol.)*, vol. 6, no. 1, p. 110, 2021, doi: 10.24252/instek.v6i1.18643.
- [9] T. Hidayat, "Perancangan Pintu Otomatis Menggunakan Keypad Berbasis Arduino At Mega 328," *J. Pendidik. dan Pengabd. Vokasi*, vol. 2720, no. 9229, pp. 138–147.
- [10] A. Kamolan and L. Sampebatu, "Dengan Input Kode Pin Dan Multi Sensor Berbasis Mikrokontroler," vol. 6, no. 1, pp. 22–31, 2021.
- [11] D. N. Bagenda and W. Adityoso, "Prototipe Sistem Keamanan Pintu Garasi Menggunakan Keypad Dengan Sensor Berbasis Mikrokontroler," no. October 2014, pp. 1–6, 2014.
- [12] N. M. Yohanes, Saghoa Sompie, Sherwin R.U.A., Tulung, "Kotak Penyimpanan Uang Berbasis Mikrokontroler Arduino Uno," *J. Tek. Elektro dan Komput.*, vol. 7, no. 2, pp. 167–174, 2018.
- [13] F. F. Iman, "Purwarupa Smart Door Lock Menggunakan Multi Sensor Berbasis Sistem Arduino," *Fak. Teknol. Inf. dan Elektro Universtas Teknol. Yogyakarta*, pp. 1–7, 2017.
- [14] I. Ihsan, D. N. Ilham, R. A. Candra, A. Yunan, and H. Hardisal, "Design of an Automatic Water Pump on a Traditional Boat," *Sinkron*, vol. 5, no. 1, p. 100, Oct. 2020, doi: 10.33395/sinkron.v5i1.10635.
- [15] B. Balkhaya, D. N. Ilham, R. A. Candra, H. Hardisal, and H. Hasbaini, "Designing an Arduino-based Automatic Cocoa Fermentation Tool," *Sinkron*, vol. 5, no. 1, pp. 92–99, Oct. 2020, doi: 10.33395/sinkron.v5i1.10611.
- [16] D. N. Ilham, R. A. Candra, M. S. Talib, M. di Nardo, and K. Azima, "Design of Smoke Detector for Smart Room Based on Arduino Uno," *Brill. Res. Artif. Intell.*, vol. 1, no. 1, pp. 13–18, 2021, doi: 10.47709/brilliance.v1i1.1079.
- [17] N. Nursila, D. N. Ilham, A. Yunan, M. K. Harahap, and R. A. Candra, "Prototype of IoT-Based Fruit Alcohol Level Measurement Tool," *Brill. Res. Artif. Intell.*, vol. 1, no. 1, pp. 8–13, 2021, doi: 10.47709/brilliance.v1i1.1078.