
ARDUINO UNO R3 BASED AUTOMATIC STATION ANNOUNCEMENT USING HC-SR04 ULTRASONIC SENSOR

Nur Amri*, Ananda Niken, Eka Fajar, Faisal Mukti, Wahyu Pribadi, Ricto Yudi

State Polytechnic of Madiun, Madiun City

*Corresponding author: nur.amri.234308106.tka@gmail.com

Abstract

The development of railway transport in Indonesia has progressed rapidly in the last decade, supported by the application of modern technology in railway facilities and infrastructure. This research aims to design and develop an automatic device to provide information to passengers to get ready and be careful when the train approaches the station. The system is designed using HC-SR04 ultrasonic sensors to detect the presence of trains at a distance of about 1 KM from the station, while DFPlayer Mini and speakers are used to deliver the announcement automatically. The system functions without manual control, replacing conventional arrival waiting tones, thus improving the efficiency and accuracy of information delivery. Implementation results show that the system is capable of automatically detecting train arrivals and providing clear information to passengers. This innovation is expected to improve the safety and comfort of railway transport users in Indonesia.

Keywords: Automatic announcement, DFPlayer Mini, HC-SR04 ultrasonic sensor, Passenger safety, Train, Transport.

INTRODUCTION

Railway transportation plays an important role in supporting community and economic activities in various countries, including Indonesia. In the past decade, the development of railways in Indonesia has shown significant progress, especially with the application of modern technology to railway facilities and infrastructure. This effort aims to improve the safety, comfort, and operational efficiency of the railway transportation system. According to a report by the Ministry of Transportation, the application of automation-based technology is one of the main focuses in the development of rail transportation (Ministry of Transportation, 2022). This is in line with global trends that show the integration of advanced technologies, such as sensors, Internet of Things (IoT), and artificial intelligence-based systems, to improve the performance of the transportation sector (Wu *et al.*, 2021).

One important aspect of train operations is the timely delivery of information to passengers. Information such as arrival schedules, departures, and hazard notifications play a vital role in creating a positive user experience. However, conventional systems that rely on manual announcements or waiting tones are often inadequate in ensuring information efficiency and accuracy. Previous research by Zhang *et al.* (2020) showed that sensor-based automation systems can reduce human error and improve responsiveness in information delivery.

In Indonesia, the need for information automation systems is increasingly urgent as the number of rail transportation users increases (BPS, 2022). One potential solution is to utilize ultrasonic sensors to automatically detect the arrival of trains at a certain distance from the station. These sensors can work alongside other hardware, such as the DFPlayer Mini audio module, to relay information automatically without the need for manual intervention.

This research aims to design and develop a sensor-based automation system that can provide information to passengers as trains approach the station. By replacing conventional methods, this

innovation is expected to improve the safety and comfort of train transportation users, as well as make a real contribution to the development of technology-based transportation in Indonesia.

LITERATURE REVIEW

2.1 Ultrasonic Sensor Formula

Ultrasonic sensors are distance detection devices equipped with transmitters and receivers that work at a frequency of 40 KHz. The working principle of the ultrasonic sensor is that the signal is emitted to the intended target, after reaching the intended target, the signal is reflected. The reflected signal is received by the receiver of the ultrasonic sensor. The amount of reflected signal received by the ultrasonic sensor is influenced by the distance between the transmitter and the target object. The further away the target object, the smaller the reflected signal received by the ultrasonic sensor. (Saragih & Bancin, 2020). The formula used to calculate the distance (d) in the program is:

$$d = \frac{t \times v}{2}$$

Description:

d = distance

t = the time it takes for the pulse to go to the object and back

v = speed of sound in the medium

2.2 Arduino Uno R3



Figure 2.2. Arduino UNO R3
Source : Wikipedia Bahasa Indonesia

Arduino UNO is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz Crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Arduino UNO contains everything needed to support a microcontroller, easily connect it to a computer with a USB cable or supply it with an AC to DC adapter or use a battery to start it (Adriansyah & Hidyatama, 2013). In this research, Arduino UNO is used to process data from sensors and control other components in the system.

2.4 Sensor Ultrasonik HC-SR04



Figure 2.3. Ultrasonic Distance Sensor (HC-SR04)
Source : www.tokopedia.com

The HC-SR04 ultrasonic sensor is an ultrasonic sensor that can be used to measure the distance between an obstacle and a sensor. The measurement range ranges from 2 cm to 400 cm. This sensor has 4 pins, namely VCC as a positive voltage source for the sensor, Trigger pin which is used to generate ultrasonic signals, Echo pin which is used to detect ultrasonic reflection signals, and Gnd pin as a negative voltage source for the sensor. The HR-SR04 ultrasonic sensor has 2 main components, namely the transmitter and receiver. The function of the ultrasonic transmitter is to emit ultrasonic waves with a frequency of 40 KHz then the ultrasonic receiver captures the reflection of ultrasonic waves that hit an object. (Ivan Kavenius Missa *et al.*, 2018). In this research, the HC-SR04 ultrasonic sensor functions to measure the distance of the train from the station in real-time to detect the arrival of the train.

2.5 Speaker 8 ohm 0,5 watt



Figure 2.4. Speaker 8 ohm 0,5 watt
Source: www.tokopedia.com

Speakers function to convert electrical signals into sound signals. the greater the power of a speaker is usually the greater its physical shape. generally divided into three namely woofer (bass) squaker (middle) and Tweeter (high). Speaker impedance is between 4 Ohms, 8 Ohms, and 16 Ohms. Nowadays there are also speakers called subwoofer speakers that are capable of producing audio signals with very low frequencies below the woofer (John Wiley & Sons Inc., 2006). The 0.5 8Ohm speaker serves to develop a train arrival information system at the station. The sound output will be issued through the speaker. Speakers carry electrical signals and convert them back into vibrations to create sound waves (Palending *et al.*, 2012). In this study, a 0.5 8Ohm speaker type is used for sound output.

2.6 DF Player Mini



Figure 2.5. DF Player Mini
Source : www.tokopedia.com

DFPlayer Mini is an audio file player module. Files that are supported on this module include mp3 format files. This mini DFPlayer is connected to Arduino using serial communication, from this module it will be directly connected to speakers such as speakers (Sudrajad *et al.*, 2021). In this research, DF Player Mini is used to play audio files containing train arrival announcements based on commands from Arduino.

2.7 Micro SD



Figure 2.6. Micro SD
Source : Kingston Technology

SD Card is a small storage device used to store data. The results of data recording contained in the data logger will be stored on the SD Card which can then be read on a computer using a card reader (Daniel *et al.*, 2019). In this research, Micro SD serves to store audio files that will be played by DF Player Mini.

2.8 Card Reader



Figure 2.7. Card Reader
Source : Dinomarket

The micro SD module is a module for accessing micro SD type memory cards for reading and writing data using the SPI (Serial Parallel Interface) interface system. This module is suitable for various applications that require data storage media, as well as other data logging application systems (Daniel *et al.*, 2019). In this research, a card reader is used to read audio files stored in a Micro SD and forward them to the DF Player Mini.

RESEARCH METHOD

3.1 Time and Place of Research

The research entitled "Arduino Uno R3 Based Automatic Station Announcement Using HC-SR04 Ultrasonic Sensor" was carried out in 2 weeks in 2024. This research was carried out at the Railway Laboratory Building Campus 2, Madiun State Polytechnic on West Ring Road Road, Winongo, Manguharjo District, Madiun City, East Java 63162.



Figure 3. 1 Research Location

3.2 Tools and Materials

Tools

- Laptop / Personal Computer
- Software Arduino
- Solder

Materials

- Arduino Uno
- Ultrasonic Distance Sensor (HC-SR04)
- Cable Jumper
- Speaker 8ohm 0,5watt
- DF Player Mini
- Micro SD
- Card Reader

3.3 Research Stages

This study consists of several series of activities that are carried out, both including the preparation process and the assembly process.

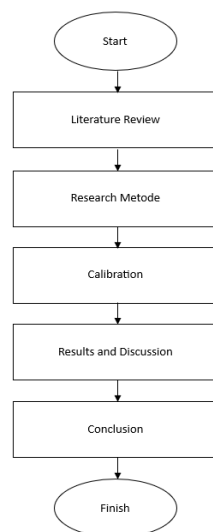


Figure 3.3 Research stages

3.4 Research Stages

Starting from the initialization of the Arduino uno system itself and ensuring that there is a power supply and all programs have been uploaded to the Arduino software. The next stage The system will work to detect objects that pass through the ultrasonic sensor HC-SR04 at a distance of 5-30 cm, then send a signal to the Arduino Uno for processing and trigger the DF Player Mini to play the audio according to the program. The indicator LED on the Arduino Uno also lights up, indicating that the system is active and functioning.

3.5 Data Collection and Analysis Techniques

This study uses qualitative data collection techniques by means of observation. The researcher observes and records data directly on the research object. The object of the research in question is in the form of data from the work of sensors in the announcement of train arrivals.

3.6 Schematic Design

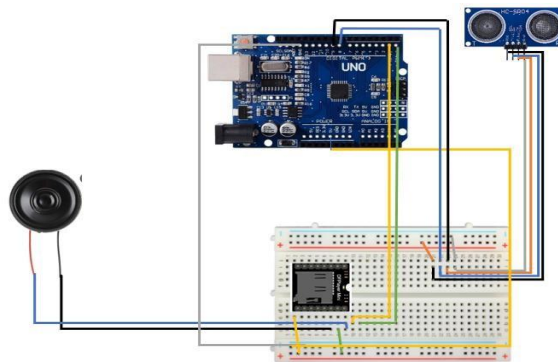


Figure 3.6 Schematic design

3.7 Research Flow Diagram

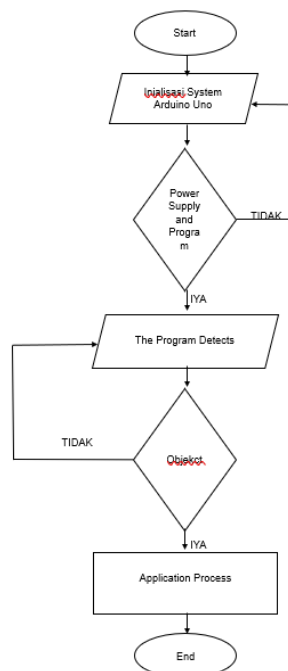


Figure 3.7 Research flow diagram

3.8 Tool Prototype Design

In the design of the tool there is a circuit design, sensors and actuators that are connected and connected to the microcontroller, the designed tool is used to monitor the arrival of trains and signs that trains are coming to the station, the data is sent by the tool to the server so that the data can be processed, can be seen in Figure 3.8.

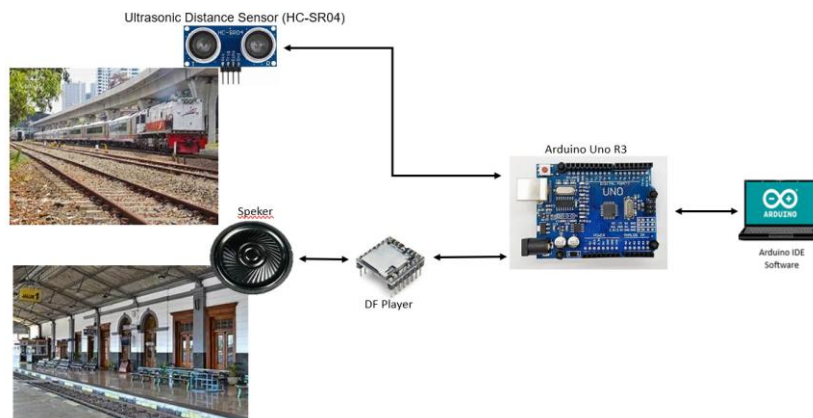


Figure 3.8 Tool prototype design

RESULTS AND DISCUSSION

This ultrasonic sensor project was successfully built and functioned well. The system successfully detects objects passing through the HC-SR04 ultrasonic sensor at a distance of 5-30 cm, then sends a signal to the Arduino Uno for processing and triggers the DF Player Mini to play the audio according to the program. The indicator LED on the Arduino Uno is also illuminated, indicating that the system is active and functional. This system has several advantages, namely that it can be applied to various needs such as alarm systems, object counters, and distance meters. In addition, the use of easy-to-find and relatively cheap components makes the system easy to apply, and the simple Arduino IDE program allows modification and further development of system functions. However, there are some suggestions for improvement to enhance the system's performance, such as increasing the sensitivity of the sensor to detect objects at a greater distance, adding a display to visually show the distance of the object, and developing the Arduino IDE program for more complex functions. With further development, this system can be applied to a variety of more complex and useful needs.

CONCLUSION

Based on the practicum that has been carried out and analyzing the results, it can be concluded that:

- 1) Improved operational efficiency and passenger comfort. The system that combines HC-SR04 ultrasonic sensor and Arduino Uno microcontroller platform is designed to provide an innovative solution in train arrival information system. Test results show that the system has significant potential to improve station operational efficiency and provide a more comfortable experience for passengers.
- 2) High accuracy in distance detection and announcement automation. The main advantage of this system lies in its ability to detect train distance with a high degree of accuracy. The distance

data obtained from the HC-SR04 ultrasonic sensor is processed by Arduino Uno to then automatically activate the announcement device. This ensures that train arrival information can be delivered in a timely and accurate manner to passengers.

- 3) Operational reliability and minimization of the risk of misinformation. The system has been designed to operate optimally under normal weather conditions, thus ensuring the reliability of the information presented. The use of ultrasonic sensors and automated systems also minimizes the potential for human error in the process of announcing train arrivals, so that the information received by passengers is more accurate and reliable.

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