NEWTON: Networking and Information Technology
Vol. 3 No. 1 June 2023, Page. 7 - 14
E-ISSN: 2797-0728

Design and build a library visitor monitoring system based on microcontrollers

Sujono[1*], Putri Ananda Salung[2]
[1,2] Informatika, Universitas KH. A. Wahab Hasbullah
Email: sujono@unwaha.com

ABSTRACT
The system combines microcontroller technology and sensors to develop an effective solution for monitoring library visitors. By utilizing hardware such as motion sensors and microcontrollers , this system can automatically identify and track visitors entering and exiting the library. The microcontroller-based visitor monitoring aims to design and construct an automatic library visitor monitoring system based on visitor entries and exits. This library visitor monitoring tool uses Ultrasonic Sensors to detect human objects, with a microcontroller as its controller, an LCD for displaying visitor data and a buzzer as an indicator for visitor entry and exit. The system operates automatically by counting the number of people entering or exiting the library space using Ultrasonic Sensors with a microcontroller as its controller. The Ultrasonic Sensors are placed beside the library entrance and exit doors. So, if a visitor passes through either of these paths at a certain range, the Ultrasonic Sensor will provide information about the incoming and outging visitors.

***Keywords**: Arduino Uno, Visitor Count, Microcontroller*

INTRODUCTION
With the advancement of modern technology, as it is today, there have been numerous new innovations discovered through various research efforts by scientists. These innovations are aimed at assiting and facilitating human activities to make them more effective and efficient. In the present era, it is important to note that humans are constantly connected to technology, from children to adults in their daily lives (Fahmawaty & Royhan, 2020). Counting the number of visitors in a place is not an easy task for humans, especially in a library where the number of visitors is quite large. To determine whether the number of library visitors increases or decreases each day, a visitor counting system is created to track the daily count of library visitors. When this counting is done manually, it can be very challenging for the staff and there is a possibility of errors in the counts made by them (Nugraha et al., 2019).

This library visitor counting device utilizes an automatic system where the device is placed at the entrance and exit of the library. Through the implementation of this system, library staff can conduct analysis and monitoring library visitors. This system operates by calculating the number of people entering or exiting a library space using Ultrasonic Sensors with a microcontroller as its controller. The ultrasonic sensor is placed beside the entrance and exit doors of the library. Therefore, if a visitor passes through either of these paths within a certain range, the Ultrasonic Sensor will provide information about the visitor entering or exiting (Bangun et al., n.d.).

Based on that background, research on microcontroller-based automation was conducted, which is beneficial for library staff. With this system, library staff no longer need to manually count visitors but can simply check the display on the LCD. The objective of this research is to design and contrast a library visitor monitoring system based on a microcontroller that tracks the number of incoming and outgoing visitors.

METHOD
The methodology employed in this development is prototyping. This model produces a software prototype that can be used as an intermediary for developers to interact with users during the information system development. A prototype is an initial version of the software used to demonstrate concepts,

explore various design options and uncover more issues and solutions.(Syarifudin, 2019)
Stages of the prototype method:

- Requirement gathering/tools collection
- Building the prototype
- Evaluating the prototype
- Coding the system
- Testing the system
- Evaluating the system
- Using the system

Tools and Materials, the essential materials used in the creation of this tool are as follows:

- Software: Arduino Uno
- Hardware:
  1 Arduino Uno
  1 LCD
  1 Buzzer
  2 Ultrasonic Sensor
  1 Breadboard
  USB connector cables
  Laptop/PC
  Jumper cables
  Battery

Literature review

- Microcontroller
  A microcontroller is a chip, in the form of an Intergrated Circuit(IC), capable of receiving input signals, processing them and providing output signals according to the programmed instructions. Input signals for the microcontroller come from sensors, which gather information from the environment, while output signals are directed to actuators that can affect the surroundings. In simple terms, a microcontroller can be likened to the brain of a device or product that can interact with its surrounding environment. Essentially, a microcontroller is a computer within a single chip, containing a microprocessor, memory, Input/Output(I/O) lines and other complementary devices. The data processing speed of a microcontroller is lower compared to a PC. PCs nowadays use microprocessors with speeds in the GHz range, whereas the operating speed of microcontrollers typically ranges from 1 to 16 MHz. similarly, the RAM and ROM capacities of PCs can reach orders of bytes/kilobytes. Microcontrollers user assembly language programming based on fundamental digital principles, making system operation easy to implement according to logical rules. Assembly language is straightforward because it uses application-specific assembly language, where input and output parameters can be directly accessed without requiring many commands.(Sitorus & Tahyudin, 2018)
- Arduino Uno
  Arduino Uno is one of the products within the Arduino ecosystem, which is essentially an electronic board containing an Atmega microcontroller. This device can be used to create electronic circuits, ranging from simple to complex. Arduino Uno is one of the affordable and widely available Arduino boards. It is equipped with a microcontroller and the latest version produced is the R3 version. This module comes with various components necessary to support the microcontroller’s operation.(Jupri et al., 2021)

Figure 1. Arduino Uno

- Arduino IDE
  Arduino IDE is software used to create programming sketches or, in other words, it serves as the programming medium for the board you want to program. Arduino IDE is essential for editing, creating, uploading to the specified board and coding specific programs. Arduino IDE is built using the JAVA programming language and is equipped with C/C++ libraries (wiring) that make input/output operations easier.(Kadarsih & Andrianto, 2022)

Figure 2. Arduino IDE

- Ultrasonic Sensor
  An ultrasonic sensor is a device used to measure the distance from an object. The range of distances it can measure is approximately 2-450 cm. this device uses two digital pins to communicate the measured distance. The operating principle of an ultrasonic pulses at around 40 KHz, then receiving the echo pulses back and calculating the time taken.(Puspasari et al., 2019)

Figure 3. Ultrasonic Sensor

- LCD
  LCD (Liquid Crystal Display) is a type of display medium that uses liquid crystal as its primary display element. LCDs have been used in various fields, such as electronic devices like televisions, calculators and computer screens. In the context of this application post, a dot matrix LCD with 2 x 16 character display is used. LCDs serve as a highly functional display that will be used to show the operational status of the device.(Jupri et al., 2021)

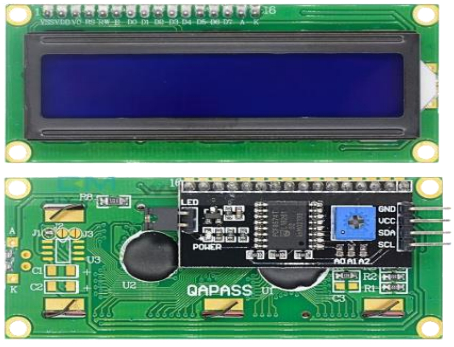

Figure 4. LCD (Liquid Crystal Display)

- Buzzer
  A buzzer is an electronic component that functions to convert electrical vibrations into sound vibrations. Essentially, the principle of a buzzer is almost the same as that of a loudspeaker. Therefore, a buzzer also consists of a coil mounted on a diaphragm and then this coil is supplied with current to become an electromagnet. The coil will be attracted inward or outward depending on the direction of the current and the polarity of the magnet. Since the coil is attached to the diaphragm, every movement of the coil will move the diaphragm back and forth, causing the air to vibrate, resulting in sound. Buzzer is commonly used as an indicator that a process has been completed or as an alert for an error in a device or alarm.(Mardiati et al., 2016)

Figure 5. Buzzer

Flowchart
The flowchart below explains the working of a visitor count device in a easy and structured manner. It begins by describing how the sensor works and then outlines the system's flow to count visitors. When a visitor passes through the ultrasonic sensor area, the data is read and processed by the Arduino Uno. Subsequently, this data is input as either an entrance or exit data. The data is then displayed on the LCD, increasing or descreasing the visitor count. If a visitor enters, the LCD will increment the data and if a visitor exits the LCS display will decrement.

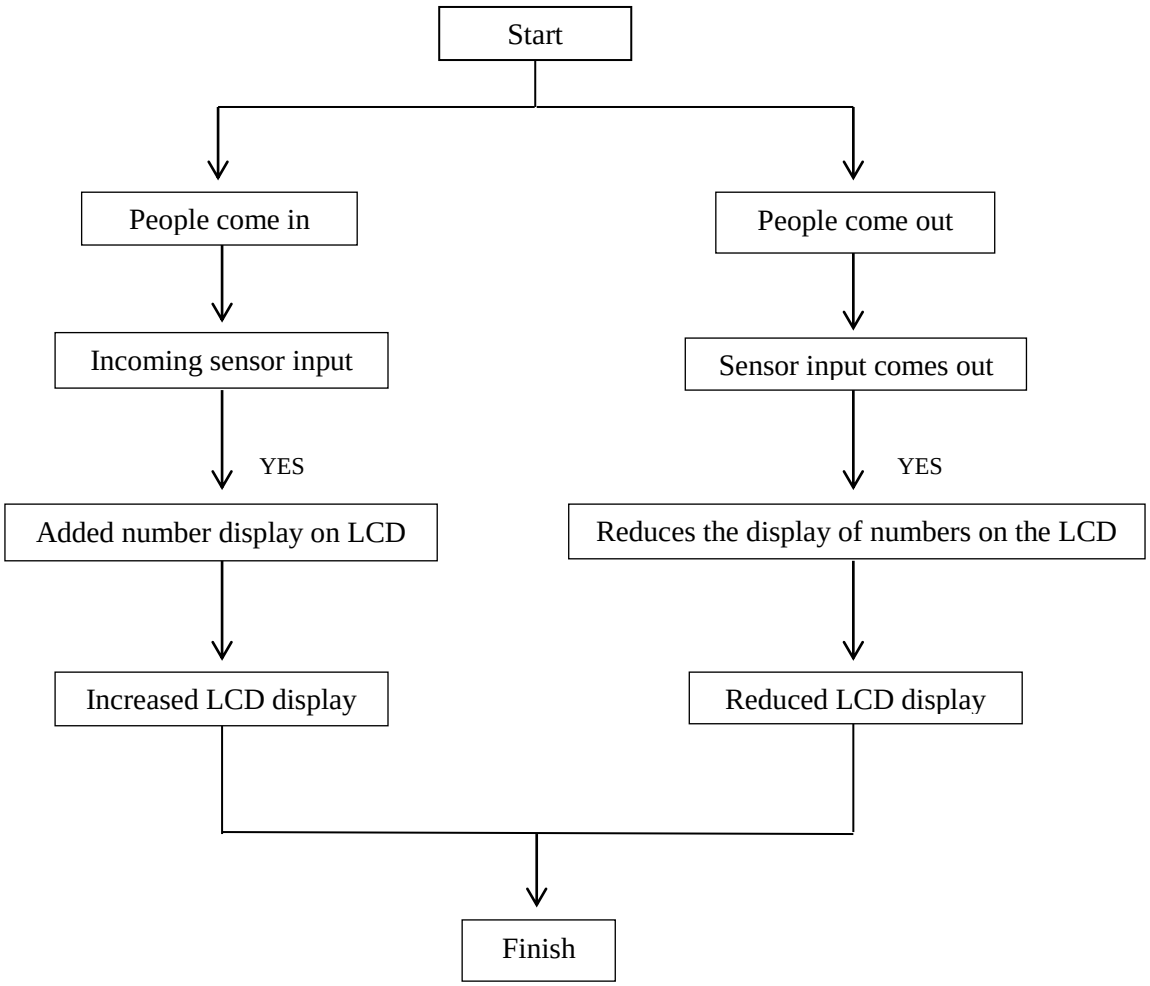

Figure 6. Flowchart

System chart
The system for this Library Visitor Monitoring consists of several components, namely Breadboard, Ultrasonic Sensor, Buzzer, Battery and LCD. The connections between these components can be illustrated in a block diagrams as follows:

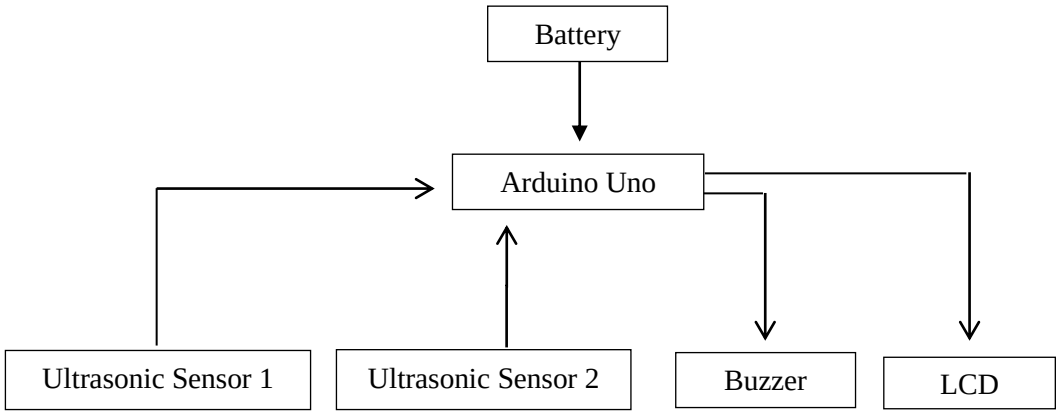

Figure 7. System chart

Explanation of the above block diagram:

- Arduino Uno : servers as the central control unit of the circuit
- Ultrasonic Sensor : detects library visitors automatically
- LCD : provides a display for data presentation
- Buzzer : acts as an indicator for visitor entry and exit
- Battery : supplies electrical power or energy

Tool Design

- Ultrasonic Sensor Design 1 (entry)
  The Ultrasonic Sensor is connected to the Arduino and Breadboard with the GND pin connected to the Breadboard negative, the Echo pin to pin 8, the Trig pin to pin -9 and the VCC pin to the Breadboard positive. For a clearer connection, you can refer to the circuit diagram below:

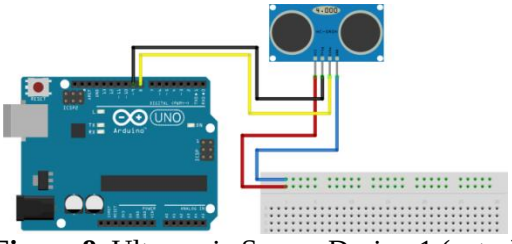

Figure 8. Ultrasonic Sensor Design 1 (entry)

- Ultrasonic Sensor Design 2 (Exit)
  The Ultrasonic Sensor is connected to the Arduino and Breadboard with the GND pin connected to the breadboard negative, the Echo pin to pin 7, the Trig pin to pin -8 and the VCC pin to the Breadboard positive.

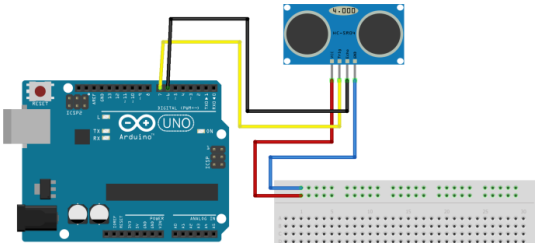

Figure 9. Ultrasonic Sensor Design 2 (Exit)

- LCD Design

  The LCD functions as a data display. In this project, the LCD will be connected to Arduino and a Breadboard with the GND pin to pin the Breadboard's negative rail, the VCC pin to the breadboard's positive rail, the SDA pin to A4 and the SCL pin to A5.

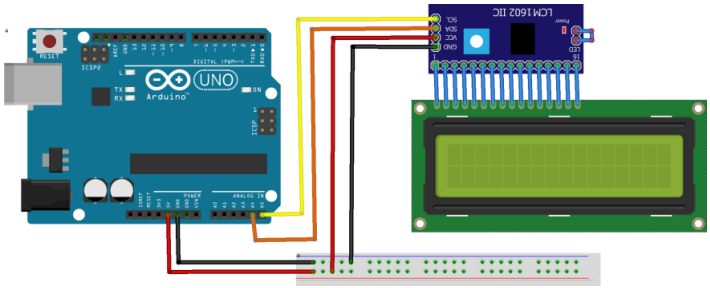

Figure 10. LCD Design

- Overall Component Design

  The design of this tool will explain the assembly of the necessary hardware components for the system, both in terms of the overall system and individual parts that support its operation.

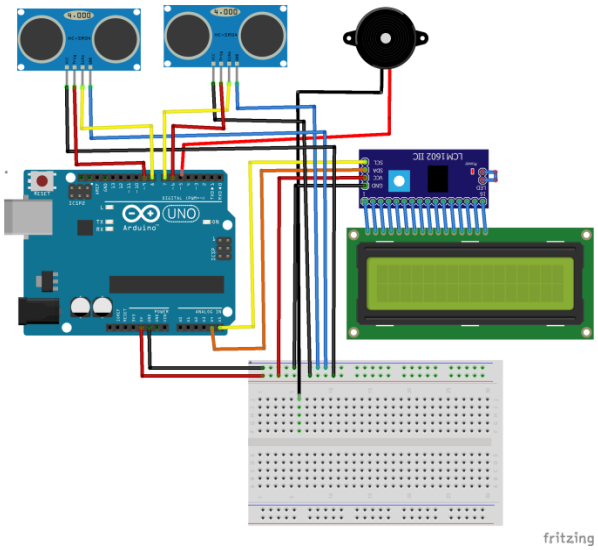

Figure 11. Overall Component Design

The entire system circuit, as seen in the above diagram, can help us understand the operation of the Ultrasonic Sensor, which can send data to the LCD as a display of the number of incoming and outgoing visitors. If a visitor passes through one of the paths within a certain range, the Ultrasonic Sensor will provide information that there is a visitor entering or exiting.

RESULT AND DISCUSSION

The display results are in the form of an automatic visitor count monitoring device using Arduino as the data processor, an LCD for data display, a buzzer for visitor entry and exit alerts, batteries for power and jumper cables for connections.To detect visitors, an ultrasonic sensor is installed. This is done to detect the entry and exit of visitors in the library.

Here are the results of the library visitor monitoring system based on a microcontroller. The device

is placed inside a box with holes on the left right sides for the ultrasonic sensor placement.

Figure 12. Entire Network

Figure 13. The front part of the ultrasonic sensor

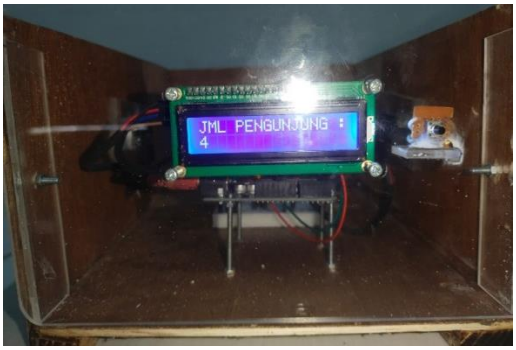

Figure 14. The front of the LCD

The results of the device testing
To test the device circuit, it can be observed from the ultrasonic sensor. The sensor will detect the entry and exit of library visitors.

- Testing the entry of visitors and exit of visitors in this stage, testing is conducted for visitors entering the library; the sensor will automatically increase when visitors enter. The testing can be seen in Figure 4.4
- Testing the exit of visitors in this stage, testing is conducted for visitors exiting the library; the sensor will automatically decrease when visitors exit. The testing can be seen in Figure 4.5

Figure 15. Visitor Entry

Figure 14. Visitor exit

The overall testing is conducted to assess the performance of the library visitor counter device. This testing begins when the sensor detects objects passing through it, and the detection count is displayed on an LCD screen.
The steps in testing this system are as follows:

- Placing the sensor in a designated location to detect visitors entering and exiting the library.
- Observing and adjusting the Ultrasonic sensor detection when visitors pass through the sensor.
- Setting the sensor distance to determine whether visitors are entering or exiting the library based on the pre-set distance.

CONCLUSION

Based on the design and testing conducted, the following conclusions can be drawn:

- A visitor monitoring system in a library room based on a microcontroller and ultrasonic sensor has been implemented. The detection system uses ultrasonic sensors to detect human movement, and the data obtained from the ultrasonic sensor is displayed on an LCD screen, allowing the library staff to determine whether there are visitors or not. If there are visitors entering or exiting, a buzzer will sound.
- The ultrasonic sensor is unable to detect visitors who are in close proximity to each other or those entering and exiting simultaneously, which may result in a lack of synchronization in the visitor count data.
- The performance testing of this device indicates that it provides convenience to library staff in monitoring the number of visitors entering and exiting. This leads to greater efficiency in tracking library visitor numbers.

During the process of working on the Final Project, which includes design and testing, there were constructive shortcomings. For future research, it is advisable to optimize the performance of the visitor counting system so that it can detect visitors entering and exiting simultaneously and also those who are in close proximity. Additional features such as a database and IoT (Internet of Things) integration are expected to be included in the next research phase.

REFERENCES

Bangun, R., Penghitung, A., Pengunjung, J., Perpustakaan, D., Negeri, P., Berbasis, B., Almuttaqin, M., Nasir, M., Bengkalis, P. N., Alam, J. B., & Alam, S. (n.d.). Politeknik Negeri Bengkalis Oktober 2021. In *Seminar Nasional Industri dan Teknologi (SNIT)*.

Fahmawaty, M., & Royhan, M. (2020). Perancangan Alat Penghitung Jumlah Pengunjung Di Perpustakaan Unis Tangerang Menggunakan Sensor Pir Berbasis IoT. *JIMTEK : Jurnal Ilmiah Fakultas Teknik*, *1*(3), 253. http://ejournal.unis.ac.id/index.php/jimtek/article/download/1124/Mega/

Jupri, S., Hendryadi, D., Syam, N., Komputer, S., & Bina Adinata, S. (2021). Pengembangan Alat Penghitung Jumlah Pengunjung Wisata Permandian Eremerasa Berbasis Arduino. *Jtriste*, *8*(2), 23–31.

Mardiati, R., Ashadi, F., & Sugihara, G. F. (2016). Rancang Bangun Prototipe Sistem Peringatan Jarak Aman pada Kendaraan Roda Empat Berbasis Mikrokontroler ATMEGA32. *TELKA - Telekomunikasi, Elektronika, Komputasi Dan Kontrol*, *2*(1), 53–61. https://doi.org/10.15575/telka.v2n1.53-61

Nugraha, D. W., Anshori, Y., & Candriasih, N. K. (2019). Rancang Bangun Sistem Penghitung Jumlah Pengunjung Perpustakaan Menggunakan Metode Haar like Features (Studi Kasus Pada Perpustakaan Universitas Tadulako). *ScientiCO : Computer Science and Informatics Journal*, *1*(1), 57. https://doi.org/10.22487/j26204118.2018.v1.i1.11902

Puspasari, F.-, Fahrurrozi, I.-, Satya, T. P., Setyawan, G.-, Al Fauzan, M. R., & Admoko, E. M. D. (2019). Sensor Ultrasonik HCSR04 Berbasis Arduino Due Untuk Sistem Monitoring Ketinggian. *Jurnal Fisika Dan Aplikasinya*, *15*(2), 36. https://doi.org/10.12962/j24604682.v15i2.4393

Sitorus, B., & Tahyudin, A. (2018). Rancang Bangun Alat Memberi Pakan Ikan Lele Otomatis Berbasis Arduino UNO. *Jurnal Ilmiah Fakultas Teknik*, *14*(1), 1–12.

Syarifudin, A. (2019). Perancangan Sistem Informasi Pengajuan dan Pelaporan Pembayaran Tunjangan Kinerja Kementerian Keuangan Menggunakan Metode Prototype. *Jurnal Sisfokom (Sistem Informasi Dan Komputer)*, *8*(2), 149–158. https://doi.org/10.32736/sisfokom.v8i2.641