IJMECIE International Journal of Mechanical, Electrical and Civil Engineering
E-ISSN: 3047-4531
P-ISSN: 3047-4523

Research Article

Design of Intercative Game to Train Children's Skills Based on Microcontroller

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Abstract. This research aims to design and develop a simple Dino-themed game based on a microcontroller, with the display using an I2C LCD. The game is inspired by the offline Dino game on Google Chrome, adapted to run on an Arduino Uno microcontroller. The research method used is Research and Development (R&D), consisting of stages such as needs analysis, system design, simulation using Wokwi, hardware assembly, programming, and testing. The system uses push buttons as input and a 16x2 I2C LCD as the output display. The testing results show that the system can respond quickly to user input and display character movement and score updates dynamically on the LCD screen. Although the graphical capability of the LCD is limited, the game runs well and successfully demonstrates the basic concepts of microcontroller programming as well as interactive input-output processing. Further development is recommended to enhance the graphical interface and add features such as sound effects and progressive difficulty levels.

Keywords: Design; Game; LCD I2C; Microcontroller Arduino Uno; Wokwi Simulation.

1. Introduction

The development of microcontroller technology has opened up significant opportunities in the field of education, particularly in the creation of interactive learning media. The use of microcontrollers such as Arduino enables the development of learning tools that are not only cost-effective but also effective in enhancing students' understanding of technical concepts. One practical implementation of this technology is the development of educational games that combine elements of entertainment and learning. This approach is not only relevant in today's digital era but also holds great potential in increasing children motivation and engagement in the learning process.

Microcontroller-based educational games have been proven to enhance students' activity and participation in learning activities. Research by (Fitriyah et al., 2025) shows that interactive media based on educational games can significantly increase students' learning motivation, particularly in Social Studies subjects. In addition, (Maxiduino & Mulyana, 2014) developed an interactive electronic hijaiyah puzzle game based on the DT-AVR Maxiduino microcontroller, which successfully improved the effectiveness of early childhood learning in recognizing hijaiyah letters. These findings reinforce the importance of utilizing microcontroller-based educational games to support a more contextual and enjoyable learning process.

From a technical perspective, the use of the I2C interface on LCD modules simplifies system design by reducing the number of pins required on the microcontroller. This is particularly important in projects that require connectivity to many components but are limited by the number of digital pins on boards such as the Arduino Uno. (Gauri et al., 2021) showed that the use of the I2C interface in microcontroller-based learning media is highly feasible due to its efficiency and ease of integration with other educational devices. They developed an I2C-based microcontroller trainer complete with a jobsheet, which proved effective for use in technical learning environments.

Received: October 19, 2025
Revised: December 24, 2025
Accepted: February 28, 2026
Published: April 30, 2026
Curr. Ver.: April 30, 2026

In the context of these issues, this study focuses on the development of a microcontroller- and I2C LCD-based "Dino Game" as an innovative solution to provide an interactive, affordable, and educational learning medium. This game adapts the offline Dino game from the Google Chrome browser, which is widely recognized, and transforms it into a learning tool to introduce programming logic, digital input-output concepts, and LCD display control via I2C. Thus, the game functions not only as entertainment but also as an educational tool that encourages students to be more active in understanding the basic concepts of electronics and microcontrollers.

2. Literature Review

Several literature reviews used in this research include the Arduino Uno microcontroller, Wokwi Simulator, I2C LCD, Arduino IDE, and the Dino Game.

Microcontroller Arduino Uno

Arduino is an open-source microcontroller platform widely used in the development of electronic and robotics projects. Its main advantages lie in its ease of programming and the availability of various additional modules that support the development of interactive systems. (Bonardo et al., 2025) developed a learning medium based on Arduino for introducing and measuring electronic components, which was considered highly suitable for use in the learning process.

The Arduino Uno microcontroller is one of the most popular development boards based on the ATmega328P microcontroller among students, university learners, and embedded system developers. The Arduino Uno is designed to simplify the learning process and the development of electronic projects because it is open-source, has extensive documentation, and is supported by a global community.

This microcontroller features 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, and a reset button. These features make the Arduino Uno an ideal choice for developing a wide range of projects, from automation systems to simple interactive devices (Sudhan et al., 2015).

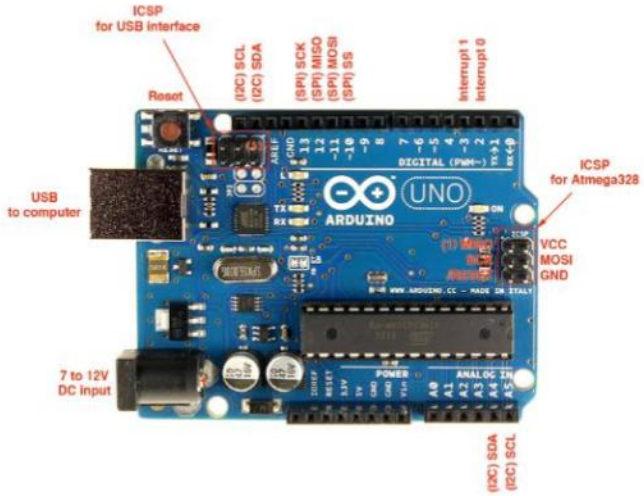

Figure 1. Microcontroller Arduino Uno.
(Source: Personal Documentation, 2025).

The Arduino Uno is programmed using the Arduino IDE, which provides a simple programming interface with syntax similar to C/C++. Programs are written in the form of sketches and can be easily uploaded to the microcontroller board via a USB cable. One of Arduino's advantages is the availability of various libraries that facilitate integration with different sensors and modules such as LCDs, temperature sensors, Bluetooth modules, and actuators like servo motors. According to (Nusyirwan et al., 2020), Arduino is highly suitable as a learning medium for electronics and automation because it provides direct visualization of programming results in the form of real actions.

Wokwi Simulator

Wokwi is a web-based simulation platform that allows users to design and test microcontroller circuits virtually without requiring physical hardware. The use of Wokwi in learning can overcome limitations in laboratory equipment and provide an interactive learning experience. (Di et al., n.d.) showed that the use of Wokwi as a simulator-based microcontroller learning medium greatly helps students understand technical concepts.

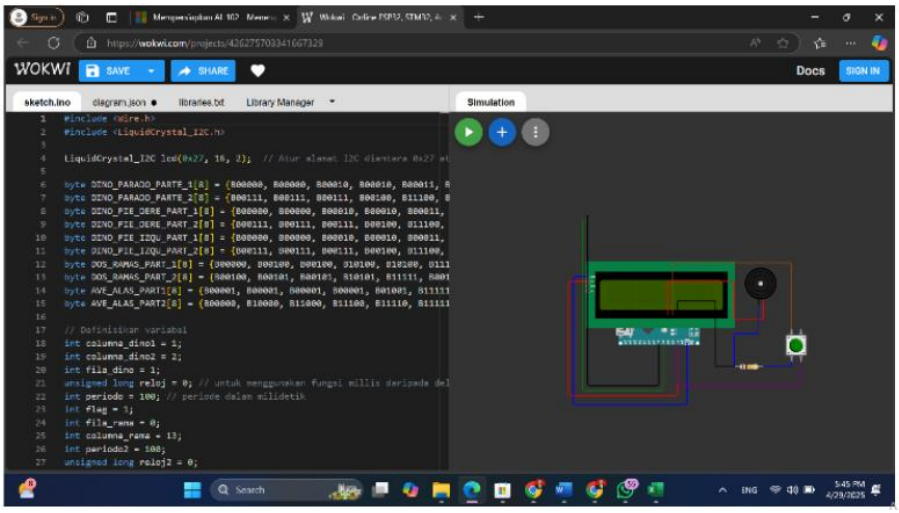

Figure 2. Wokwi Simulator.
(*Source*: *Personal Documentation*, 2026).

Wokwi is a web-based simulation platform that allows users to design, program, and test various microcontroller projects such as Arduino, ESP32, and AVR without requiring physical hardware. This platform is highly useful for students, university learners, and developers who want to conduct experiments or initial testing before implementing them on real devices. Wokwi's main advantages lie in its ease of use, intuitive interface, and support for various electronic components such as LED, LCD, sensors, motors, as well as serial and I2C communication. With real-time simulation and debugging features, Wokwi helps identify logical and syntactical errors in programs quickly and efficiently.

According to (Yoga et al., 2023) , the use of Wokwi in learning electronics and Arduino programming can improve the effectiveness of the learning process because students can directly see the results of their programming visually without having to set up physical circuits first. This is particularly advantageous in situations with limited laboratory facilities or during online learning. In addition, Wokwi also enables integration with Arduino libraries online, allowing users to easily add additional modules according to the needs of their projects.

LCD I2C

LCD with an I2C interface allows data communication between the microcontroller and the display module using only two pins, namely SDA (Serial Data) and SCL (Serial Clock). This is very useful in projects that require efficient use of pins**.** (Bonardo et al., 2025) showed that the use of the I2C interface in microcontroller-based learning media enables access to various outputs such as LEDs, switches, seven-segment displays, real-time clocks, and compass sensors with high efficiency.

Figure 3. LCD I2C.
(Source: (Series, 2020)).

Arduino IDE

Arduino IDE (Integrated Development Environment) is the main software used to write, edit, and upload programs to Arduino development boards such as the Arduino Uno, Arduino Nano, and Arduino Mega. Arduino IDE is designed with a simple and user-friendly interface, making it suitable for both beginners and advanced developers. The programming language used is based on C/C++ with a number of simplified functions and libraries to help users control various hardware devices such as sensors, actuators, and communication modules (Syst et al., 2018) .

Figure 4. Software Arduino IDE.
(*Source*: *(Gauri et al., 2021)).*

Arduino IDE provides various important features such as a code editor, serial monitor, and code upload functionality via USB. One of its main advantages is the ease of integration with third-party libraries and compatibility with various operating systems (Windows, macOS, and Linux). Users can also download libraries directly from the Library Manager to control devices such as I2C LCD, ultrasonic sensors, and WiFi modules. According to (Le et al., 2018), Arduino IDE offers high flexibility in embedded system development and has been widely used in engineering education because it supports rapid experimentation and prototype-based development processes.

Dinosaurus Offline Game

The Chrome Dino Offline Dino Game is a simple game that appears in the Google Chrome browser when there is no internet connection. This game teaches the basic concept of user interaction with a system through simple input and output mechanisms. Adapting this concept into a microcontroller-based project can provide an enjoyable and educational learning experience for students.

3. Proposed Method

In this research, uses the Research and Development (R&D) method, which involves several stages ranging from needs analysis, design, to implementation. The first stage is needs analysis, which is carried out by identifying all important components that will be used in developing this microcontroller-based Dino Game. The main components include the Arduino Uno, I2C 16x2 LCD, push buttons, jumper wires, and a breadboard. In addition, the game concept is adapted from the Chrome Dino game in offline mode, which is well known for being simple yet challenging.

4. Results and Discussion

Resuts and discussion after the design and simulation stages were carried out in wokwi, the system implementation was continued in physical form. The circuit consists of an Arduino Uno as the main controller, push buttons as input devices to move the "Dino" character, and an I2C 16x2 LCD as the output display medium. The circuit was assembled on a breadboard using jumper wires.

Figure 5. Code Arduino Uno.
(*Source*: *Personal Documentation*, 2026).

The Dino Game program was written using Arduino IDE with a C++-based structure. The use of the Wire.h and LiquidCrystal_I2C.h libraries is an important part of the program, enabling two-way communication between the Arduino Uno and the I2C LCD. After the program was completed and validated in the Wokwi simulator, the next step was to upload the sketch to the Arduino Uno. The upload process was carried out by connecting the Arduino Uno to a computer using a USB Type-B cable, selecting the appropriate COM port in Arduino IDE, and pressing the Upload button.

During the upload process, the IDE first compiles the code. If no syntax errors or basic logical errors are found, the program is automatically transferred to the microcontroller's flash memory. In this project, the upload process was completed successfully without any errors, indicated by the message "Done uploading" at the bottom of the IDE window. The program then ran immediately, and the LCD began displaying the game's initial screen. The success of this process indicates that the hardware was functioning properly and that the connection between Arduino IDE and the Arduino Uno was working well.

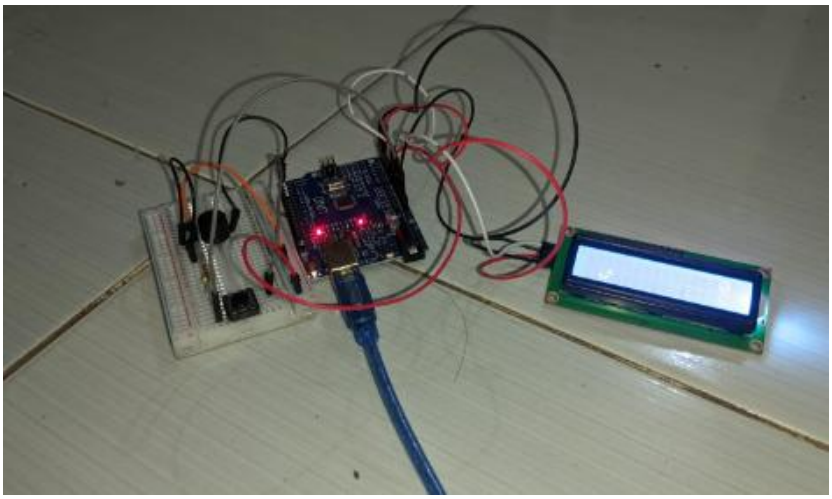

Figure 6. Dinosaurus Game Circuit Design.
(*Source*: *Personal Documentation*, 2026).

Figure 6 shows the physical circuit of a Dino Game project based on an Arduino Uno and a 16x2 I2C LCD module, complete with push buttons and a buzzer assembled on a breadboard. The entire system is connected and programmed through Arduino IDE using a blue USB connection. When the push button is pressed, the Arduino reads the digital input and sends display changes to the LCD (for example, the "Dino" symbol jumps). Simultaneously, the game generates obstacles that move from right to left on the LCD. If the Dino character does not "jump" when an obstacle appears, the system displays "Game Over" and may activate the buzzer as an audio signal. The score increases as long as the player survives and is displayed on the second row of the LCD screen.

Figure 7 shows that:

The system has been successfully implemented in real-world conditions (not just in simulation). This project uses a minimalist and efficient approach, making it suitable for learning microcontroller concepts, digital input, and I2C communication. The active LCD display indicates that the program has been successfully uploaded to the Arduino Uno and is currently running.

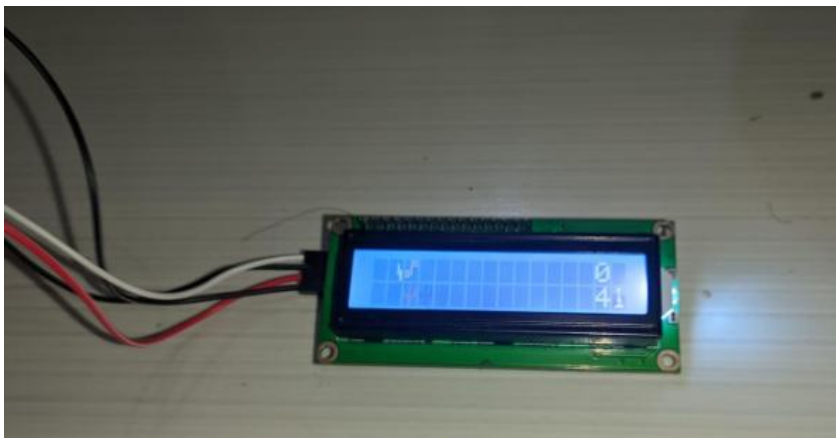

Figure 7. Display Dinosaurus Game.
(Source: Personal Documentation, 2026).

After being successfully run on the hardware, the game showed a good response to input from the push button. When the button is pressed, the Dino character "jumps" (displayed through a change in the character's position on the first row of the LCD), and obstacles (specific characters moving from right to left) are also successfully displayed alternately. If the Dino does not jump when an obstacle arrives, the system detects a collision and displays the message "GAME OVER" while stopping the game. The system also displays a score that increases over time during gameplay, shown on the second row of the LCD.

5. Conclusion

Dino Game based on the Arduino Uno microcontroller and I2C LCD was successfully developed and operated according to the designed functions. The system is able to respond well to button input, display scores and character movements on the LCD in real time, and detect collision conditions during gameplay. The programming process using the Arduino IDE ran smoothly, and the physical implementation of the system proved to be stable. This game is not only entertaining but also effective as an interactive learning medium for understanding the basics of programming, I2C communication, and input-output processing on microcontroller.

Further development is recommended by replacing the LCD display with a graphical screen such as an OLED or TFT for more attractive visualization, adding sound effects using a buzzer, and storing the highest score using EEPROM. Additional features such as game levels and increased obstacle speed can also enhance the challenge of the game. With these improvements, the Dino Game can become a more engaging and practical educational tool in the field of technology and basic electronics learning.

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