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Unlocking Communication Wonders: Exploring Transmitter and Receiver Concepts with p5.js

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ABSTRACT

This research presents comprehensive results in various forms such as images, graphs, tables, etc., to facilitate a profound understanding of the developed transmitter-receiver simulation using p5.js. Each component, including setting the canvas, dynamic display, user interaction, binary conversion, transmitter and receiver objects, simulation reset, and testing and evaluation, is thoroughly discussed in separate subsections. A comparative analysis with previous studies is incorporated for enhanced context. The testing phase not only validates the simulation's functionality and accuracy but also emphasizes its role as a potent educational tool. The successful execution of the experiment attests to the codebase's robustness, confirming its ability to effectively illustrate digital communication fundamentals. The visualization of binary signals enhances the project's educational dimension, transforming intricate concepts into an accessible, interactive learning experience. Future testing and refinements present exciting opportunities to augment user experience and extend simulation capabilities. This positive outcome establishes a solid foundation for the program's educational utility, making it a valuable resource for imparting digital communication knowledge. In conclusion, the validated transmitter-receiver simulation marks a significant milestone, combining functionality, visual representation, and potential enhancements. Positioned as an innovative educational technology, it fosters curiosity and understanding in learners exploring digital communication nuances.

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1. INTRODUCTION

In the ever-evolving landscape of technology, understanding the fundamental concepts of communication is paramount [1]. As author navigate the intricate world of data transmission, the interplay between transmitters and receivers becomes a crucial focal point. This article delves into the captivating realm of transmitter and receiver concepts, employing the dynamic capabilities of p5.js to create an engaging educational experience [2]. Author tries to unravel the intricacies of communication systems, where author harness the power of code to visualize and comprehend the essence of transmitting and receiving information. As author embark on this educational adventure, author find ourselves in the immersive world of p5.js—a creative JavaScript library that empowers individuals to express and visualize ideas in the realm of interactive graphics. Leveraging its user-friendly syntax and extensive functionality, p5.js proves to be an ideal companion for unraveling the complexities of transmitter and receiver systems.

At the heart of every communication network lies the transmitter, a device entrusted with the task of encoding and sending information across the digital landscape. In author exploration, author employ p5.js to simulate the functionality of a transmitter, allowing students to witness firsthand the process of input, encoding, and initiation of communication. Through interactive demonstrations, author unveil the inner workings of a virtual transmitter, shedding light on the critical role it plays in transforming words and ideas into a language that can traverse the digital domain. With each click and keypress, students engage with the coding magic behind transmitting messages, demystifying the complexities with the elegance of p5.js.

On the opposite end of the communication spectrum stands the receiver, a counterpart responsible for decoding and interpreting the transmitted information. With p5.js as author guide, author delve into the intricacies of receiving messages, exploring how a receiver processes, interprets, and ultimately comprehends the encoded data. Through captivating visualizations, students witness the journey of a message from transmission to reception, gaining insights into the vital role of receivers in extracting meaning from the digital signals. The synergy of code and graphics transforms abstract concepts into tangible knowledge, fostering a deep understanding of the symbiotic relationship between transmitters and receivers.

Through the lens of p5.js, author embark on an exploration that not only enlightens but also empowers students with a hands-on approach to mastering these foundational principles. Welcome to the convergence of technology and education, where p5.js serves as the gateway to understanding the magic behind transmitters and receivers. P5.js provides a unique bridge between theoretical concepts and hands-on practice. By immersing students in a simulated environment, author cultivate a dynamic learning experience that goes beyond traditional classroom teachings. The visual and interactive nature of p5.js transforms abstract theories into tangible, memorable lessons.

In the subsequent sections of this article, author will guide author through the code snippets, explaining how p5.js functions as a canvas for illustrating key concepts in communication technology. Brace yourself for an interactive and enlightening journey through the interconnected worlds of transmitters and receivers, as author decode the language of communication using the captivating language of code.

2. METHODOLOGY

The method employed in this research is the experimental method [3]. This approach involves systematically manipulating one or more independent variables to observe their effect on a dependent variable while controlling for other factors. The goal is to establish causal relationships and draw conclusions about the cause-and-effect interactions within the research context. Experimental methods are characterized by their emphasis on control, randomization, and manipulation to isolate and identify the impact of specific variables. This methodology is particularly valuable for investigating hypotheses, testing interventions, and gaining insights into the underlying mechanisms of phenomena. The experimental design allows for a rigorous and systematic examination of research questions [4], contributing to the scientific rigor and validity of the study outcomes.

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In the realm of educational technology and interactive learning, Figure 1 stands as a visual gateway to the captivating universe of "Unlocking Communication Wonders." This intricately designed flowchart serves as a roadmap, guiding us through the exploration of Transmitter and Receiver Concepts with the dynamic capabilities of p5.js.

As author gaze upon Figure 1, each symbol, decision point, and connecting arrow becomes a narrative thread, weaving together the principles of communication technology and the elegance of coding. This visual masterpiece unveils the journey from transmitter initiation to the receiver's comprehension, illustrating the synergy between theory and practice [5].

In the forthcoming exploration, author will dissect the components of Figure 1, unraveling the symbolic language that communicates the essence of transmitting and receiving information. From user interaction to dynamic display, this flowchart encapsulates the essence of the p5.js library as a powerful tool for hands-on education.

2.1. Needs Analysis

Needs analysis involves a comprehensive examination of the current state of affairs [6], focusing on identifying the underlying needs, challenges, and opportunities that warrant attention. This phase is dedicated to understanding the context in which the project will operate, ensuring alignment with overarching organizational goals.

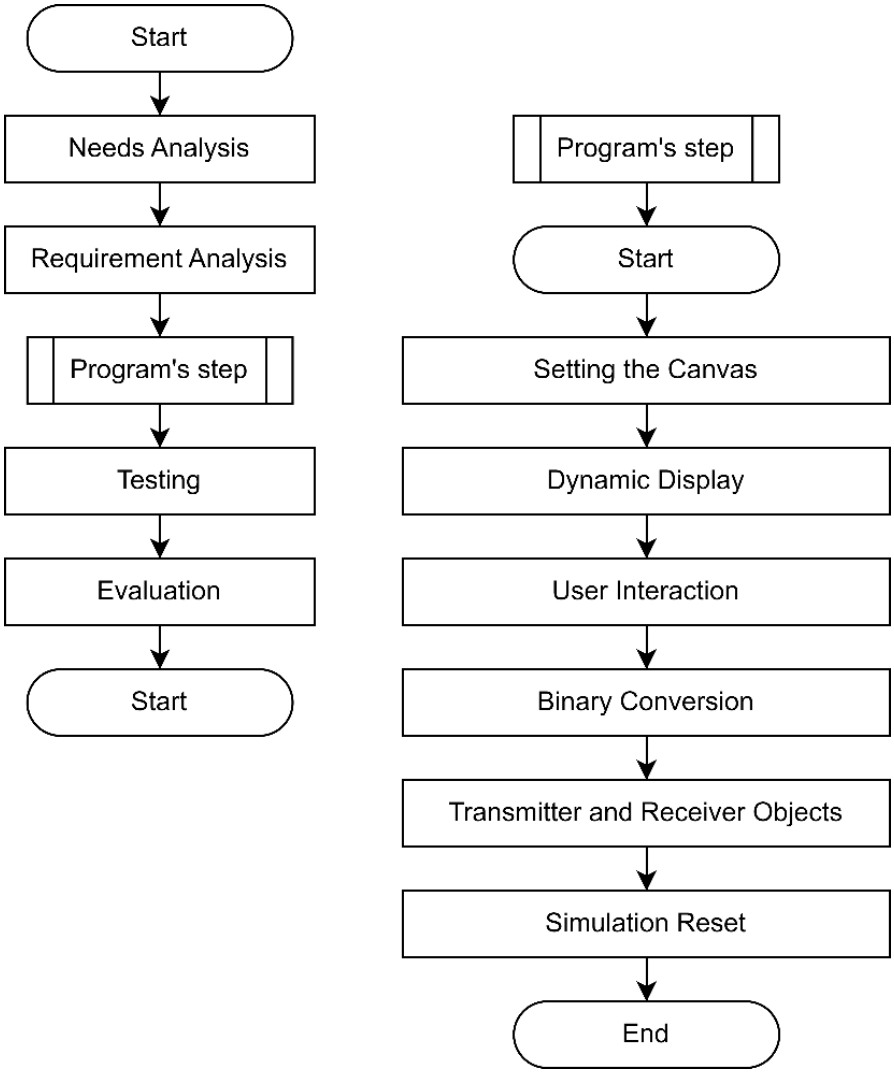

Figure 1. Flowchart of Methodology

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2.2. Requirement Analysis

Building upon the insights gained from needs analysis, requirement analysis dives deeper into the specific functionalities, features, and constraints that the project must address [7]. This phase is characterized by detailed documentation, stakeholder collaboration, and the creation of a comprehensive set of project requirements.

2.3. Program's Step

The "Program's Step" phase marks the actionable implementation steps based on the defined requirements. This involves breaking down the project into manageable tasks [8], assigning responsibilities, and creating a roadmap for development. Each step is carefully designed to contribute to the overall progress of the program.

2.4. Testing

Testing is a critical phase where the developed program undergoes rigorous examination to identify and rectify any potential defects or errors [9]. This phase encompasses various testing methodologies, including unit testing, integration testing, and system testing, ensuring that the program meets specified standards and functions as intended.

2.5. Evaluation

The evaluation phase involves assessing the overall performance, effectiveness, and alignment of the program with initial objectives [10]. Key performance indicators are measured, and feedback from stakeholders is gathered to evaluate the success of the program against predetermined criteria. This phase provides insights for future improvements and adjustments.

3. RESEARCH FINDINGS AND DISCUSSION

In this section, author delve into the fascinating world of dynamic displays using p5.js. The ability to create interactive and visually engaging content is at the core of effective communication through programming. Author will explore techniques to dynamically update and refresh the canvas, ensuring that author visual elements respond dynamically to user input or changing conditions. By the end of this section, readers have a solid understanding of how-to bring author p5.js sketches to life with dynamic and responsive displays, laying the groundwork for more advanced communication concepts in the subsequent sections.

3.1. Setting the Canvas

In this phase, author is preparing the foundational elements of author p5.js canvas. Author creates variables (transmitter, receiver, countdown, countdownStartTime, and showResults) that will be used to manage the state of author simulation.

```
let transmitter;
let receiver;
// Countdown time in seconds
let countdown = 5;
let countdownStartTime; // Time when the countdown starts
// Indicates whether transmitter and receiver results will
be displayed
let showResults = false;
```

Source Code 1. Initial Configuration of Communication with Countdown Timer

This part of the code establishes the initial conditions and variables that will be crucial for managing the simulation and controlling the flow of the p5.js sketch. It sets the stage for the subsequent steps in the methodology, where the canvas is configured, dynamic display is implemented, and user interaction is handled.

Educational journey begins by setting up the p5.js canvas—a virtual space where the magic of coding and communication unfolds. The canvas dimensions, background color, and initializations are configured to create a visually appealing and interactive environment.

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```
function setup() {
   createCanvas(600, 300);
   background(220);
   // Initialize transmitter and receiver objects
   transmitter = new Transmitter(width / 4, height / 2);
   receiver = new Receiver((3 * width) / 4, height / 2);
}
```

Source Code 2. Canvas Configuration with Transmitter and Receiver Initialization

3.2. Dynamic Display

The heart of author simulation lies in the dynamic display of the transmitter and receiver objects. Utilizing p5.js functionalities, author continuously refresh the canvas, ensuring real-time rendering of the communication scenario.

```
function draw() {
 // Clear the canvas
 background(220);
 // Display transmitter and receiver
 transmitter.display();
 receiver.display();
 // Display countdown
 if (transmitter.inputActive) {
  let elapsedTime = (millis() - countdownStartTime) / 1000;
  let remainingTime = countdown - elapsedTime;
  fill(0);
  textSize(30);
  textAlign(CENTER, CENTER);
  text("t: " + nf(remainingTime, 0, 1), width / 2, height - 20);
  // Check if the countdown time is up
  if (remainingTime <= 0) {
    transmitter.inputActive = false;
    // Restart countdown after entering the message
    countdownStartTime = millis();
    showResults = true; // Enable results display
   }
  }
  // Display results after the countdown is finished
  if (showResults) {
   fill(0);
   textSize(20);
   textAlign(CENTER, CENTER);
   text("Sender's words:\n" + transmitter.messageToSend, width / 4, height / 2 + 80);
   text("What receiver gets:\n" + receiver.receivedMessage, (3 * width) / 4, height / 2 + 80);
   // Display binary representation of the sent message
   let binaryText = convertToBinary(transmitter.messageToSend);
   text("Binary:\n" + binaryText, width / 2, height / 2 - 80);
  }
}
```

Source Code 3. Dynamic Canvas Rendering with Countdown and Communication Results

To simulate real-world scenarios, author introduce a countdown mechanism that triggers the transmission process. The results are then displayed, showcasing the sender's words, what the receiver receives, and the binary representation of the transmitted message.

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3.3. User Interaction

p5.js facilitates user interaction through mouse and keyboard events. The mousePressed() function initiates the transmission process when the user clicks, and the keyPressed() function resets the simulation upon pressing the spacebar.

```
function mousePressed() {
  // Execute mousePressed action on transmitter
  if (!transmitter.inputActive && !showResults) {
    transmitter.inputActive = true;
    transmitter.requestMessage();
    countdownStartTime = millis(); // Start countdown after
    the user enters words
  }
}
function keyPressed() {
  // Detect spacebar to reset the simulation
  if (keyCode === 32) {
    resetSimulation();
  }
}
```

Source Code 4. Handling Mouse and Keyboard Inputs for Simulation Control

3.4. Binary Conversion

To enhance the educational experience, author utilize a function to convert transmitted messages into binary representation, providing students with a glimpse into the underlying digital encoding process.

```
Binary Conversion
// Function to convert a string to binary
function convertToBinary(message) {
  let binaryText = "";
  for (let i = 0; i < message.length; i++) {
    let binaryChar = message[i].charCodeAt(0).toString(2);
    binaryText += binaryChar + " ";
  }
  return binaryText.trim();
}
```

Source Code 5. Binary Conversion Function for String Messages

3.5. Transmitter and Receiver Objects

The core of author simulation lies in the Transmitter and Receiver classes, encapsulating the behavior of these communication entities. From message transmission to display functionalities, p5.js enables the visualization of abstract concepts.

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```
// Object for transmitter
class Transmitter {
  constructor(x, y) {
    this.x = x;
    this.y = y;
    this.messageToSend = "";
    this.input;
    this.inputActive = false;
  }
  requestMessage() {
    // Request text input from the user
    this.input = prompt("Enter the words author want to send: ");
    if (this.input) {
      this.messageToSend = this.input;
      receiver.receiveMessage(this.messageToSend);
    }
  }
  display() {
    // Display transmitter computer
    fill(100, 149, 237);
    rect(this.x - 50, this.y - 50, 100, 100);

    // Display the message to be sent
    fill(0);
    textSize(16);
    textAlign(CENTER, CENTER);
    text("Transmitter", this.x, this.y);
  }
}
// Object for receiver
class Receiver {
  constructor(x, y) {
    this.x = x;
    this.y = y;
    this.receivedMessage = "";
  }
  receiveMessage(message) {
    // Function to receive a message from the transmitter
    this.receivedMessage = message;
  }
  display() {
    // Display receiver computer
    fill(255, 69, 0);
    rect(this.x - 50, this.y - 50, 100, 100);

    // Display the received message
    fill(0);
    textSize(16);
    textAlign(CENTER, CENTER);
    text("Receiver", this.x, this.y);
  }
}
```

Source Code 6. Transmitter and Receiver Objects for Communication Simulation

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3.6. Simulation Reset

The resetSimulation() function ensures a seamless and repeatable learning experience by resetting all relevant variables and preparing the canvas for a new exploration.

```
// Function to reset the simulation
function resetSimulation() {
  transmitter.messageToSend = "";
  receiver.receivedMessage = "";
  transmitter.inputActive = false;
  showResults = false; // Reset results display
  background(220);
}
```

Source Code 7. Simulation Reset Function for Transmitter-Receiver Communication

3.7. Testing and Evaluation

The testing results were conducted on the p5.js website. After substituting the code in the editor window, the results can be immediately tested shown in Figure 2. The experiment is initiated by starting the simulation with a click anywhere on the canvas. The simulation results can be observed in Figure 3. Based on the observations, it can be concluded that the program runs as intended by the author. Testing can be performed by inputting words such as 'Test.' As a result, the author can demonstrate the transmitter-receiver simulation in digital signal, showcasing the utilization of binary.

Figure 2. Running code on p5.js

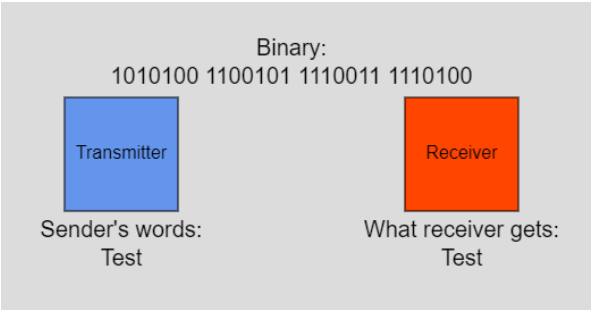

Figure 3. Result

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Furthermore, the simulation successfully responds to user interactions, initiating the countdown and demonstrating the transmission process. The visual representation of the sender's words and the corresponding received message by the receiver provides a clear illustration of the binary signal encoding.

The ability to input custom words, such as 'Test,' showcases the flexibility and adaptability of the program. This feature allows users to explore different messages and observe how they are translated into binary representation.

4. CONCLUSION

In conclusion, the testing phase not only confirms the functionality and accuracy of the transmitter-receiver simulation developed with p5.js but also underscores its significance as a powerful educational tool. The successful execution of the experiment stands as a testament to the robustness of the codebase, validating its capacity to effectively illustrate fundamental concepts in digital communication.

The visualization of binary signals within the simulation adds a compelling educational dimension to the project. By representing abstract digital communication processes in a tangible and visual manner, the program transforms complex ideas into an accessible and interactive learning experience. This dynamic approach has the potential to engage and captivate learners, facilitating a deeper understanding of the intricate workings of transmitter and receiver systems. Looking ahead, future testing endeavors and potential refinements represent exciting opportunities to further enhance the user experience and extend the capabilities of the simulation. Incorporating additional features, expanding the scope of simulated scenarios, or refining the user interface could contribute to an even more immersive and comprehensive educational tool. The positive outcomes observed during the testing phase lay a robust foundation for the educational utility and effectiveness of the developed program. As an innovative resource, it not only imparts knowledge about digital communication but also fosters an interactive learning environment that encourages exploration and experimentation.

In summary, the successful testing and validation of the transmitter-receiver simulation with p5.js mark a significant milestone in the project's development. The combination of functionality, visual representation, and potential for future enhancements positions the program as a valuable asset in the realm of educational technology, poised to inspire curiosity and understanding in learners exploring the nuances of digital communication concepts.

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AUTHOR BIOGRAPHY

First Author, **Firza Septian,** the primary author of this project, is a highly driven individual with a profound fascination for visualizing complex phenomena and a passion for intellectual pursuits. He possesses an innate ability to adapt to new tasks and enthusiastically embraces diverse environments, thriving on novel challenges, voracious learning, and generous knowledge sharing. Firza holds a Bachelor's degree in Physics with a concentration in Data Analysis from Sriwijaya University (UNSRI) and continued his academic journey as a postgraduate research student at The University of Tokyo. Engaging in advanced research further honed his analytical skills. Building on this foundation, Firza successfully obtained a Master's degree in Computer Science with a concentration in Data Transformation Intelligence from AMIKOM University, showcasing his commitment to merging physics, data analysis, and computer science. Passionate about global exploration, Firza seizes every opportunity to travel extensively, gaining valuable perspectives on diverse cultures and environments. His multifaceted journey—from studying physics to advanced research in Tokyo and mastering computer science—reflects an unwavering dedication to continuous learning and an insatiable curiosity for the world. Firza's willingness to embrace challenges and share knowledge exemplifies his commitment to intellectual growth and the empowerment of others.