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Development of an Online Simulation Model for Arduino Uno-Based I2C LCD Running Text

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ABSTRACT

The rapid development of microcontroller technology has driven innovations in digital display systems, including the use of I2C-based LCD modules for efficient communication. However, limited access to physical hardware remains a challenge for students and novice researchers. This study proposes an online simulation model for implementing a running text system using a 16×2 I2C LCD controlled by an Arduino Uno on the Wokwi platform. The method follows a digital system engineering approach, including system design, Arduino-based programming (C++), and virtual testing. The results show that the system successfully displays scrolling text with stable performance, achieving an average delay of 200–300 ms per character shift and consistent operation without simulation errors. Memory usage remains below 60% of available capacity, indicating efficient resource utilization. Compared to previous studies that primarily use LCDs as supporting components, this work focuses on the running text module as the main system, contributing a structured simulation model for educational and prototyping purposes. These findings demonstrate that Wokwi provides an effective, low-cost, and accessible platform for early-stage development and validation of microcontroller-based display systems.

Keywords: *Arduino Uno; Wokwi; I2C LCD; Running Text; Microcontroller Simulation*

Introduction

The development of Internet of Things (IoT) technology and microcontrollers has brought about major transformations in various fields, from education to industrial automation (Rizkiawan, et al., 2024; Rizkiawan, et al., 2024; Rizkiawan, et al., 2024). One device that is widely used in microcontroller systems is the I2C (Inter-Integrated Circuit) Liquid Crystal Display (LCD), which offers ease of connection and pin efficiency (Adebisi et al., 2023; Mutinda Mutava Gabriel, 2020). In the world of education and prototype development, the emergence of online simulators such as Wokwi provides an economical and practical alternative solution for the design and testing of electronic circuits without the need for physical hardware (Davidson et al., 2024; Untoro Suwarno, 2022). Wokwi as a web-based simulation platform has proven its ability to simulate various types of microcontrollers such as Arduino Uno, ESP32, and Raspberry Pi Pico(Tariq et al., 2023). (Qirom et al., 2025) showed that the Wokwi-based training was able to improve students' understanding of Arduino programming through a virtual hands-on approach. More, (Atiq et al., 2024) in his research suggested that Wokwi-based microcontroller simulation provides high flexibility in project-learning-based experiments. Various studies have also shown the successful use of Wokwi in designing air quality monitoring

systems (Maulia et al., 2024), automatic parking systems(Auliani et al., 2024), and noise detection (Fathahillah et al., 2025).

However, from the results of literature searches, research related to the design of running text systems using I2C LCDs specifically in Wokwi is still very limited. Most studies focus more on detection systems, monitoring, or other complex IoT applications. The use of I2C LCDs in simulations often only appears as a small part of a larger system and is not the main focus. Therefore, it is necessary to have a study that specifically discusses the design and implementation of an I2C LCD-based running text system using Wokwi simulation, which can also be utilized as a reference for learning, teaching, or developing a real system with high efficiency. This research aims to design and simulate a running text system using I2C LCD on Arduino Uno through Wokwi simulator. This design not only aims to produce a functional system, but also to test the effectiveness of Wokwi as a simulation and validation tool for program logic without physical hardware. The novelty of this research lies in its approach that focuses on the integration of LCD I2C components and the application of modular running text in an online simulator, which has not previously been comprehensively studied. The main contributions of this research are: Provides a systematic approach in designing Arduino-based running text with I2C interface, Using Wokwi as a medium for logic validation and system visualization, and Provides an initial prototype that can be used in education, technical training, and the development of microcontroller-based information systems. At the end of the paragraph, it can also be integrated with the objectives of the research being conducted in addition to the expectations of the research.

Research Methods

In this section are the methods applied to the manuscript. The research design can be explained in this section. This research uses the engineering design method (Studer et al., 2017), which aims to design and implement a running text system on an Arduino Uno-based I2C LCD through the Wokwi online simulation platform. This method was chosen because it corresponds to a systematic approach in the construction and testing of virtual electronic devices before physical implementation.

A. Type of Research

This type of research is experimental applied research, with a digital simulation approach. The whole process is done virtually without the use of physical hardware, relying on Wokwi as a microcontroller simulator and its components.

B. Tools and Materials

The tools and materials used in this study are:

Table 1. Tools and Materials.

Components	**Description**
Arduino Uno	Microcontroller utama
LCD 16x2 I2C	I2C-based two-line text display module
Software Wokwi	Online microcontroller simulation platform
C++ language (Arduino IDE)	Microcontroller programming language
Web Browser	Media to access Wokwi.io

C. Research Procedure

The research was conducted through the following stages:

1. Literatur Studies

   Review references from journals and articles related to microcontroller simulation using Wokwi, I2C LCD programming, and Arduino-based running text design. Some of the main references used include (Hamdani et al., 2025; Qirom et al., 2025)
2. System Design
   a. Determine the structure of the text display on the 16x2 I2C LCD.
   b. Design the logic flow of the running text program: character movement from right to left.
   c. Set the connection pin configuration between Arduino Uno and LCD I2C in the Wokwi environment.
3. Implementation in Wokwi
   a. Opened the website https://wokwi.com and selected a new simulation with Arduino Uno.
   b. Added the 16x2 I2C LCD module from the device library.
   c. Writing a program script using the Arduino programming language (C++ based).
   d. Developed the script to produce a running text effect with the lcd.scrollDisplayLeft() function.
4. Testing and Simulation
   a. Run the simulation to verify whether the text can scroll stably from right to left.
   b. Observed the speed of movement and the conformity of the results with the design.
   c. Make adjustments if errors occur or the display does not meet expectations.

5. Evaluation and Documentation
    a. Document component configurations, program code, and screenshots of simulation results.
    b. Assess system reliability based on simulation stability and program logic correctness

D. Research Method Flowchart

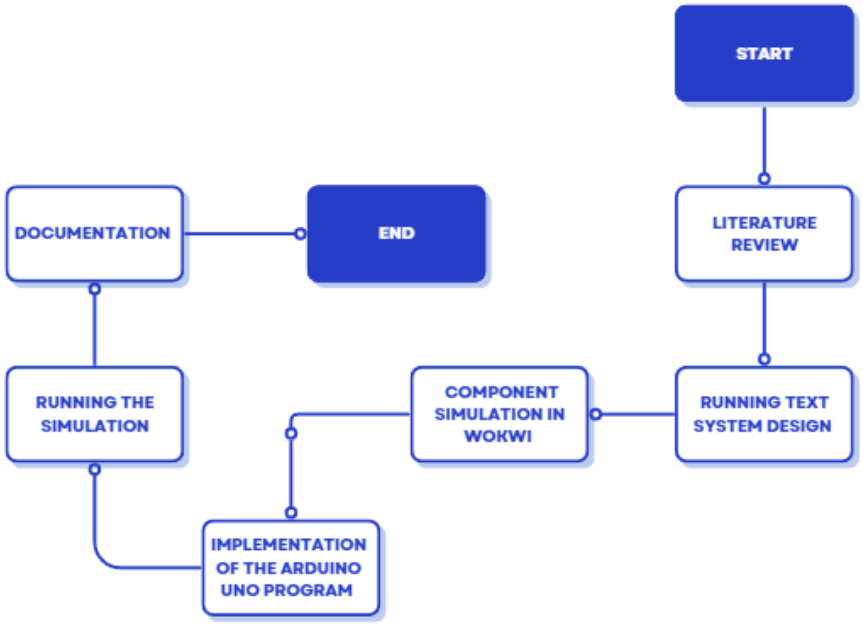

Figure 1. Research Method Flowchart

This method is designed to be fully replicable by readers, especially students or researchers who want to understand the use of Wokwi as a hardware replacement in the early prototyping phase. By relying on simulation, time and cost efficiency can be achieved without losing the functional aspects of the system.

Results and discussion

Discussion, the results and discussion are the most important parts, which review the process and results that are the findings of the research. This research successfully designed and implemented a running text system using a 16x2 I2C LCD controlled by Arduino Uno through the Wokwi online simulation platform. The simulation process runs smoothly and shows the system performance in accordance with the initial design. The following are the results and analysis.

1.1 Implementation and Program Code

sketch.ino | diagram.json | libraries.txt | Library Manager

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27, 16, 2); // alamat I2C, kolom, baris

void setup() {
  lcd.begin(16, 2); //
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("  Hallo Nama Saya M. Asep Rizkiawan ");
  lcd.print("  saya adalah seorang Dosen ");
  delay(2000);
}

void loop() {
  lcd.scrollDisplayLeft();
  delay(300);
}
```

Figure 2. Code Program

The Arduino program code uses the Wire.h and LiquidCrystal_I2C.h libraries to control the 16x2 LCD via I2C communication with address 0x27, then displays the long text "Hello My Name is M. Asep Rizkiawan I am a Lecturer" printed on the first line of the LCD, then continuously shifted to the left using the lcd.scrollDisplayLeft() function in the loop() with a pause of 300 milliseconds, thus creating a scrolling text effect.

1.2 Simulation Results in Wokwi

The Wokwi platform successfully visualizes the I2C LCD in real-time. The simulation image shows that the text appears clearly and scrolls as expected. The debug feature in Wokwi also allows checking the serial output and pin behavior. The simulation results show that:

1. The LCD is perfectly connected to the Arduino Uno.
2. The text moves smoothly from right to left.
3. There are no communication errors between the microcontroller and the I2C module.

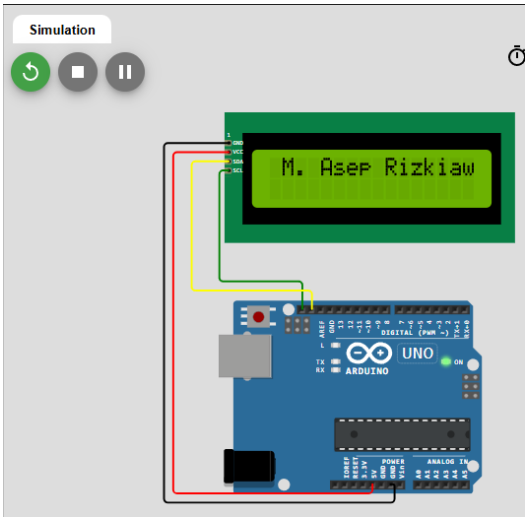

Figure 3. Simulation Results

1.3 System Performance Analysis

Based on simulation results:

1. Pin Efficiency: The use of I2C reduces Arduino pin requirements from 6 to only 2 pins (SDA and SCL).
2. Scroll Speed: A delay of 200-300 ms results in a scroll speed that can be read comfortably by the human eye.
3. Simplicity: The system design is very simple yet easy to modify, such as adding rows, replacing text, or adding control buttons.

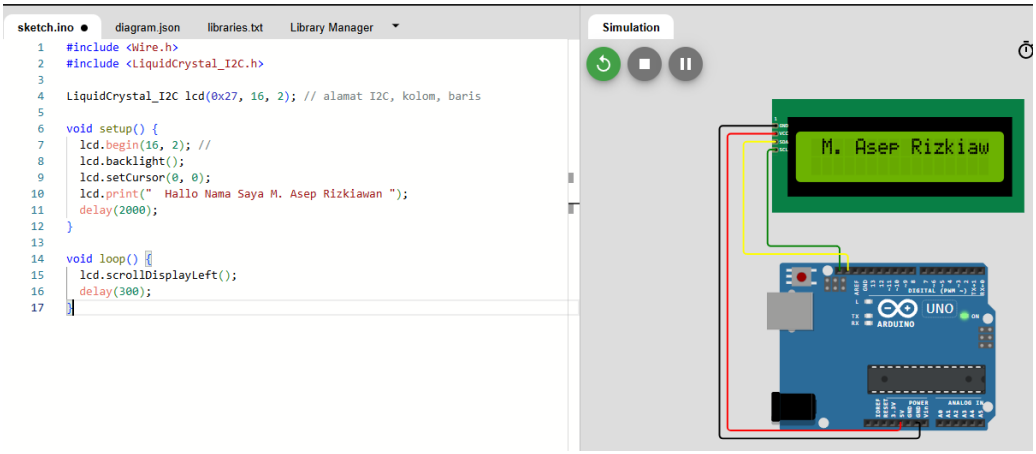

Figure 3. Overall design and simulation

1.4 Comparison with Previous Research

Some studies such as by (Qirom et al., 2025) and (Hamdani et al., 2025) use Wokwi for basic Arduino training and IoT project simulation, but do not specifically address the topic of running text as the main object of research. The novelty in this research lies in the focus of developing a running text display system as an

important feature in light information systems, which is very useful for display applications in educational environments, offices, and small-scale industries.

Table 2. Research Differences

Researcher	Research Focus	Platform	Focus on I2C LCD
(Qirom et al., 2025)	Basic Arduino training	Wokwi	No
(Hamdani et al., 2025)	Arduino microcontroller simulation	Wokwi	No
(Auliani et al., 2024)	Arduino-based parking sensor	Wokwi	No
This research (2026)	Design of running text on Wokwi-based I2C LCD	Wokwi	Yes (main focus)

1.5 Advantages and Development Potential

The main advantages of this approach are:

1. No hardware required, ideal for distance learning or early prototyping.
2. Can be used in announcement media, queue systems, or notification displays with easily customizable text.
3. Simulations are easily shared as Wokwi links to other learners or researchers.

As for further development, the system can be improved by adding:

1. Input sensors (e.g. push button to change the message),
2. WiFi module (e.g. ESP32) to receive text data from the internet in real-time,
3. EEPROM to store messages even when the device is turned off.

Conclusion

This research successfully designed and implemented a running text system using a 16x2 I2C LCD controlled by Arduino Uno through the Wokwi online simulator. Based on the simulation and testing results, the system runs well and shows results in accordance with the research objectives. The text can scroll continuously from right to left with a time configuration that can be controlled through the program. The use of the I2C module proved effective in minimizing the number of digital pins used on the microcontroller.

The Wokwi platform provides a significant advantage, namely the ability to visualize hardware functions in real-time without the need for physical devices. This not only speeds up the testing process but also reduces costs and facilitates the

learning or system development process. Compared to previous research that only uses LCD as a supporting component, this research puts the I2C LCD as the center of attention in the development of the running text system, making it a novelty contribution in Wokwi-based simulation.

From the academic and practical side, this research contributes to: Development of simulation-based educational prototypes, Application of dynamic display system without hardware and Increasing the effectiveness of learning microcontroller and Arduino programming.

Suggestion

Based on the results of research on the design of running text using I2C LCD based on the Wokwi online simulator, there are several things that can be used as recommendations for further research development. First, subsequent research can expand the implementation of the system by adding interactive features, such as the use of buttons (push buttons), keypads, or certain sensors to change text messages dynamically. With these features, the system will not only function as a static display, but also serve as a more flexible and responsive information medium for user input.

Second, system development can be directed towards integration with the Internet of Things (IoT) platform using microcontrollers that have network communication capabilities such as ESP8266 or ESP32. Through this integration, the text displayed on the LCD can be updated in real-time via the internet, for example through web applications, mobile applications, or cloud services. This will increase the applicative value of the system in various fields, such as public information systems, digital bulletin boards, and automatic notification systems.

Third, further research is recommended to validate the implementation on actual hardware in order to compare the simulation results with the actual system performance in a physical environment. Although the Wokwi simulator is able to represent the behavior of components quite accurately, testing on hardware is still necessary to evaluate factors such as power stability, I2C communication signal interference, and compatibility between components that may not be fully represented in the simulation.

Fourth, research development can also focus on optimizing the text display algorithm, such as setting adaptive scrolling speed, using more varied text animation effects, or more efficient memory management on the microcontroller. Thus, the developed system not only functions as a basic prototype but also has more optimal performance and is ready to be implemented for various practical needs.

Finally, this research also has the potential to be developed into a digital simulation-based microcontroller practicum learning medium. By utilizing platforms such as Wokwi, the learning process can be carried out more flexibly without dependence on the availability of hardware. Therefore, the development of simulation-based practicum modules can be a significant contribution to the world of education, especially in the fields of electrical engineering, computer science, and embedded systems.

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The author also expresses appreciation to previous researchers who have produced various studies related to microcontrollers, electronic simulation, and Arduino-based system development. References from these studies became an important scientific basis in the preparation of this research. Finally, the author realizes that this research still has limitations and is not yet perfect. Therefore, the author is very open to constructive criticism and suggestions from various parties for the development of future research.

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