EN2160 - Electronic Design Realization

3D - Scanner Machine

Final Design Document

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Contents

Project Documentation - 3D Scanner Machine

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I Introduction

Unlock the potential of digital replication and exploration with our cutting-edge mini 3D scanner, meticulously designed for prototyping, model making, research, and beyond. This powerful device leverages laser scanning technology, precision motors, mechanical systems, and an Arduino controller to transform physical objects into detailed 3D models.

Our selected project is to create a 3D scanner machine. It would be capable of scanning the surface of any 3D object and then plot the particular object using the Matplotlib library in Python. Obtaining the actual 3D plot of a certain 3D object is very much useful in many different industries for making their outcomes efficient. To make decisions on a 3D object on an industrial basis, gaining a pointwise knowledge of the particular object is crucial. So our approach in this project is to build and operate a simple yet effective 3D scanner machine using readily available components and basic electronics skills which can be introduced to the market with an affordable price and a considerable accuracy.

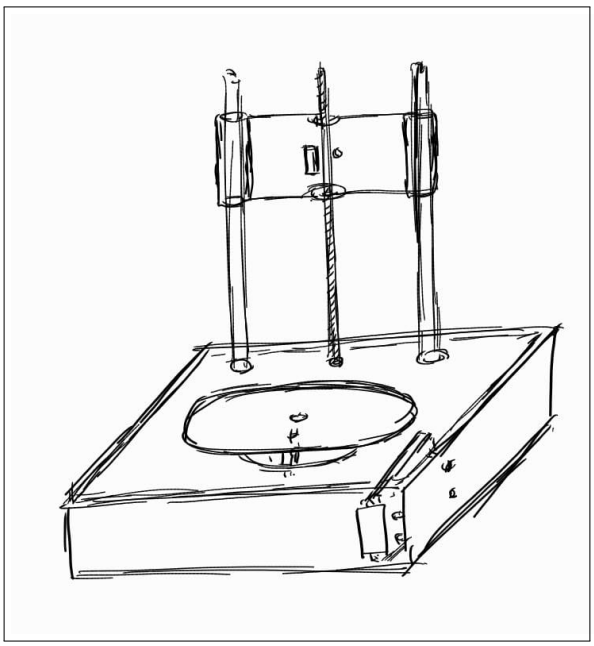

Fig. 1: 3D Scanner Assembled image

II Review Progress

Our progress report highlights the final planning phase of our 3D scanner project, focusing on the identification of necessary components and the delineation of key system elements.

We have outlined two main components:

- the rotating disk (Tray), serving as the platform for object scanning,
- and the TOF (Time-of-Flight) sensor holder, essential for capturing accurate distance data.

Additionally, emphasis has been placed on the development of the control unit, which will orchestrate the synchronized movement of these components to facilitate efficient and precise scanning operations. This progress marks a significant step towards realizing our vision for an innovative and functional 3D scanning solution.

III Identify Stakeholders

Our stakeholder map identifies key individuals and groups vital to the success of our 3D scanner in the market. From end users like researchers, engineers, and artists to industry partners such as technology manufacturers and distributors, each stakeholder plays a crucial role in driving adoption and market penetration. Engaging with educational institutions, government bodies, and professional associations further enhances our reach and credibility. By cultivating relationships with investors, media influencers, and industry thought leaders, we aim to generate excitement and support for our product, positioning it as the go-to solution for precision 3D scanning needs across various sectors.

- Project Team: The core group responsible for the design, testing, and implementation of the 3D scanner machine.
- University of Moratuwa: Provides guidance, resources, and ensures academic standards are maintained throughout the project.
- Technology Manufacturers and Distributors: Potential industry partners representing practical applications and market needs, ensuring the 3D scanner meets industry standards.
- Material Suppliers: Companies supplying components and materials essential for constructing the 3D scanner, impacting its quality and functionality.
- Classmates and Academic Community: Collaborators and peers who provide feedback, fostering a collaborative learning environment and contributing to the project's iterative improvement.

Users	Those are interested in 3D mapping, printing and prototyping Researchers, Engineers, and artists
Industry partners	Technology manufacturers and distributors
Institutions	Educational institutions, government bodies, and professional associations

Fig. 2: Stakeholder Map

IV Observe Users

3D scanners are used in various applications, such as:

- 3D printing: Creating digital models of objects for 3D printing.
- Reverse engineering: Analyzing existing objects to create digital models for redesign or replication.
- Quality control: Inspecting manufactured parts for defects.
- Virtual reality (VR) and augmented reality (AR): Creating 3D models of real-world objects for use in VR/AR applications.
- Healthcare: Creating 3D models of body parts for prosthetics, implants, and surgical planning.

V Need List

To ensure our 3D scanner design meets the diverse needs of all stakeholders, we compiled a comprehensive list of requirements:

- Functional Needs:
  - Accurate and detailed 3D scanning capabilities for various objects.
  - Real-time data processing and transmission to connected devices or software.
  - Flexibility to scan objects of different shapes and sizes without manual adjustments.
- Accessibility Needs:
  - User-friendly interface for easy operation and integration.
  - Comprehensive documentation and support for setup, troubleshooting, and maintenance.
- Usability Needs:
  - Intuitive calibration and operation process.
  - Reliable performance with minimal downtime and high accuracy.
- Technical Needs:
  - Robust and durable hardware capable of withstanding industrial and academic environments.

  - Compatibility with various software platforms and file formats used in 3D modeling and printing.
- Business Needs:
  - Cost-effective design providing significant ROI through enhanced productivity and reduced errors.
  - Scalable solution adaptable for various applications, including education, research, and industrial design.
- Regulatory Needs:
  - Compliance with industry standards for safety and performance.
  - Adherence to environmental regulations to ensure sustainable operation
- Contextual Needs:
  - Effective operation in diverse environments, including varying lighting conditions and space constraints.
  - Seamless integration into existing workflows to enhance productivity without significant disruptions.

By addressing these needs, we aim to develop a 3D scanner that not only meets the technical and functional requirements but also enhances the overall efficiency and reliability of various applications, from education and research to industrial design and prototyping.

VI Stimulate Ideas

what is this? should be updated
Another issue that another literature mentioned that causes pressure and temperature rise during refueling is because the compressor hydrogen gas is not cooled at a given temperature. CHSS must be cooled to about -30 degrees to the hydrogen station before refueling to prevent a rise in temperature in the tank that causes embrittlement, leakage, or even explosions [18].

VII Design Criteria

A new product's success and general efficacy in the market will depend on a number of critical factors that must be considered at all times during the design process. Performance and usefulness should be taken into account first and foremost. Ensuring the product can effectively and consistently achieve its intended goal is of utmost importance in its design. This means that in addition to functioning well in the best of circumstances, the product must also be able to handle any difficulties that may occur when using it.

In addition to the performance, there are several other factors to be considered in the design process of a product. Listed below are some of such criteria to be considered when designing a new product.

- Aesthetics
- Heat Dissipation
- Assembly and Serviceability
- Ergonomics
- Simplicity
- Durability
- User Experience
- Manufacturing Feasibility
- Cost
- Power Consumption

VIII Conceptual Designs

1 Conceptual Design 1

Images - Fig 3 and Fig 4

2 Conceptual Design 2

Images - Fig 5 and Fig 6

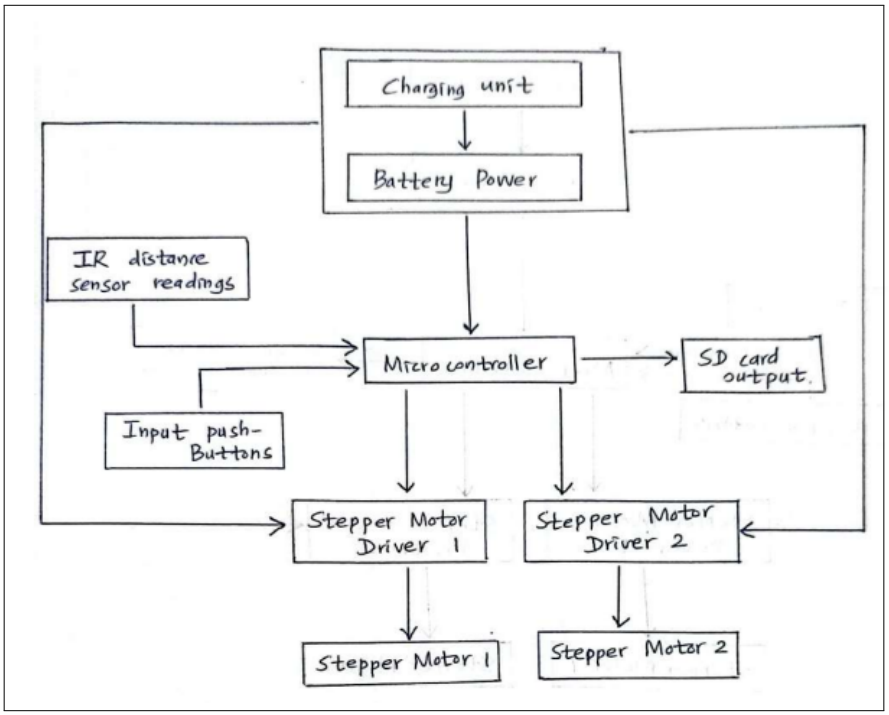

Fig. 3: Concept 1 - Block Diagram

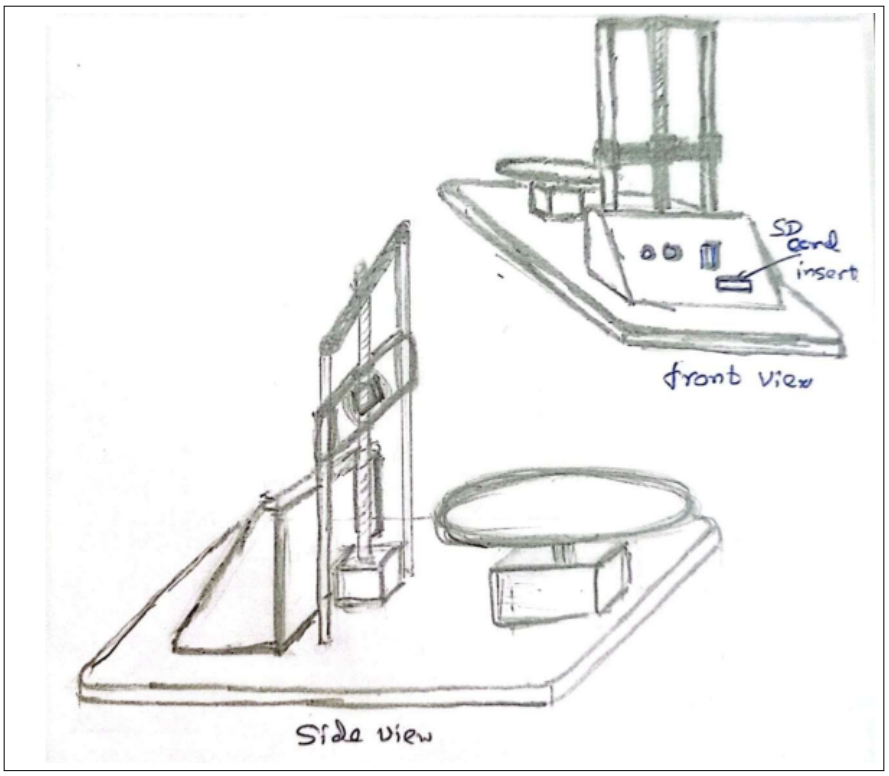

Fig. 4: Concept 1 - Design

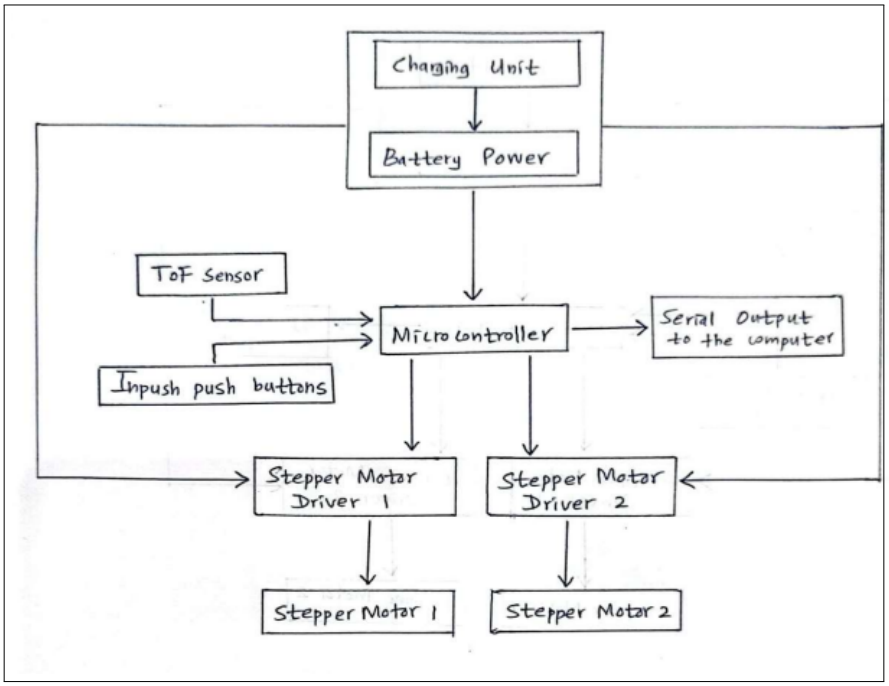

Fig. 5: Concept 2 - Block Diagram

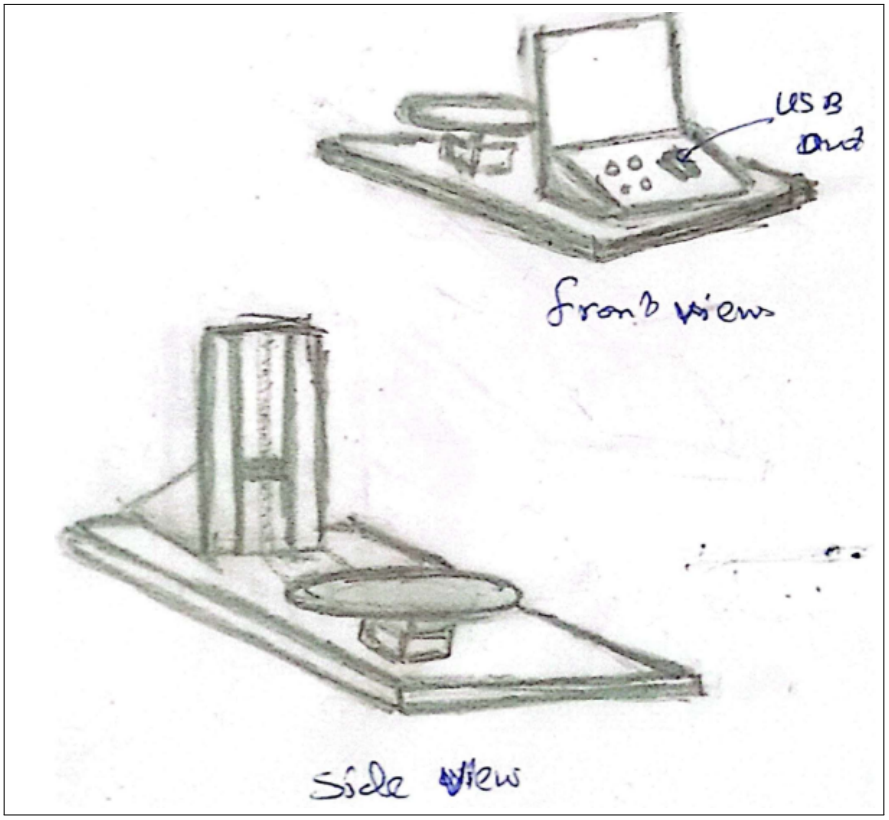

Fig. 6: Concept 2 - Design

3 Conceptual Design 3

Images - Fig 7 and Fig 8

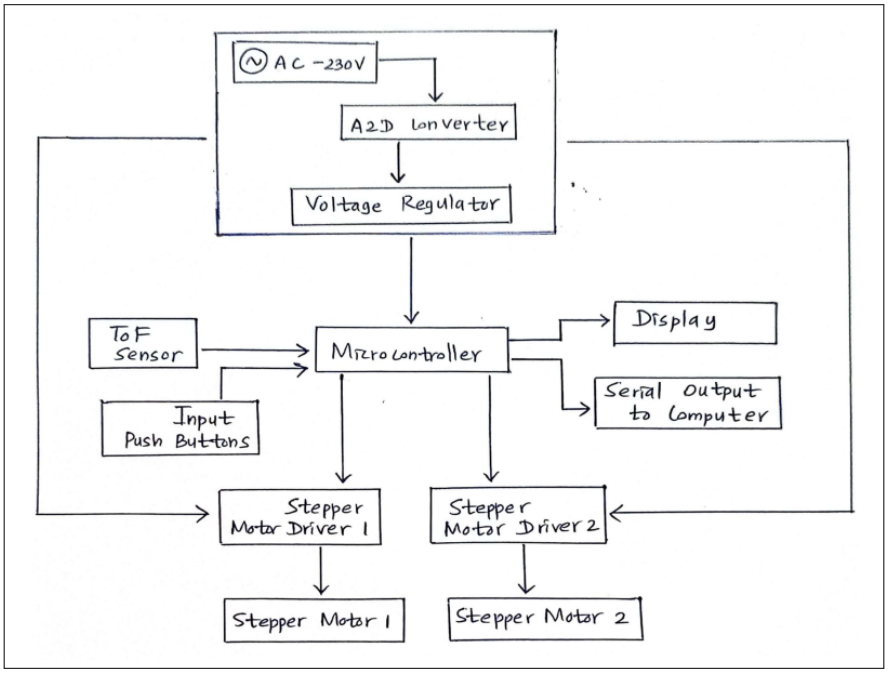

Fig. 7: Concept 3 - Block Diagram

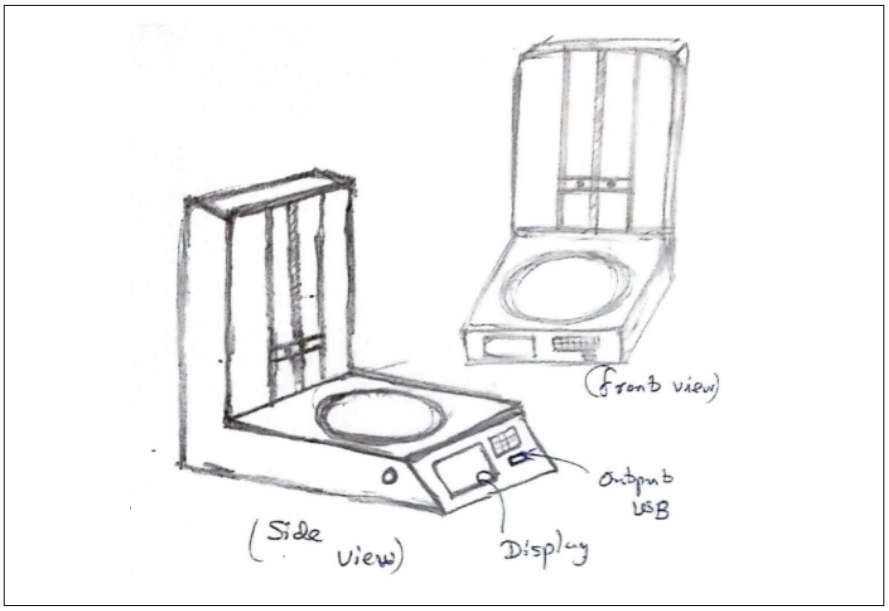

Fig. 8: Concept 3 - Design

IX Evaluation Criteria

1 Functional Block Diagram Criteria

- Functionality: The amount in which the circuit design meets functional requirements.
- User experience: How simple and easy to use the interface is.
- Manufacturing feasibility: Analyze whether the design is feasible to be manufactured.
- Cost: Overall cost-effectiveness for the desired functionality.

- Performance: How accurate are the results?
- Power Consumption: The amount of power to be consumed by the product with the particular circuit design.

2 Enclosure Design Criteria

- Functionality: The way which the design supports the main functionalities.
- Aesthetics: How good the overall appeal of the user.
- Heat dissipation: The amount of heat generated and the way in which it is managed.
- Assembly and Serviceability: How well the design is compatible for easy assembly, maintenance, and troubleshooting with modular components and intuitive interfaces.
- Ergonomics: How well the design can prioritize user comfort and efficiency for intuitive interaction and reduced physical strain.
- Simplicity: Simplicity of manufacturing and assembling the enclosure.
- Durability: How well does the design withstand impacts and environmental conditions.

X Conceptual Design Evaluation

		Conceptual Design 1	**Conceptual Design 2**	**Conceptual Design 3**
Newly Added features		SD card output Charging Circuit	USB Output to PC Serial Output to the computer	Display to show output DC power supply
Removed features		Display	SD card output	Battery power supply and charging unit.
Enclosure Design Criteria Comparison	Functionality	8	8	9
	Aesthetics	5	7	9
	Heat Dissipation	9	8	6
	Assembly and Serviceability	9	9	8
	Ergonomics	6	8	9
	Simplicity	9	8	6
	Durability	6	6	9
Functional Block Diagram Idea Comparison	Functionality	7	7	9
	User Experience	6	7	9
	Manufacturing Feasibility	9	8	8
	Cost	9	8	7
	Performance	8	8	9
	Power Consumption	9	9	8
Total		**100**	**101**	**106**

Fig. 9: Conceptual Design Evaluation

Our team thought of proceeding with the third design after careful consideration and thorough discussion sessions. Also according to the comparison, Conceptual Design 3 scores the highest and it would satisfy user requirements easily. It is also safer and more easier to use when compared with the other conceptual designs listed above.

XI Schematic Design

1 Block Diagram

Includes all the sub-sections of the pcb schematics as blocks, integrated into one diagram, renamed as the block diagram.

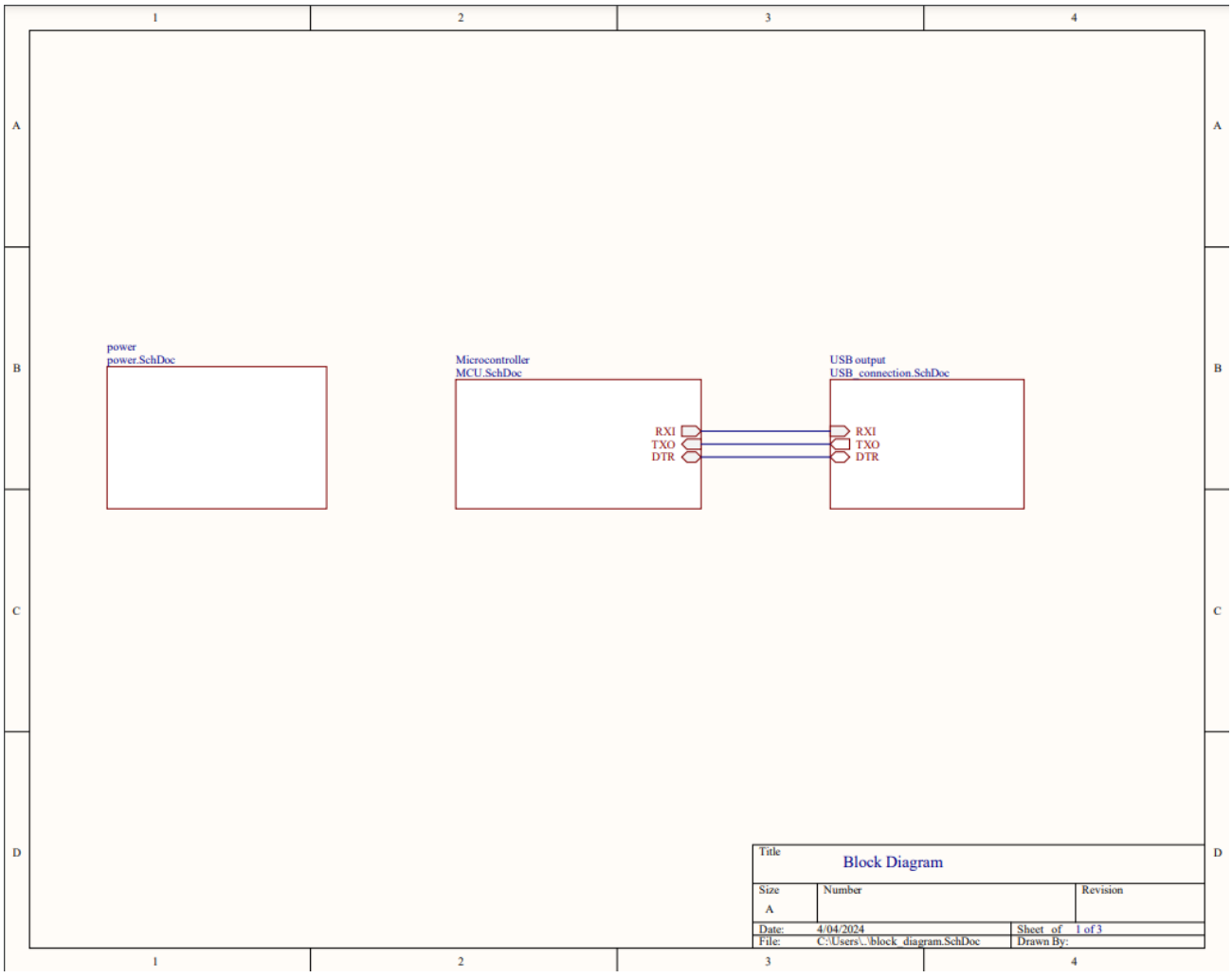

Fig. 10: Overall Block Diagram

2 Micro-controller

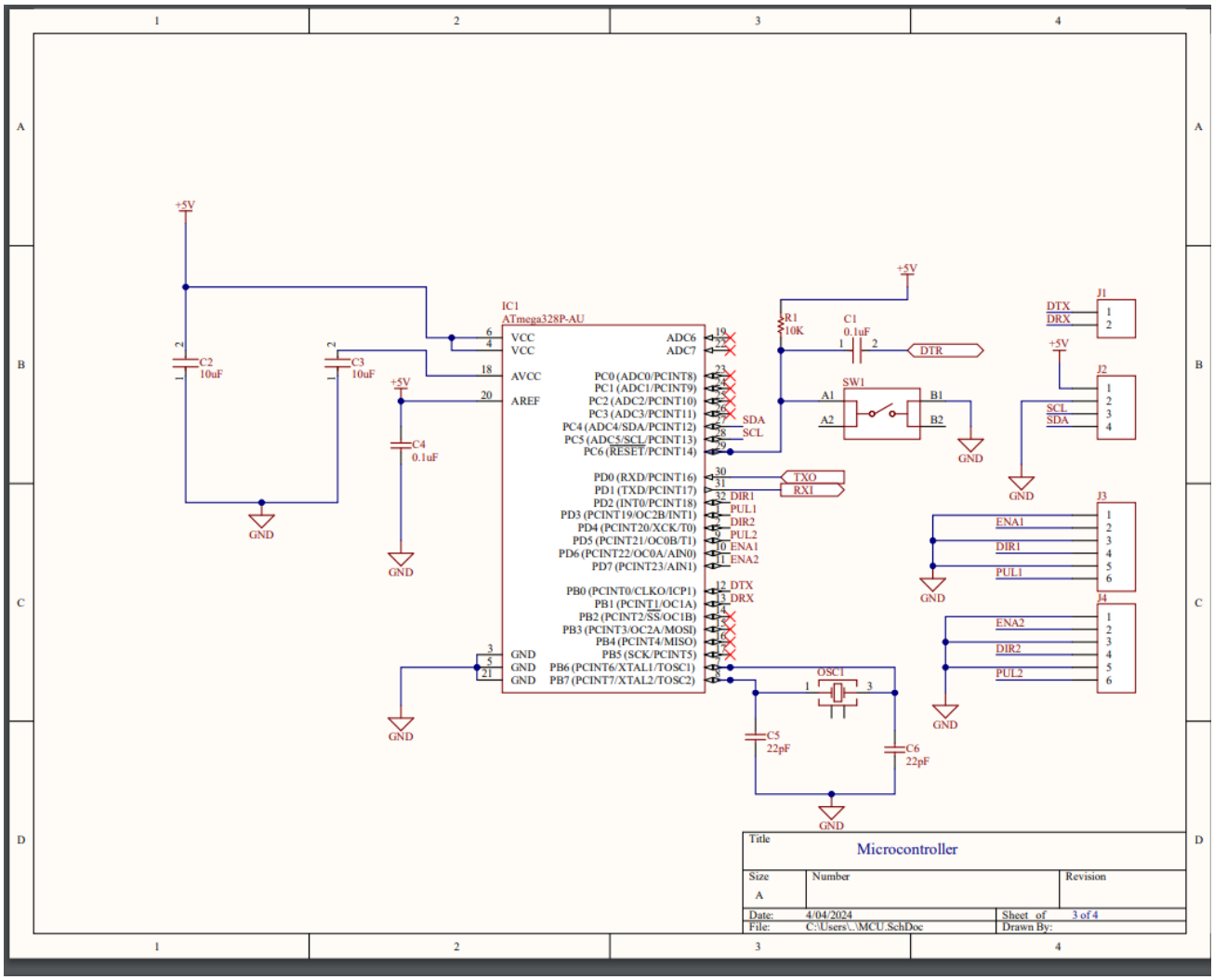

Fig. 11: Micro-controller Diagram

3 Voltage Converter

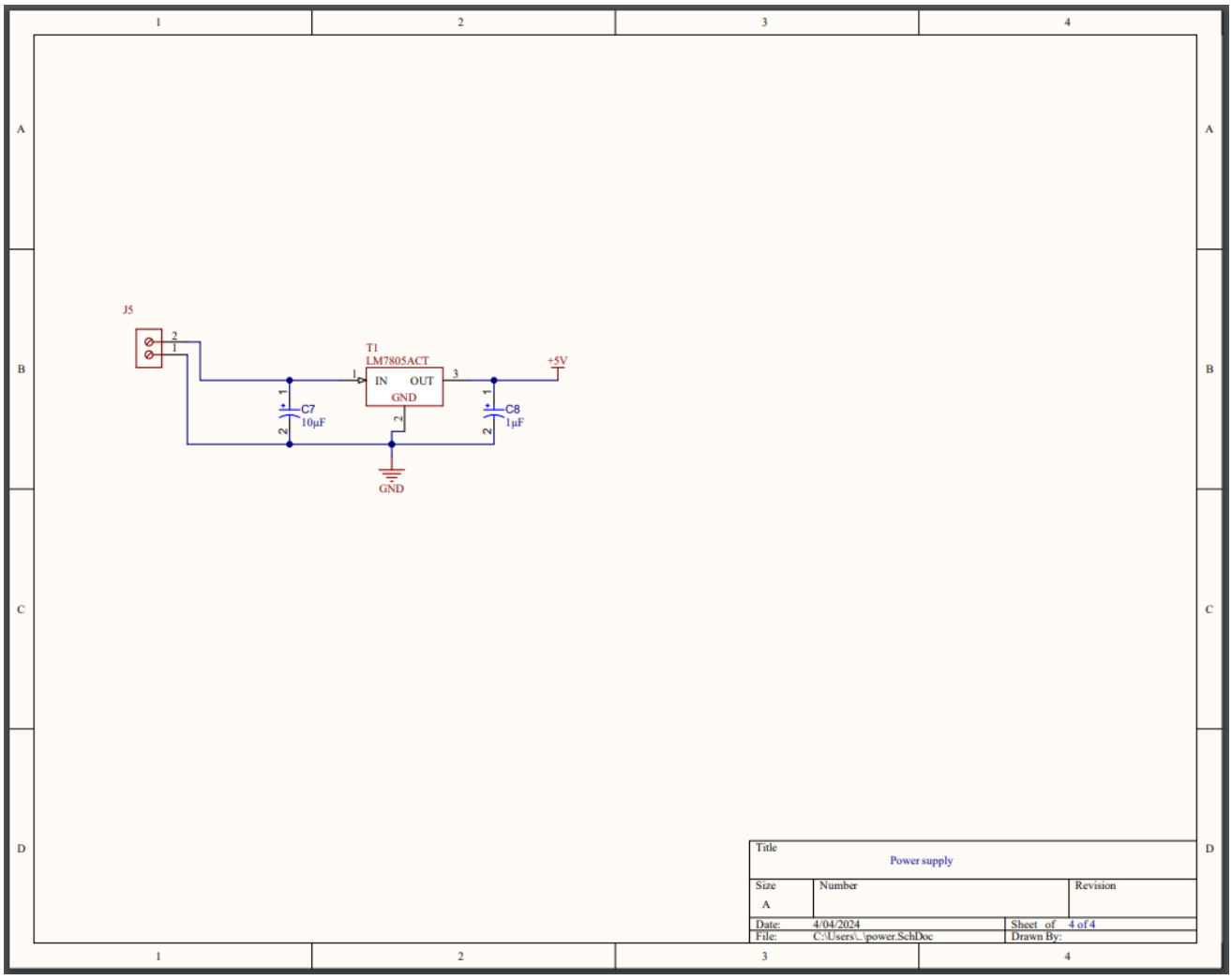

Fig. 12: Voltage Converter Diagram

4 USB Controller

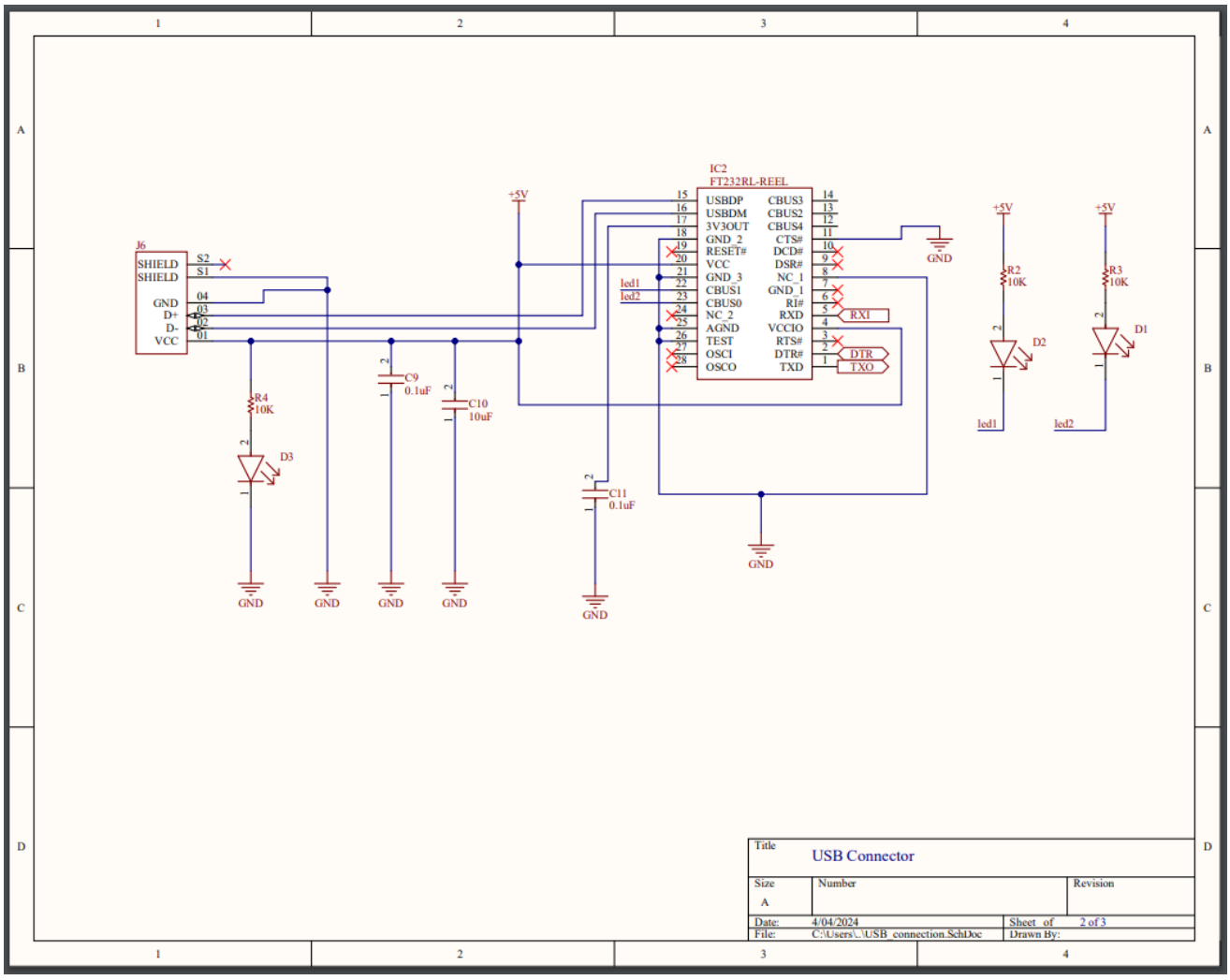

Fig. 13: USB Controller Diagram

XII PCB Design

Designed as a two-layer PCB with both smd and through-hole components.

1 Front Layer

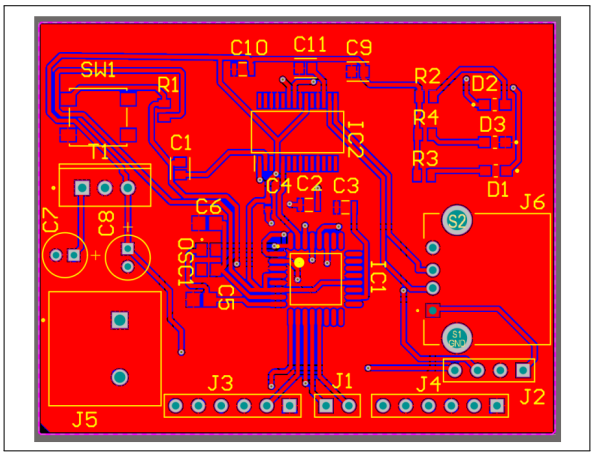

Fig. 14: PCB front layer

2 Bottom Layer

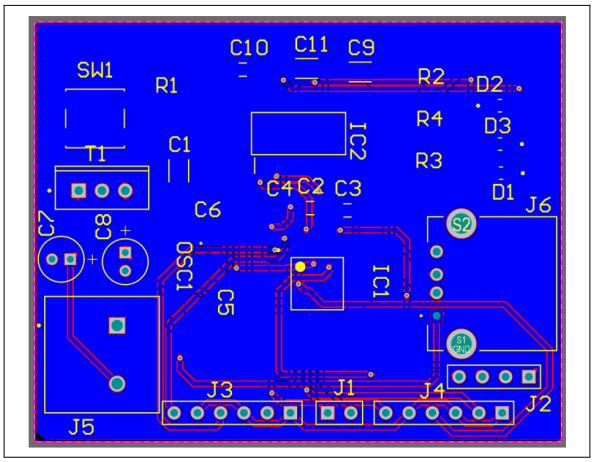

Fig. 15: PCB bottom layer

3 PCB with components

4 Printed PCB

5 Soldered PCB

6 PCB Testing

XIII Solidwork Design

Enclosure design

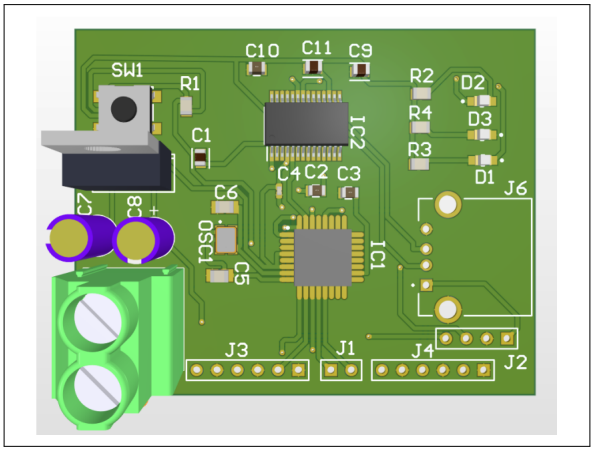

Fig. 16: PCB with components

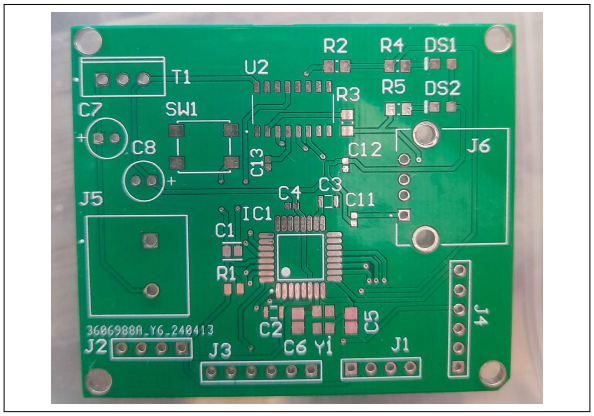

Fig. 17: Printed PCB

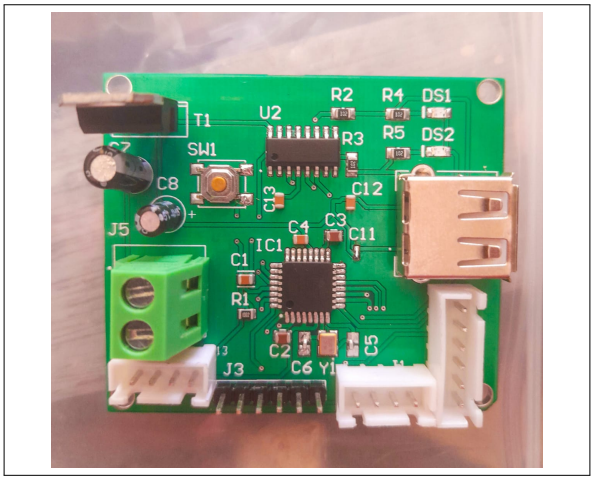

Fig. 18: Soldered PCB

Fig. 19: Soldered PCB

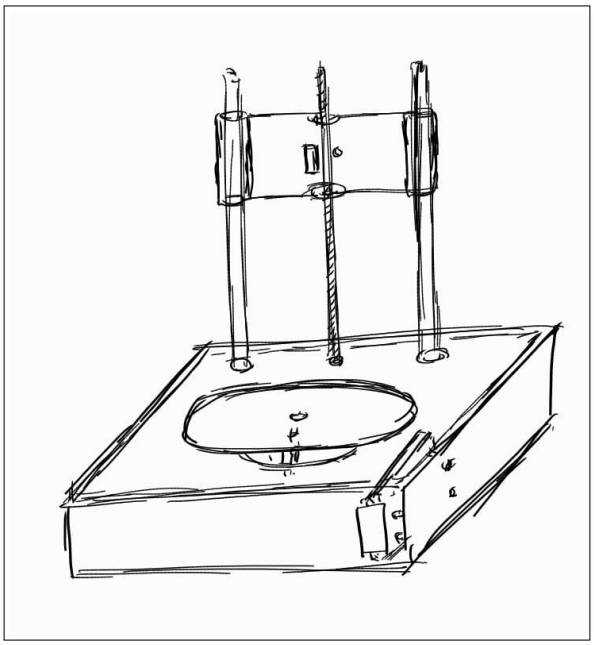

Fig. 20: 3D Scanner Final Proposed Design

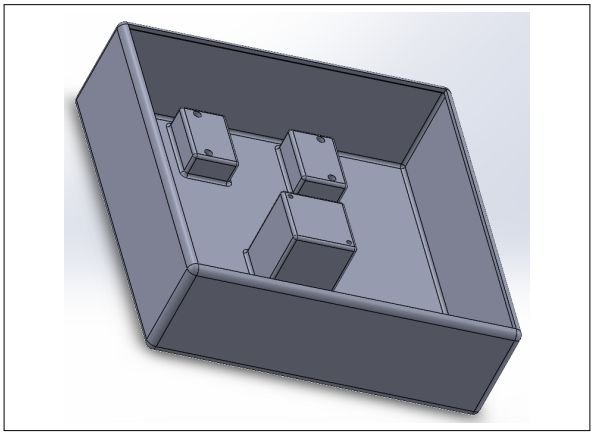

Fig. 21: 3D Scanner Main base

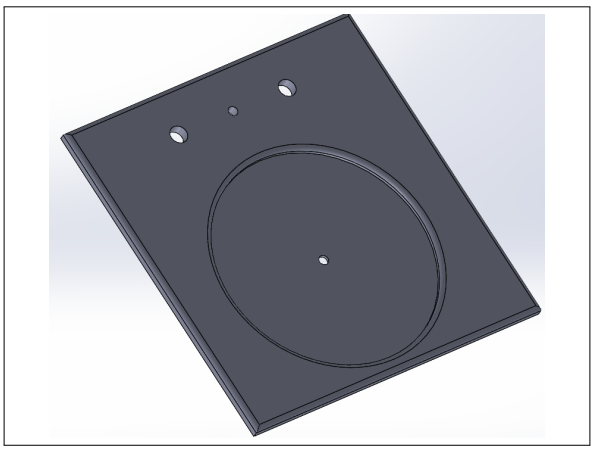

Fig. 22: 3D Scanner Top lid

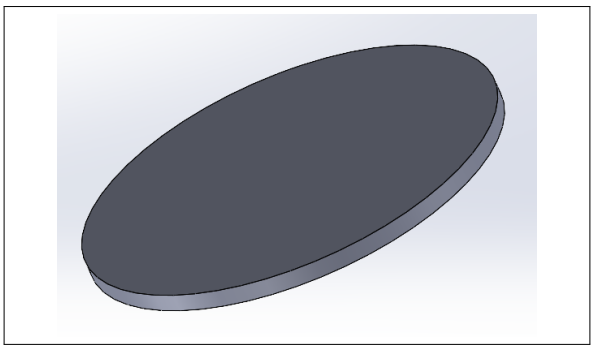

Fig. 23: 3D Scanner Tray

1 Finalized enclosure Assemble
2 Main Base
3 Top Lid
4 Tray
5 Moving Holder

XIV Stimulate Ideas

what is this? should be updated
Another issue that another literature mentioned that causes pressure and temperature rise during refueling is because the compressor hydrogen gas is not cooled at a given temperature. CHSS must be cooled to about -30 degrees to the hydrogen station before refueling to prevent a rise in temperature in the tank that causes embrittlement, leakage, or even explosions [18].

XV CONCLUSIONS

In summary, the 3D scanner prototype demonstrates promising capabilities in capturing detailed three-dimensional objects efficiently. Further development and strategic partnerships will be crucial in

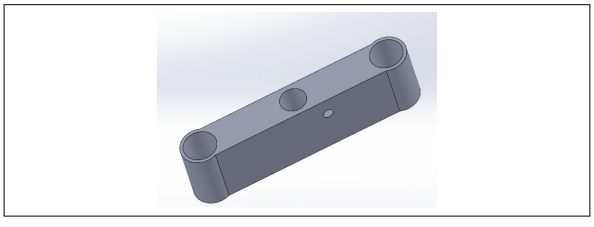

Fig. 24: 3D Scanner Moving Holder

refining the prototype for widespread adoption and transformative applications across industries.

References

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