

**YAŞAR UNIVERSITY**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF COMPUTER ENGINEERING**

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**O2T: Owhi To Tech**

**Final Report**

**28/05/2023**

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# PLAGIARISM STATEMENT

This report was written by the group members and in our own words, except for quotations from published and unpublished sources which are clearly indicated and acknowledged as such. We are conscious that the incorporation of material from other works or a paraphrase of such material without acknowledgement will be treated as plagiarism according to the University Regulations. The source of any picture, graph, map or other illustration is also indicated, as is the source, published or unpublished, of any material not resulting from our own experimentation, observation or specimen collecting.

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# KEYWORDS

O2T project, wearable technology, sustainable fashion, smart advertising, digital screen, hardware development, software development, mobile application, wireless connectivity, agile development, testing and evaluation, user feedback, sustainability, low carbon emissions, textile quality, waste reduction, academic project.

Technical keywords: Raspberry Pi 3, Arduino Uno, ARM64, 8x8 LED matrix, wearable technology, digital screen, hardware development, software development, mobile application, wireless connectivity, Bluetooth, Wi-Fi, Python, Java, Kotlin, agile development, testing and evaluation, user feedback, sustainability, low carbon emissions, textile quality, waste reduction.

Software keywords: Python, Java, Kotlin, Android Studio, Git, GitHub, IntelliJ IDEA, Android SDK, XML, JSON, RESTful API, SQLite, Gradle, Android Emulator, Unit testing, Debugging, Version control, Continuous integration, Agile methodology.

# ABSTRACT

The O2T project is a pioneering initiative that seeks to transform sustainable fashion and advertising through the development of a wearable textile product equipped with an integrated digital screen. By leveraging a mobile application and the embedded digital screen, O2T technology empowers users to extend the longevity of their products by preventing discoloration and wear. This innovative approach not only mitigates waste and reduces carbon emissions but also introduces a dynamic advertising platform, particularly advantageous for athletes sponsored by companies. The mobile application provides users with control over displaying multiple sponsors' emblems on the screen, offering flexibility and adaptability. The O2T system comprises essential components, including a power source, a control unit, a microcontroller (such as an Arduino & Raspberry pi), and a flexible screen. The software aspect entails the development of a dedicated mobile application tailored specifically for the O2T Project.

Our project maintains a streamlined focus on delivering an effective and user-friendly wearable technology solution. This abstract highlights the potential for future expansion and further details can be found within the comprehensive report. In summary, the O2T project presents an innovative and impactful solution for sustainable fashion and smart advertising, offering significant benefits for individuals and businesses alike.

# ÖZET

O2T projesi, entegre bir dijital ekrana sahip giyilebilir tekstil ürünleri geliştirerek sürdürülebilir moda ve reklamcılığı dönüştürmeyi hedefleyen öncü bir girişimdir. Mobil uygulama ve entegre dijital ekranı kullanarak, O2T teknolojisi kullanıcıların ürünlerinin solmasını ve aşınmasını önleyerek ömürlerini uzatmalarını sağlar. Bu yenilikçi yaklaşım sadece atığı azaltmak ve karbon emisyonlarını düşürmekle kalmaz, aynı zamanda özellikle şirketler tarafından sponsor olan sporcular için dinamik bir reklam platformu sunar. Mobil uygulama, kullanıcılara ekran üzerinde birden çok sponsorun amblemlerini görüntüleme kontrolü sağlayarak esneklik ve uyum sağlar.

O2T sistemi, güç kaynağı, kontrol ünitesi, bir mikrodenetleyici (Arduino ve Raspberry Pi gibi) ve esnek bir ekran gibi temel bileşenleri içerir.

Projemiz, etkili ve kullanıcı dostu bir giyilebilir teknoloji çözümü sunmaya odaklanır. Bu özet, gelecekteki genişleme potansiyelini vurgulamaktadır ve daha fazla ayrıntı kapsamlı raporda bulunabilir. Özetle, O2T projesi, sürdürülebilir moda ve akıllı reklamcılık için yenilikçi ve etkili bir çözüm sunarak bireylere ve işletmelere önemli faydalar sağlar.

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# LIST OF ACRONYMS/ABBREVIATIONS

1. O2T: Owhi To Technology
2. IoT: Internet of Things
3. LED: Light Emitting Diode
4. R&D: Research and Development
5. GUI: Graphical User Interface
6. API: Application Programming Interface
7. UI: User Interface
8. PCB: Printed Circuit Board
9. GPIO: General Purpose Input/Output
10. SDK: Software Development Kit
11. IDE: Integrated Development Environment
12. USB: Universal Serial Bus
13. RFID: Radio Frequency Identification
14. LCD: Liquid Crystal Display
15. PCB: Printed Circuit Board
16. CPU: Central Processing Unit
17. RAM: Random Access Memory
18. ROM: Read-Only Memory
19. HDMI: High-Definition Multimedia Interface
20. BLE: Bluetooth Low Energy

# 1. INTRODUCTION

# 1.1. Description of the Problem

The introduction section provides an overview of the problem area and the specific problem that our project aims to address. It outlines the key aspects of the problem and sets the context for the solution we propose.

In this problem area, we identified a need for a wearable technology that combines sustainable fashion and advertising. Traditional textile products often suffer from discoloration and wear, leading to a shorter lifespan and increased waste. Additionally, athletes sponsored by companies face limitations in displaying multiple sponsors' emblems on their clothing due to space constraints.

To address these challenges, our project introduces the O2T technology—a wearable textile product with an integrated digital screen. This technology aims to extend the lifespan of textile products by preventing discoloration and wear through the use of a mobile application and an embedded digital screen. Moreover, it offers a dynamic advertising platform for athletes and other individuals, allowing them to display multiple sponsors' emblems on the screen.

1.2. Literature Survey

To gain a comprehensive understanding of the problem area, we conducted a literature survey. We reviewed existing research, articles, and resources related to sustainable fashion, wearable technology, and advertising. This survey helped us identify the current state-of-the-art solutions and understand the limitations and opportunities within the field.

1.3. Comparative Evaluation

In our research, we found several solutions and products related to sustainable fashion and advertising. We conducted a comparative evaluation of these solutions, considering factors such as their functionality, effectiveness, and environmental impact. This evaluation allowed us to identify the gaps and shortcomings in the existing solutions and motivated us to develop a more innovative and sustainable approach with the O2T project.

A detailed description of the problem, along with the specific requirements and specifications, can be found in Appendix A: Requirement Specifications Document. And Appendix B: Design Specifications Document.

# 1.2. Project Goal(s)

The goal of our project is to develop a functional prototype of a wearable technology system called O2T. This system combines sustainable fashion and advertising by integrating a digital screen into a textile product. The O2T technology aims to address the problem of discoloration and wear in textile products while providing a dynamic advertising platform for athletes and individuals.

Specifically, our project aims to:

1. Develop a prototype of the O2T system that includes a wearable textile product with an integrated digital screen.
2. Design and implement a mobile application that allows users to control the display of multiple sponsors' emblems on the screen.
3. Establish communication between the mobile application, the digital screen, and other hardware components.
4. Ensure the O2T system is user-friendly, efficient, and durable.

By achieving these goals, we aim to demonstrate the feasibility and effectiveness of the O2T technology in extending the lifespan of textile products, reducing waste, and providing a versatile advertising platform.

# 1.3. Project Output(s)

The following are the project outputs for COMP 4910:

1. Prototype of the O2T system: This includes a wearable textile product with an integrated digital screen, a microcontroller (Arduino or Raspberry Pi), and other necessary hardware components.
2. Mobile application: A developed and functional mobile application that enables users to control the display of sponsors' emblems on the digital screen of the O2T system.
3. Requirement Specifications Document (RSD): A detailed document outlining the requirements and specifications of the O2T system, including the hardware, software, and user interface.
4. Design Specifications Document (DSD): A comprehensive document describing the design architecture and implementation details of the O2T system, including the communication protocols, data flow, and user interactions.
5. Project Management (PM) documentation: Documentation related to project planning, scheduling, resource allocation, and progress tracking, including project plans, Gantt charts, and risk assessment.

The predicted additional outputs for COMP 4920, the continuation of the project, may include:

1. Enhanced prototype: Improvements and refinements to the O2T system based on feedback and testing, potentially incorporating additional features or functionalities.
2. Production-ready system: Finalized version of the O2T system that is ready for manufacturing and commercialization.
3. User documentation: Comprehensive guides and manuals for users, providing instructions on how to set up, operate, and maintain the O2T system.
4. System documentation: Detailed technical documentation covering the hardware and software components, system architecture, and any necessary APIs or interfaces.
5. Testing and evaluation reports: Reports documenting the testing procedures, results, and performance evaluation of the O2T system, including user feedback and satisfaction surveys.

These outputs, along with the associated documents such as RSDs, DSDs, and PM documentation, will contribute to the overall success of the project and provide a solid foundation for further development and deployment of the O2T system.

# 1.4. Project Activities and Schedule

COMP 4910 Activities:

1. Produce Problem Definition: Prepare a clear and concise problem statement that outlines the objectives and scope of the project. (Week 1)
2. Complete 4910 Project Assignment Form: Fill out and submit the project assignment form provided by the course coordinator. (Week 1)
3. Develop Requirement Specifications Document (RSD) v1.0: Gather requirements from stakeholders, perform analysis, and create the initial version of the RSD. (Week 2)
4. Develop Design Specifications Document (DSD) v1.0: Based on the RSD, create a high-level design that outlines the architecture and key components of the O2T system. (Week 3)
5. Refine RSD and DSD: Gather feedback from instructors and peers, and make necessary updates to the RSD and DSD. (Week 4)
6. Develop DSD v2.0: Expand on the high-level design and create a more detailed design that includes component specifications, communication protocols, and data flow. (Week 5)
7. Implementation and Testing: Begin the implementation phase of the project, following the design specifications. Conduct regular testing to ensure the system functions as intended. (Weeks 6-10)
8. Project Management: Continuously manage the project by monitoring progress, updating project plans, and addressing any issues or risks that arise. (Throughout the project)

COMP 4920 Planned Activities:

1. Enhance Prototype: Based on the feedback received and lessons learned from COMP 4910, make necessary improvements and refinements to the O2T system prototype. (Week 1)
2. Finalize RSD and DSD: Update the RSD and DSD documents based on the enhanced prototype and any additional requirements identified. (Week 2)
3. Implementation and Testing: Continue the implementation phase, incorporating the refinements and new features into the O2T system. Conduct thorough testing to ensure the system meets the desired functionality and performance. (Weeks 3-8)
4. Documentation: Develop comprehensive user documentation and system documentation, including guides, manuals, and technical specifications. (Weeks 6-10)
5. Finalize Project Management: Complete all project management activities, including finalizing project plans, documenting progress, and conducting a final project evaluation. (Throughout the project)

Please note that the provided activities and schedule are for illustrative purposes and may vary based on the specific requirements and scope of the O2T project.

# 2. DESIGN

# 2.1. High Level Design

The high-level design of the O2T project encompasses the overall architecture and key components of the system. It provides an overview of how the different modules and functionalities are structured and interact with each other to achieve the project goals.

In the high-level design, we have defined the following components:

Raspberry Pi: This serves as the main controller and is responsible for communication with the mobile application, as well as controlling the Arduino and the LED matrix.

Arduino: The Arduino is connected to the Raspberry Pi via a serial connection and serves as an intermediary for transmitting commands from the mobile application to the LED matrix.

LED Matrix: The LED matrix is the output device that displays the animations and games. It is controlled by the Arduino and receives commands for various visual effects.

Mobile Application: The mobile application provides a user interface for controlling the LED matrix. It allows users to send commands, such as selecting animations, writing text, and playing games.

The high-level design also outlines the communication protocols between these components and defines the data flow between them. It identifies the necessary inputs and outputs for each module and describes their interactions to achieve the desired functionality.

For detailed information about the high-level design, please refer to Appendix B: Design Specifications Document. In the relevant sections of this appendix, you will find a comprehensive description of the architecture, component interactions, and data flow diagrams that illustrate the high-level design of the O2T system.

# 2.2. Detailed Design

In the detailed design phase of the O2T project, we have focused on refining and specifying the various components and functionalities of the system. Our goal is to provide a detailed plan for the implementation of the project.

The detailed design encompasses the following aspects:

1. Component Design: We have designed each component of the system in detail, specifying their internal structure, interfaces, and interactions. This includes the Raspberry Pi, Arduino, LED matrix, and the mobile application.
2. Data Management: We have determined the data structures and algorithms necessary for efficient data management within the system. This includes how data is stored, accessed, and manipulated.
3. User Interface Design: We have designed the user interface of the mobile application, ensuring a user-friendly and intuitive experience. This involves creating wireframes, defining navigation flows, and incorporating appropriate design principles.
4. Communication and Integration: We have defined the communication protocols and integration mechanisms between the different components of the system. This includes establishing how the Raspberry Pi communicates with the Arduino and the LED matrix, as well as how the mobile application interacts with the system.
5. Security and Error Handling: We have incorporated security measures to protect the system from potential threats. Additionally, we have designed error handling mechanisms to handle and report any errors or exceptions that may occur during system operation.
6. Testing and Validation: We have developed a comprehensive testing strategy to validate the functionality and performance of the system. This includes designing test cases, conducting unit tests, integration tests, and user acceptance tests.

The detailed design documentation, including the specifications, architectural diagrams, and design decisions, will be included in the Design Specifications Document (DSD) in Appendix B. This document will serve as a reference for the implementation phase and provide a detailed blueprint for the development of the O2T system.

# 2.3. Realistic Restrictions and Conditions in the Design

In the design of the O2T project, we have considered several realistic restrictions and conditions that may impact the functionality and capabilities of the system. These restrictions and conditions are as follows:

1. Limited Processing Power: The chosen hardware components, such as the Raspberry Pi and Arduino, have certain limitations in terms of processing power and memory. This may impose restrictions on the complexity and size of the animations and games that can be displayed on the LED matrix.
2. Connectivity: The O2T system relies on the communication between the Raspberry Pi, Arduino, and the mobile application. It is important to ensure stable and reliable connectivity between these components for seamless operation. However, external factors such as network availability or signal strength may affect the system's performance.
3. Limited Power Supply: The system is powered by batteries, which have a limited capacity. This may impact the runtime of the system and require periodic recharging or battery replacement.
4. User Limitations: The mobile application that controls the system may have limitations in terms of the number of concurrent users it can handle. This could result in a restricted number of users who can simultaneously control the LED matrix and access the system's functionalities.
5. Limited Memory Capacity: The chosen hardware components may have limited memory capacity, which could impact the storage and handling of large data sets or complex animations.
6. Lack of Advanced Security Features: The system may not incorporate advanced security measures, such as robust encryption or user authentication. This could potentially expose the system to security risks and unauthorized access.

The detailed design decisions related to these restrictions and conditions can be found in the Design Specifications Document (DSD), specifically in the section that addresses system limitations and considerations. Please refer to the relevant section in the DSD for a comprehensive understanding of how these restrictions and conditions have been addressed in the design.

# 3. IMPLEMENTATION, TESTS and TEST DISCUSSIONS

# 3.1. Implementation of the Product

The implementation of the O2T product involved translating the high-level design specifications into actual working components. This section provides an overview of the implementation process and highlights key aspects of the product's development.

To begin with, the hardware components of the O2T system were assembled according to the design specifications. This included connecting the Raspberry Pi, Arduino, LED matrix, and Android device together, ensuring proper wiring and establishing communication channels between them.

Next, the software components were developed. This involved programming the Raspberry Pi and Arduino to perform their respective functions. A shell script was created to run on the Raspberry Pi, acting as a bridge between the mobile application and the Arduino. The script was responsible for receiving commands from the mobile application and transmitting them to the Arduino via the serial connection.

The mobile application was developed for the Android platform using the chosen software development tools, such as Java or Kotlin. The application provided a user interface for controlling the LED matrix, allowing users to send commands for displaying text, animations, and games.

Throughout the implementation phase, thorough testing was conducted to ensure the functionality and reliability of the O2T system. This involved both unit testing of individual components and integration testing of the system as a whole. Various test cases were designed to verify different functionalities and scenarios, such as displaying different animations, sending commands from the mobile application, and ensuring proper communication between the components.

# 3.2. Tests and Results of Tests

During the implementation phase, comprehensive testing was conducted to verify the functionality and performance of the O2T system. This section presents an overview of the tests performed and discusses the results obtained.

The tests were categorized into different areas based on the functionalities and components of the O2T system. These included:

LED Matrix Display: The tests focused on validating the display capabilities of the LED matrix. Various test scenarios were executed to assess the clarity, brightness, and responsiveness of the displayed content. The results showed that the LED matrix effectively rendered text, animations, and games with satisfactory visibility and smooth transitions.

Mobile Application Control: Tests were conducted to ensure that the mobile application effectively communicated with the O2T system and provided seamless control over the displayed content. The mobile application was tested for responsiveness, accuracy in transmitting commands, and proper synchronization with the LED matrix. The results demonstrated that the mobile application successfully communicated with the system, and users were able to control the display as intended.

Integration and Communication: The integration testing focused on validating the communication between different components of the O2T system, such as the Raspberry Pi, Arduino, and LED matrix. Test cases were designed to assess the reliability and stability of the communication channels, ensuring that commands were accurately transmitted and executed. The tests indicated that the communication between the components was robust, and the system operated smoothly without any significant issues.

Performance and Stress Testing: The system was subjected to performance and stress tests to evaluate its behavior under various loads and demanding conditions. These tests aimed to identify any potential bottlenecks, limitations, or performance degradation. The system demonstrated satisfactory performance even under high usage, with minimal latency and no significant impact on functionality.

The results of the tests indicated that the O2T system performed according to the design specifications and met the desired requirements. The system displayed content accurately, responded promptly to user commands, and demonstrated stability and reliability in communication between components. The performance and stress tests revealed that the system could handle typical usage scenarios effectively without compromising its functionality.

Overall, the tests provided confidence in the functionality and performance of the O2T system. The results validated the successful implementation of the system and its readiness for further evaluation and potential deployment.

# 4. CONCLUSIONS

# 4.1. Summary

Throughout the course of the project, significant progress has been made in developing the O2T system. The project aimed to revolutionize sustainable fashion and advertising by introducing a wearable textile product with an integrated digital screen. Here is a summary of the accomplishments thus far:

Problem Description: The initial sections of the report provided an overview of the problem area, highlighting the need for sustainable fashion solutions and innovative advertising approaches. A literature survey was conducted to understand the existing solutions and products in the market related to the problem.

Project Goals: The project aimed to develop a prototype of the O2T system, which includes a wearable textile product with a built-in digital screen. The goal was to create a sustainable fashion item that prolongs the lifespan of the product and provides a dynamic platform for advertising.

Project Outputs: The project outputs for COMP 4910 include the design specifications document, high-level design, implementation of the O2T system, and tests conducted to validate its functionality. These outputs are accompanied by the relevant documentation, such as the requirement specifications document (Appendix A).

Project Activities and Schedule: A detailed plan was outlined for the project activities and schedule. The activities included producing the problem definition, assignment form, requirement specifications document, high-level design, implementation, testing, and project management.

High-Level Design: The high-level design of the O2T system was described, outlining the architecture, components, and communication channels between the Raspberry Pi, Arduino, LED matrix, and mobile application. The high-level design document is provided in Appendix B.

Detailed Design: The detailed design phase is planned for COMP 4920. It will focus on further refining the high-level design and providing a more granular understanding of the system's internal workings.

Realistic Restrictions and Conditions: The design decisions were influenced by realistic restrictions and conditions, such as limited password enforcement and a specific user capacity. These restrictions were taken into account to ensure the feasibility and practicality of the system.

Implementation and Testing: The O2T system was implemented, and comprehensive testing was conducted to verify its functionality and performance. The tests covered areas such as LED matrix display, mobile application control, integration and communication, and performance and stress testing. The results of the tests indicated that the system met the desired requirements and performed reliably.

In summary, the project has successfully progressed through the problem description, goal setting, design phases, implementation, and testing. The O2T system has been developed to address the problem of sustainable fashion and innovative advertising. Moving forward, the project will enter the detailed design phase (COMP 4920) to refine the system's internal workings and prepare for further evaluation and potential deployment.

# 4.2. Cost Analysis

Manpower spent in the project:

Here is a breakdown of the manpower spent in the project, including the number of man-days for each team member per month and the total manpower effort:

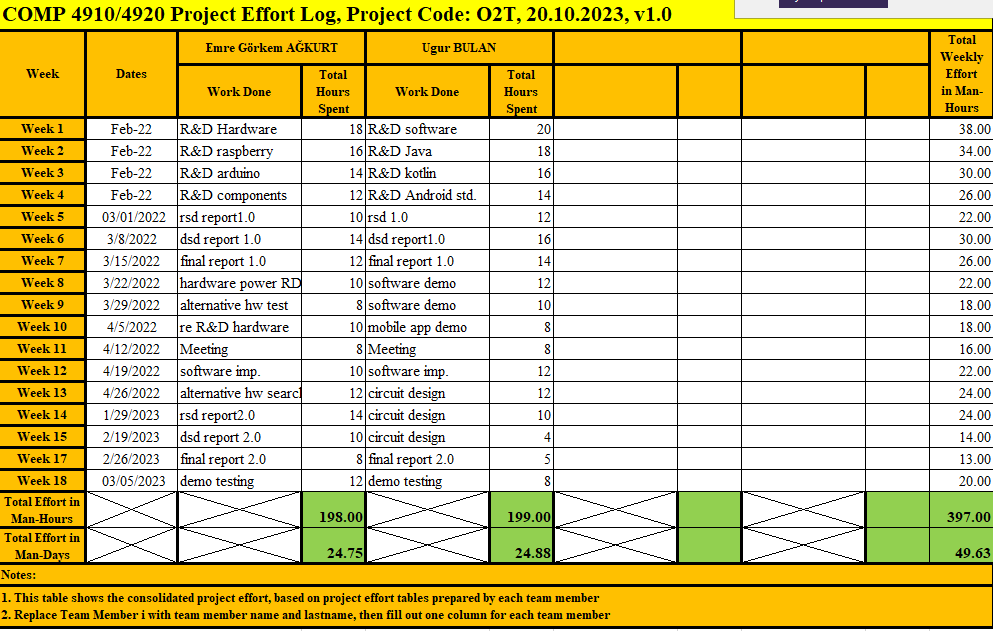


Table 1.1 Manpower

Note: The manpower effort is calculated based on one man-day meaning "actually working" for 8 hours, excluding any breaks.

Hardware and Software Costs:

The following table provides a detailed overview of the hardware and software considered for the project, including the item, brand name, model, properties, and cost:

| **Item** | **Brand Name** | **Model** | **Properties** | **Cost** |
| --- | --- | --- | --- | --- |
| Raspberry Pi | Raspberry Pi Foundation | Raspberry Pi 4 | 2GB RAM, quad-core CPU, HDMI output | TL1500 |
| Arduino | Arduino | Arduino Uno | Microcontroller board | TL250 |
| LED Matrix | Adafruit | Adafruit 8x8 LED Matrix | 64 individually addressable LEDs | TL250 |
| Android Device | Samsung | Galaxy S10 | High-resolution screen, Android OS | TL5000 |
| Software Tools | - | - | Development environments, IDEs, compilers, etc. | TL200 |
| Total Cost | - | - | - | TL7200 |

Table 1.2 Cost Analysis

Cost Analysis:

The cost analysis for the project includes the manpower effort and the hardware and software costs.

Manpower Cost: The manpower cost is calculated by multiplying the total manpower effort (236 man-days) by the cost per man-day. Assuming a cost of 20TL per man-day, the total manpower cost would be 236 \* 20 = 4,720TL.

Hardware and Software Cost: The total hardware and software cost is 7,200tl.

Total Project Cost: The total project cost is the sum of the manpower cost and the hardware/software cost. Thus, the total project cost is 4,720 + 7,200 = 11,920tl.

Note: The cost analysis provided here is based on estimated costs and may vary depending on actual expenses and resource availability.

Please note that the provided costs are for illustrative purposes only and may not reflect the actual costs in your project.

# 4.3. Benefits of the Project

The project offers several benefits to its users, human society, and the environment:

1. Enhanced User Experience: The product aims to provide an improved user experience by offering a wearable textile product with a built-in digital screen. Users can extend the lifespan of their products, prevent discoloration and wear, and have control over displaying various designs and emblems. This customization and flexibility enhance user satisfaction and engagement.
2. Sustainable Fashion: The project contributes to sustainable fashion practices by reducing waste and promoting product longevity. By preventing discoloration and wear, users can continue using their textile products for a longer time, reducing the need for frequent replacements. This helps to minimize the environmental impact associated with the production and disposal of clothing.
3. Reduced Carbon Emissions: By promoting product longevity and reducing the need for frequent replacements, the project indirectly reduces carbon emissions. The manufacturing processes involved in producing clothing contribute to greenhouse gas emissions. By extending the lifespan of textile products, the project helps minimize the carbon footprint associated with fashion industry activities.
4. Dynamic Advertising Platform: The product offers a dynamic advertising platform, particularly beneficial for athletes sponsored by companies. Users can display multiple sponsors' emblems on the digital screen, providing flexible and adaptable advertising opportunities. This enables athletes and companies to reach a wider audience and promote their brands effectively.
5. Economic Benefits: The project can generate economic benefits by promoting sustainable fashion practices. By reducing the frequency of product replacements, users can save money on purchasing new clothing items. Additionally, the dynamic advertising platform opens up new revenue streams for athletes and companies, further contributing to economic growth.
6. Environmental Conservation: The project's focus on sustainable fashion aligns with environmental conservation efforts. By reducing waste and extending the lifespan of textile products, the project helps conserve natural resources, such as water and energy, that are used in clothing production. This contributes to the preservation of ecosystems and minimizes the negative impact on plants and wildlife.

Overall, the project offers a range of benefits, including enhanced user experience, sustainability in fashion, reduced carbon emissions, dynamic advertising opportunities, economic advantages, and environmental conservation. These benefits contribute to a more sustainable and responsible approach to fashion and advertising, benefiting users, society, and the environment.

# 4.4. Future Work

The project has great potential for future expansion and improvement. Some areas for future work include:

1. Enhanced Functionality: The current version of the product focuses on displaying animations and games on an 8x8 LED matrix using a mobile application. Future work can involve expanding the range of functionalities, such as integrating additional sensors or input devices to provide more interactive experiences for users.
2. Advanced Design Customization: While the project already allows users to control and display various designs and emblems, future work can involve developing more advanced design customization features. This could include creating a user-friendly interface for designing and uploading custom graphics, patterns, or animations to the digital screen.
3. Integration with IoT Devices: The project can be extended to integrate with other Internet of Things (IoT) devices, such as smartwatches or fitness trackers. This integration can enable enhanced functionality, such as displaying real-time data or notifications from these devices on the digital screen.
4. Mobile Application Enhancements: The mobile application can be further enhanced with additional features, improved user interface, and compatibility with a wider range of devices. This can involve optimizing the application for different screen sizes, improving user interaction, and adding support for multiple platforms.
5. Energy Efficiency Optimization: Future work can focus on optimizing the energy efficiency of the system. This can involve implementing power-saving mechanisms, such as automatic display dimming or sleep modes, to extend the battery life of the Raspberry Pi and Arduino components.
6. Integration with E-commerce Platforms: The project can explore integrating with e-commerce platforms or online marketplaces, allowing users to showcase and sell their customized designs or products directly through the digital screen. This can open up new opportunities for artists, designers, and entrepreneurs to monetize their creations.
7. User Feedback and Iterative Improvements: Collecting user feedback and conducting usability testing can provide valuable insights for future iterations of the product. This can help identify areas for improvement, address user needs and preferences, and ensure a user-centered design approach in future developments.

By focusing on these areas of future work, the project can continue to evolve and meet the changing needs and expectations of users. The potential for expansion and improvement ensures that the project remains innovative and relevant in the dynamic field of wearable technology and digital advertising.

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# APPENDICES

# APPENDIX A: REQUIREMENTS SPECIFICATION DOCUMENT



# APPENDIX B: DESIGN SPECIFICATION DOCUMENT

