NATIONAL INSTITUTE OF BUSINESS MANAGEMENT

HIGHER DIPLOMA IN SOFTWARE ENGINEERING 23.1F

INTERNET OF THINGS

IoT INTEGRATED 3D PRINTER AND 3D SCANNER

SUBMITTED BY

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Abstract

The IoT-Enabled Integrated 3D Scanning and Printing System represents a novel integration of traditional 3D scanning and printing technology with modern Internet of Things (IoT) capabilities. Leveraging components such as Arduino, stepper motors, ESP32 DEVKIT V1 for Wi-Fi connectivity, and Firebase for secure data storage, the system aims to seamlessly combine scanning and printing functionalities while introducing advanced IoT features.

Key objectives include enhancing hardware integration for IoT, optimizing Wi-Fi networking, implementing intelligent coordination mechanisms utilizing a Sharp infrared sensor for precise item placement, and facilitating real-time monitoring through the wifi portal platform. Additionally, the project prioritizes data security by employing Firebase for safe data storage.

Through extensive IoT testing and updated documentation, this project not only aims to deliver a seamless user experience but also to redefine the landscape of 3D creation. The resulting technology promises to offer an intelligent and connected experience suitable for educational purposes, prototyping, and personal projects, thereby contributing to the advancement of 3D printing technology in the IoT era.

Acknowledgement

We extend our sincere thanks to all who contributed to the success of the IoT-Enabled Integrated 3D Scanning and Printing System. Our gratitude goes to Mr. T.D. Ganegoda for their invaluable guidance and support, and to our team members for their hard work and dedication. We are grateful to National Institute of Business Management for providing their assistance. Special thanks to our friends and family for their unwavering support throughout.

Sincerely,

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Introduction

The IoT-Enabled Integrated 3D Scanning and Printing System elevates the traditional 3D scanning and printing experience by incorporating cutting-edge IoT concepts and leveraging advanced wireless connectivity through access technologies. This project seamlessly integrates a 3D scanner and a 3D printer(FDM-CNC type machine) into a unified system, utilizing components such as stepper motors, Arduino, Sharp infrared sensor, ESP32 DEVKIT V1 and ESP-01 ESP8266 Wi Fi Module connectivity, and Firebase for secure data storage. The primary focus is to provide users with an enhanced, connected, and intelligent 3D creation solution for educational exploration, prototyping, and personal projects.

3D Printer

Adding layers of material to create 3D objects and parts is known as additive manufacturing, and it is done with a 3D printer. Another name for it is rapid prototyping. Using a machine that is connected to a computer that holds the blueprints for any object, 3D objects can be quickly created according to the necessary size using this automated process. The subtractive method, which involves drilling or molding material out of a block, may not be the same as the additive method. The primary benefits of using a 3D printer are increased material utilization (90%) and lighter, stronger, longer-lasting products. Many industries, including aerospace, automotive, medical, construction, and the manufacture of numerous consumer items, effectively employ 3D printing. The 3D Printer is a **CNC** type machine.

3D Scanner

The "3D Scanner with IR Sensor" is designed to make 3D scanning more accessible and provides consumers with an affordable, educational option. This project makes studying electronics and programming more practical. Its affordability, which opens 3D scanning technology to a wider audience, and its versatility for prototyping, which encourages creativity inside projects, are its two main advantages. By enabling users to delve further into the intriguing realm of 3D scanning, the scanner fosters skill development and unleashes creative energy among the maker community.

Methodology

Methods and Objectives:

1. IoT Integration: Infuse IoT concepts into the project to create a smart, connected ecosystem that enhances user interaction and control over the 3D scanning and printing processes.
2. Access Technologies in Wi-Fi Connectivity: Implement advanced access technologies within WiFi connectivity, utilizing ESP32 DEVKIT V1 and ESP-01 ESP8266 Wi Fi Module, to ensure seamless communication between the integrated system and the user's mobile device.
3. Seamless Coordination: Develop a system that enables seamless coordination between the 3D scanning and printing processes, enhancing the overall efficiency and user experience.
4. Real-Time Monitoring: Integrate real-time monitoring capabilities using the wifi portal, allowing users to remotely observe and control the scanning and printing processes while accessing 3D coordinates and heat levels.
5. Secure Data Storage: Leverage Firebase is a robust and secure platform for data storage, ensuring that 3D coordinates and heat level data are accessible to users at any time.

Scope of Work

1. **Advanced Wi-Fi Connectivity Setup:**

- Implement access technologies in Wi-Fi connectivity using ESP32 DEVKIT V1, ESP-01 ESP8266 Wi Fi Module to establish a reliable connection between the integrated system and the wifi portal.

2. **Intelligent Coordination System:**

- Develop an intelligent coordination system that optimizes the interaction between the 3D scanner and printer, enhancing efficiency and reducing processing times.
- Using sharp IR sensor to record X,Y,Z position coordinates of 3D object.

3. **IoT-Enabled Real-Time Monitoring:**

- Enable real-time monitoring through the wifi portal, exposing IoT capabilities for users to monitor, control during the 3D scanning and printing processes.

4. **Fortified Data store with Firebase:**

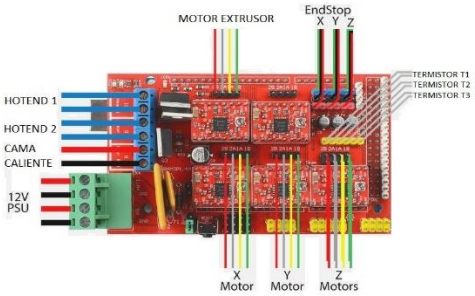
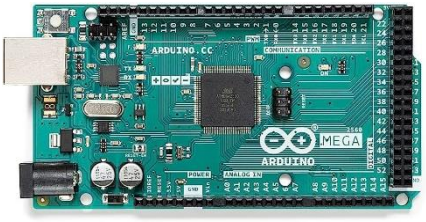
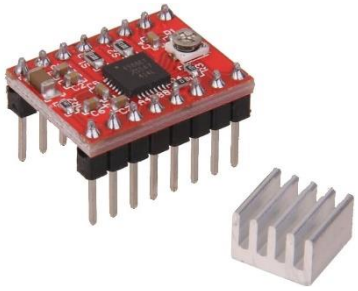
- Implement Google Firebase for secure data storage, reinforcing the project's commitment to data integrity and accessibility.

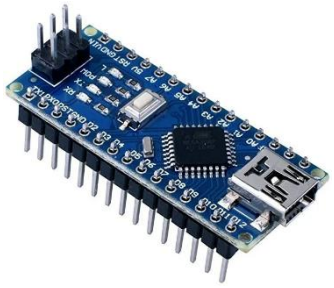
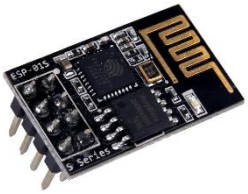
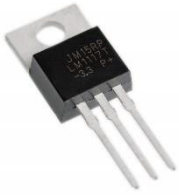
5. **Comprehensive Testing of IoT Features:**

- Conduct thorough testing of IoT functionalities, ensuring the stability and reliability of the enhanced connectivity and monitoring features.

Main Components(Sensors, Actuators and Controllers)

Table 1 | Main components

Component	Image	Usage
Infrared distance sensor 2Y0A710K		Measures distance during scanning, giving important data for creating a 3D point cloud.
Ramp Shield 1.4		This interfaces with the Arduino Mega and various parts like stepper motors, heaters, and sensors to function as the printer's control board.
Arduino Board(mega)		Arduino Mega has many digital and analog I/O pins, which are necessary for controlling RAMPS 1.4
Stepper Motor Driver A4988 Module		To accurately move the NEMA stepper motors during 3D printing and scanning, control signals from the printer's mainboard must be translated by the A4988 Stepper Motor Driver Module.

Nano V3 (Arduino)		Works as the main control unit, coordinating the motor motions, processing data from the IR sensor, and controlling the scanning procedure.
Stepper Motor (NEMA 17)		Use to control the scanning and printing platform's horizontal movement and another to control its vertical movement.
ESP32 DEVKIT V1		Establish connection between 3D scanner and Firebase data transfer.
ESP-01 ESP8266 Wi Fi Module		Establish connectivity between the integrated system and the wifi portal(monitoring).
LM1117T Low Drop-out voltage Regulator		Ensure a stable and consistent voltage output.(Step down AC 5V to 3.3V)

How Real time Monitoring Works?

We can use wifi portal to real-time monitoring.

Step 01:

Setup the ESP-01 ESP8266 Wi Fi Module.

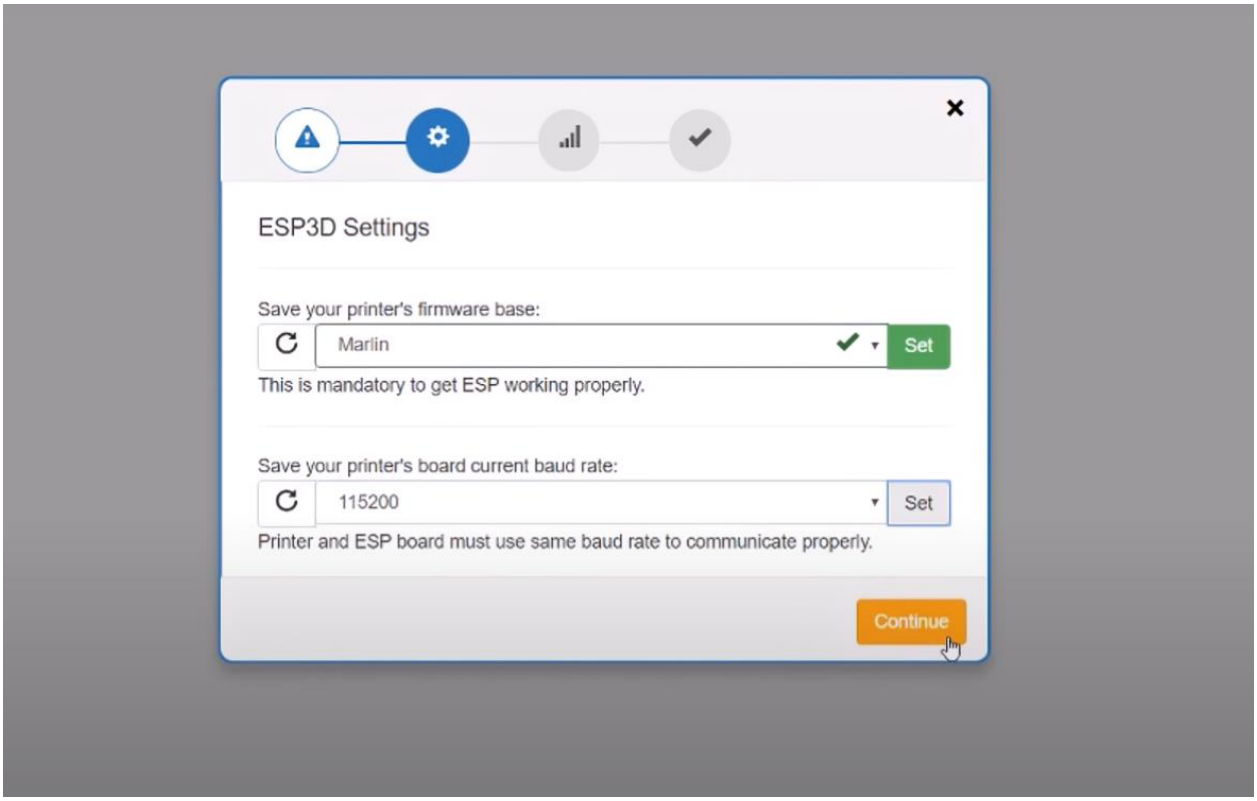


Figure 1 | Setting up board.

Step 02:

Configure WIFI and board settings.

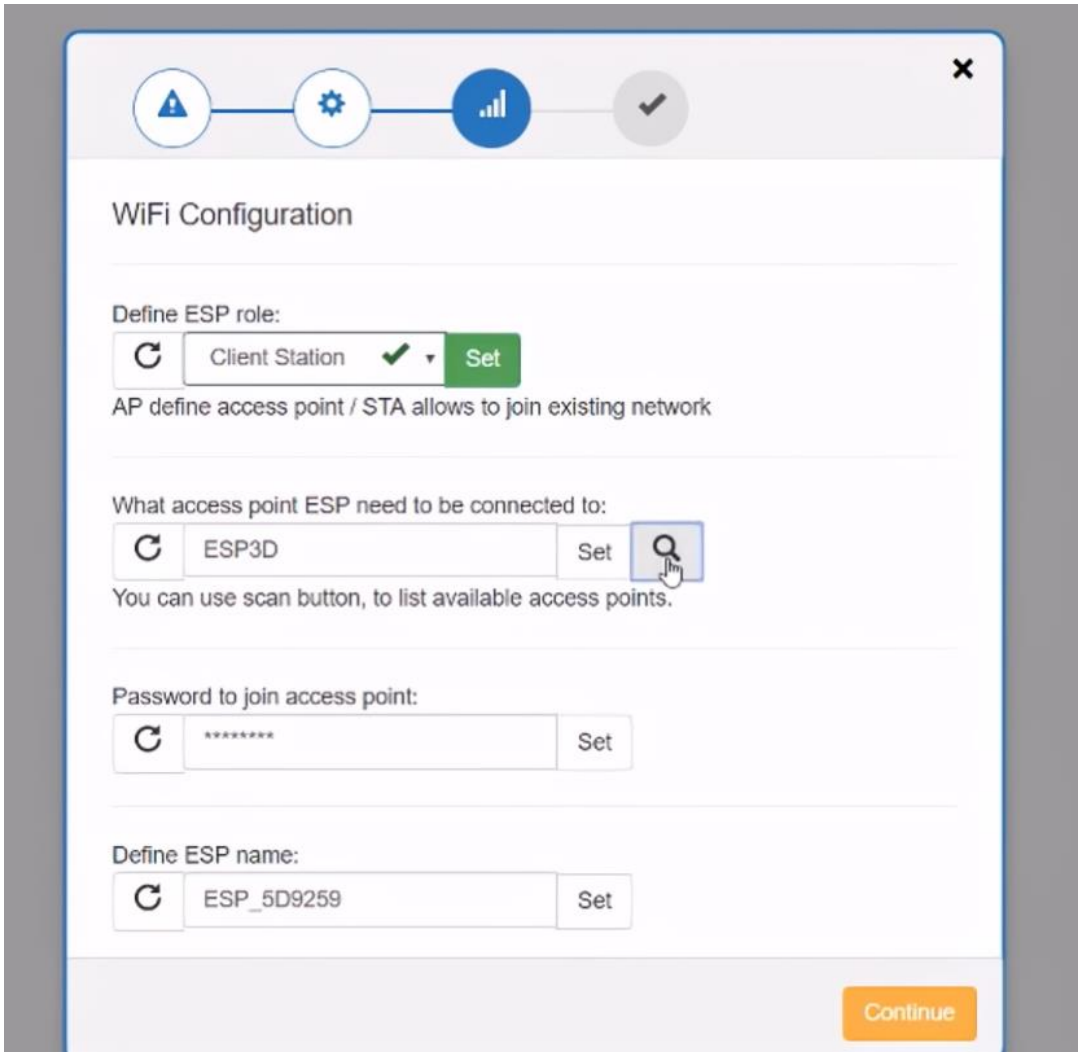


Figure 2| Configuring WIFI

Step 03:

Using 3D printer firmware tool and select 0x0 boot register and upload blank sketch file.

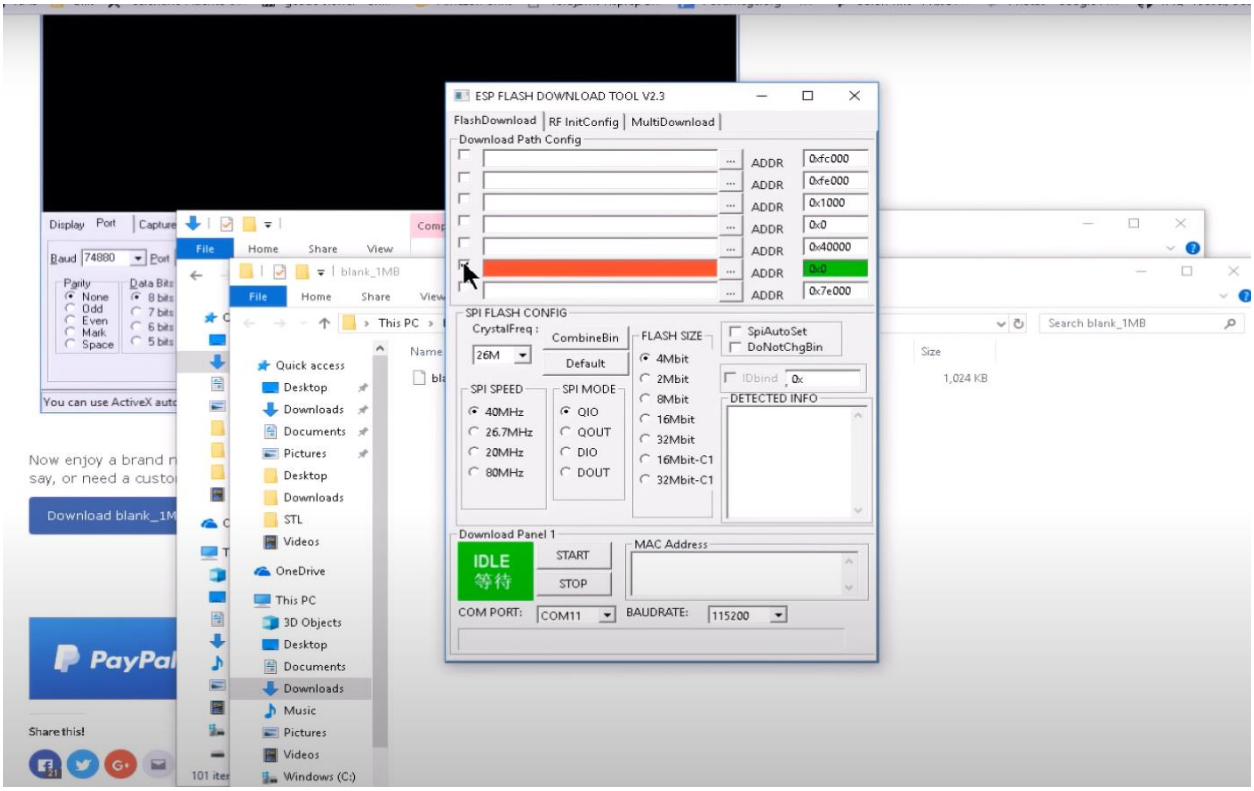


Figure 3| Using firmware tool to upload sketch file.

Step 04:

Adjust 3D settings. (if necessary)

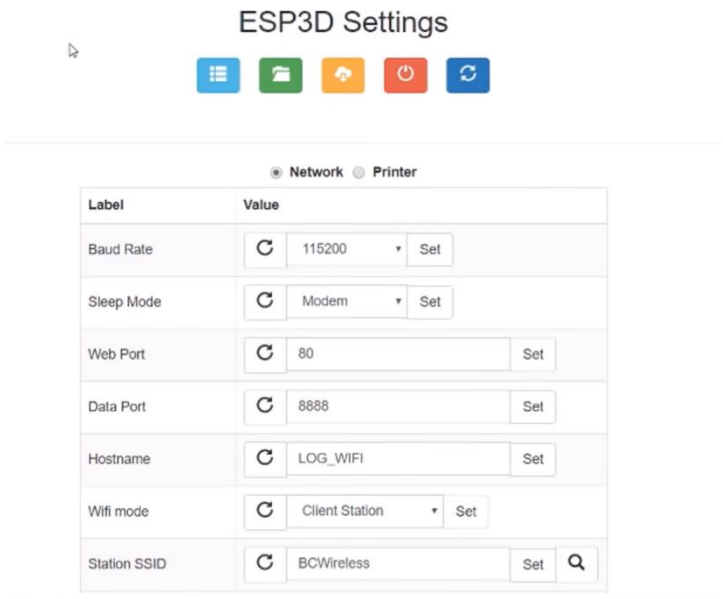


Figure 4| Adjust Settings

Step 05:

Real time Monitoring using wifi portal.

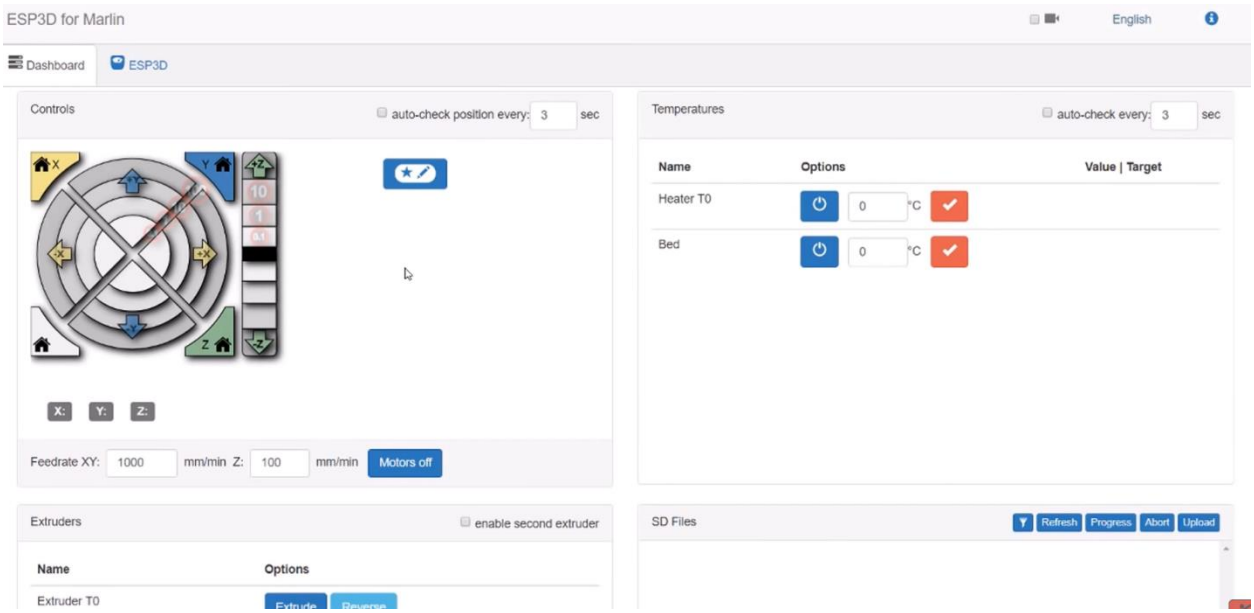


Figure 5| WIFI Portal

Mobile App Connectivity

- Connect Mobile app through the wifi.(This is the mobile app that we create our own for real time monitoring)
- READ DATA : Displaying all the recording X,Y,Z axis coordinates during the scanning process. (Real time monitoring)
- SAVE DATA: Saving all the recorded coordinates for .txt file.
- This .txt file can use to create mesh and convert to .stl file that can used to be 3D print.

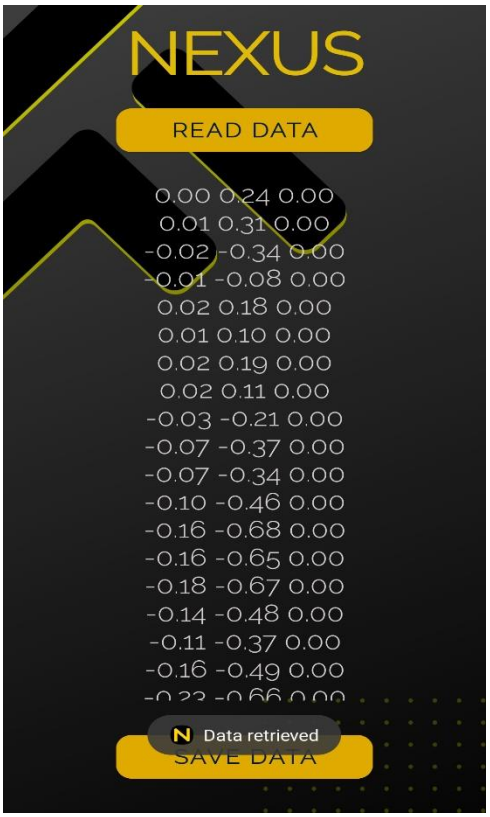


Figure 6 | Mobile App

Discussion

Limitations

1. **Financial Restraints:**

- The availability of sufficient funding is a prerequisite for the project's success. The amount of funds that can be allocated may restrict the use of some advanced functions or technologies.

2. **Time Restrictions:**

- Limited timelines could make thorough testing of IoT features difficult. Time constraints can limit the ability to handle unforeseen problems, which could lower the integrated system's overall quality.

3. **Interference from the Environment:**

- Outside factors that might limit the processing and real-time monitoring capabilities include environmental elements and interference from other electronic devices. (The 3D printer requires a specific temperature to heat up and extrude filament. If the external temperature fails to reach the minimum required level (excluding internal heat), there is a high possibility that the process will terminate automatically – 3D printer project expertise).

Advantages

1. **Efficient Wi-Fi Networking:**

- Using ESP-01 ESP8266 Wi Fi Module ESP32 DEVKIT V1 and for Wi-Fi connectivity enables efficient communication between the system components, facilitating remote monitoring, control, and data transfer.

2. **Real-Time Monitoring:**

- The system enables real-time monitoring through the wifi portal platform, allowing users to remotely monitor the progress of scanning and printing tasks from anywhere with internet access.

3. **Secure Data Storage:**

- Leveraging Firebase for data storage ensures the security and integrity of scanned models and printing instructions, providing peace of mind to users regarding data privacy and protection.

Future Implementations

- **Enhanced IoT Features:** Continuously improving and expanding the IoT capabilities of the system to enable more advanced functionalities and connectivity options. This could involve integrating additional sensors, expanding compatibility with other IoT platforms, or incorporating machine learning algorithms for predictive maintenance or optimization.
- **Scalability and Flexibility:** Designing the system architecture to be scalable and flexible, allowing for easy integration with new hardware components or upgrades. This could involve modularizing the system components, adopting standardized communication protocols, and designing for interoperability with other systems or devices.

Conclusion

The objective of the "Enhanced IoT Integration for 3D Scanning and Printing System" project is to maximize the capabilities of 3D printing by utilizing improved Wi-Fi connectivity and IoT. Precise 3D object positioning is provided by the intelligent coordination system, which uses a focusing IR sensor. Using the wifi portal for real-time monitoring improves control features for the user. Firebase ensures strong data security; yet financial and technological limits may be an issue. Unlike obstacles, the project aims to revolutionize 3D printing by enhancing efficiency and connection.

References

ADRIAN . (2021, December 06). *BLANK 1MB AND 4MB – FOR CLEANING ESP8266/ESP8285*. Retrieved from smartnydom: https://www.smartnydom.pl/download/blank-1mb-do-czyszczenia-esp8266-esp8285-1mb-flash/

Espressif Systems. (2014). *Flash Download Tools*. Retrieved from ESPRESSIF: https://www.espressif.com/en/support/download/other-tools

luc-github. (2018, April 26). *luc-github*. Retrieved from GitHub: https://github.com/luc-github/ESP3D/releases/tag/1.0

Riley, C. (2018, January 10). *Add WiFi To Your 3D Printer For $5!!! - ESP8266 - LUC ESP3D - Chris's Basement*. Retrieved from https://www.youtube.com/watch?v=pJGBRriNc9I&t=964s

Wijesooriya, C. (2023). *Previous 3D printer and 3D scanner projects*. Retrieved from Google Drive: https://drive.google.com/file/d/16nCHZhE7LQtAuDBOJaF-8xBKI6unohQG/view?usp=sharing

Gantt Chart

Table 2 | Gantt Chart

Task	Date			
	Feb 27	March 04	March 17	March 19
IoT Integration and Hardware establishing with 3D printer and 3D scanner.				
Wi-Fi Connectivity Setup.				
Intelligent Coordination System. (PCB Configuration.)				
IoT-Enabled Real-Time Monitoring.				
Testing system and IoT Features.				
Documentation and User Guide Updates.				