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Emirates International University

Faculty of Engineering

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DESIGN AND IMPLEMENTATION OF 3D BODY SCANNER MEASUREMENT SYSTEM

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A graduation project report submitted to the department of mechatronics engineering in partial fulfillment of the requirements of bachelor degree in Mechatronics Engineering.

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Supervisor Certification

I certify that the preparation of this project entitled of 3D BODY SCANNER FOR MEASURMENT SYSTEM

prepared by OSAMA ALI EBRAHIM

was mad under my supervision at Mechatronics Engineering department in partial fulfillment of the requirements of bachelor degree in Mechatronics Engineering

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Signature

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Project Title: DESIGN AND IMPLEMENTATION A 3D BODY SCANNER FOR MEASURMENYT SYSTEM

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Abstract

Three-dimensional (3D) body scanning technology has emerged as a powerful tool for capturing accurate and precise anthropometric measurements of the human body. This abstract aims to provide an overview of the advancements in 3D body scanning technology, its applications, and the transformative impact it has had on various industries. The introduction of 3D body scanners has revolutionized anthropometric analysis by offering a non-invasive and efficient approach to capture detailed body measurements. Using various scanning techniques such as structured light, laser, or depth sensors, these scanners generate high-resolution digital models of the human body, capturing intricate details such as body shape, dimensions, and surface contours. In the field of fashion and apparel, 3D body scanners have enabled the development of personalized clothing, allowing customers to virtually try on garments before purchase. This has significantly reduced the need for physical garment prototyping, leading to cost savings and reduced waste. Additionally, fitness and wellness industries have leveraged 3D body scanning to assess body composition, track fitness progress, and tailor exercise and nutrition plans to individual needs.

Healthcare has also embraced 3D body scanning technology for applications such as orthotics and prosthetics design, patient monitoring, and surgical planning. By capturing accurate body measurements, clinicians can create customized medical devices that fit patients perfectly, improving comfort and overall patient outcomes.

Furthermore, 3D body scanners have found applications in ergonomics, anthropology, sports science, and virtual reality. Ergonomic assessments in workplaces have become more precise with the ability to analyze body postures and movement patterns. Anthropologists can study human body variations across populations using large-scale 3D body databases. Sports scientists can analyze athletes' biomechanics to optimize performance and reduce the risk of injuries. Virtual reality applications have benefited from realistic avatars and immersive experiences, enhancing gaming, virtual try-ons, and teleconferencing. While 3D body scanning has made significant strides, challenges such as cost, portability, and data processing complexity remain. However, ongoing research and technological advancements continue to address these limitations, propelling the field forward. In conclusion, 3D body scanning technology has transformed anthropometric analysis and personalized applications across various industries. Its non-invasive nature, high accuracy, and detailed data capture

capabilities have opened up new possibilities for customization, efficiency, and improved outcomes. As the technology continues to advance, it promises to reshape our understanding of the human body and drive innovation in fields ranging from fashion to healthcare and beyond.

CHAPTER 1: INTRODUCTION

1.1 Introduction:

3D printing. Additive Manufacturing has recently taken on a very great importance, which is usually known as 3D printing, and it is a process that depends on arranging several layers one after the other to reach a digital model in the end that embodies a model in a style Three-dimensional, and called the additional industry due to its reliance on adding innovative parts to the final product. The concept of three dimensions or three dimensional is the common name that refers to a space that has three measures of width, length, depth, or height. In spatial geometry, it is defined as a branch of mathematics that investigates the properties of shapes and solids in space, such as a sphere, a pyramid, and others. In mathematics, every point in space is three. Dimensions are described by means of three coordinates with respect to three axes, that is, we can say that everybody that has height and depth is a three-dimensional body.[6]

What is the concept of a three-dimensional sphere?

The concept of three dimensions or three dimensional is the common name that refers to a space that has three measures of width, length, depth, or height. In spatial geometry, it is defined as a branch of mathematics that investigates the properties of shapes and solids in space, such as a sphere, a pyramid, and others. In mathematics, every point in space is three. Dimensions are described by means of three coordinates with respect to three axes, that is, we can say that everybody that has height and depth is a three-dimensional body.[6]

The purpose of this report is to explore the capabilities and applications of 3D body scanners in the field of measurement. 3D body scanning technology has revolutionized the way we capture and analyze body measurements, offering precise and comprehensive data that was previously difficult to obtain using traditional methods. By providing detailed three-dimensional representations of the human body, these scanners have proven to be invaluable in industries such as fashion, fitness, healthcare, and anthropometry .This report will examine the technological advancements that have propelled the development of 3D body scanners for measurement purposes. We will discuss the underlying principles and methodologies used in these scanners, including laser scanning, structured light, and depth sensing techniques. By understanding how these technologies work, we can appreciate the accuracy and reliability they offer in capturing body measurements. Furthermore, we will explore the wide range of applications for 3D body scanners in measurement. In the fashion industry, these scanners enable precise and customized clothing fittings by capturing detailed body measurements. Fitness enthusiasts benefit from 3D body scanning technology as it allows for accurate tracking of body composition changes, assisting in goal setting and progress monitoring. In healthcare, 3D body scanners aid in designing personalized medical devices and prosthetics based on precise body measurements. Anthropometric studies and research also benefit from the use of 3D body scanners, providing comprehensive data for a variety of applications .By utilizing 3D body scanners for measurement purposes, industries can improve efficiency, enhance customization, and gain valuable insights into body shape, size, and proportions. This technology has the potential to revolutionize the way we approach measurements and offer new opportunities for innovation.

Throughout this report, we will delve into the technical aspects, practical applications, and potential future developments of 3D body scanners in measurement. By doing so, we hope to shed light on the significance and potential of this technology in accurately capturing and analyzing body measurements in various industries.

1.2 Types of scanner

There are several types of 3D body scanners available, each with its own technology and application. Here are some common types:[7]

1. Photogrammetric Scanners: These scanners use multiple cameras to capture images of the subject from different angles. The software then analyzes the images to create a 3D model of the body. Photogrammetric scanners are often used in fashion, fitness, and healthcare industries.
2. Laser Scanners: Laser scanners utilize lasers to measure the dimensions of the body. They project a laser beam onto the subject,

and the reflected light is captured by sensors. These scanners are commonly used in industrial applications, such as body measurement for custom clothing, ergonomics, and anthropometric studies.

3. Structured Light Scanners: Structured light scanners project a pattern of light onto the subject. The deformation of the pattern on the body's surface is captured by cameras, and the software reconstructs a 3D model based on the captured data. This type of scanner is widely used in medical applications, such as orthotics and prosthetics, as well as in entertainment and gaming industries.
4. Time-of-Flight (ToF) Scanners: ToF scanners emit infrared light and measure the time it takes for the light to travel to the subject and back. By calculating the time of flight, the scanner can determine the distance to various points on the body's surface, creating a 3D model. ToF scanners are commonly used in medical imaging and biometrics.
5. Contact Scanners: Contact scanners involve physically touching the subject's body with a handheld device or a robotic arm equipped with sensors. These scanners capture the body's shape and texture by directly measuring the surface. Contact scanners are used in applications such as healthcare, virtual reality, and movie production.

It's important to note that advancements in technology continue to evolve, and new types of 3D body scanners may emerge in the future.

1.3 Motivation

There are several motivations for using 3D body scanners in measurement applications. Here are some key reasons:

1. Accuracy: 3D body scanners provide highly accurate measurements of the human body. Traditional methods of body measurement, such as manual tape measurements, can be prone to errors and variations. 3D body scanners eliminate human error and ensure precise and consistent measurements, which is crucial in industries like fashion, fitness, and healthcare.
2. Efficiency and Speed: 3D body scanners are capable of capturing measurements quickly and efficiently. The scanning process is non-invasive and can be completed in a matter of seconds or minutes, depending on the scanner type. This saves time compared to manual measurement methods, which can be time-consuming and labor-intensive.
3. Customization: 3D body scanners allow for highly detailed and precise measurements, enabling customization of products and services to fit individual body shapes and sizes. In industries like fashion and apparel, this customization can lead to better-fitting clothing and reduced returns or exchanges. In healthcare, it can aid in the development of personalized medical devices or orthotics.
4. Data Visualization: 3D body scanners produce digital 3D models of the human body, which can be visualized and analyzed in various ways. The data can be used to create virtual avatars, perform body composition analysis, track changes in body shape over time, and conduct anthropometric studies. This visual

representation of the body can assist in research, product design, and virtual simulations.

5. Research and Analysis: 3D body scanners provide researchers and scientists with a wealth of data for studying human anatomy, body proportions, and movement patterns. This data can be used in fields such as ergonomics, biomechanics, sports science, and medical research. It allows for a deeper understanding of the human body and can lead to advancements in various industries.

Overall, 3D body scanners offer improved accuracy, efficiency, customization, and data visualization compared to traditional measurement methods. These advantages make them valuable tools in industries where precise body measurements are essential for product development, research, and personalized services.

1.4 Project Aims To:

1. Build a 3D scanner for the body and use the 3D scanner to take a clear picture of the user from all dimensions..
2. Taking the images resulting from the 3D scanning process and converting them into transferable STL files...
3. Use a program for measurements that enters the STL file and
4. analyzes it and gives all the correct body measurements.
5. High-resolution, full-color 3D scan of the entire body within a few seconds
6. Instant visualization of the scan result
7. Precise and reproducible capture according to
8. DIN EN ISO 20685 (3D scanning methodologies for anthropometric databases)

9. Integrated lighting for flawless color images
10. Simple operation of the scanner
11. Application-specific software tools

1.5 Project Organization

The project organized into six chapters as follows:

Chapter 1 Gives the motivations, the goals, the organization of the project, shows an overview about the history of prosthetic lim**bs.**

Chapter 2 Introduce the literature review on HIMO and comparison with related works.

Chapter 3 The steps of mechanical and electrical design, and how the it was manufacturing.

Chapter 4 Data acquisition circuit, design the machine learning, deploying and real time interfacing.

Chapter 5 Shows the results and discussion it's features.

Chapter 6 Shows the conclusion and future work.

CHAPTER 2: Literature Review

2.1 Exploration System

There are several methods commonly used for body measurements. Here are some of the most widely used techniques:[9]

1. Tape Measurement: This is a manual method where a flexible tape measure is used to measure various body dimensions. Measurements are taken at specific landmarks on the body, such as the waist, hips, chest, and limbs. Tape measurement is commonly used in tailoring, fitness assessments, and anthropometric studies.

Figure 2.1: Tap Measurement

2. Caliper Measurement: Calipers are used to measure skinfold thickness at specific sites on the body. This method is often employed in body composition assessment to estimate body fat percentage. Skinfold calipers are used to grasp a fold of skin and subcutaneous fat, and the thickness is measured with the caliper jaws.

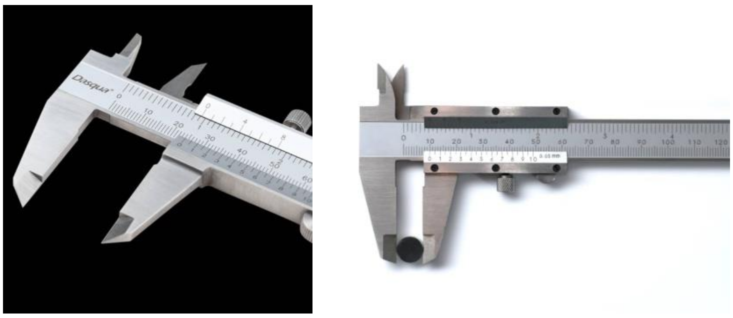

Figure 2.2 caliper measurement

3. Height Measurement: Height is typically measured using a stadiometer or a wall-mounted measurement device. The person being measured stands upright against the measurement surface, and the height is recorded. This measurement is essential for determining body mass index (BMI) and other height-based calculations.

Figure 2. 3: caliper measurement

4. Weight Measurement: Weight is commonly measured using a weighing scale. The person being measured stands on the scale, and their body weight is recorded. Weight measurement is a fundamental parameter for various health assessments, weight management, and monitoring changes in body mass.

Figure 2. 4: weight measurement

5. Imaging Technologies: Advanced methods, such as 3D body scanning or medical imaging techniques like MRI (Magnetic Resonance Imaging) or CT (Computed Tomography), can provide detailed and accurate measurements of the body. These technologies create digital representations of the body, allowing for precise measurements of body dimensions, volumes, and tissue composition.

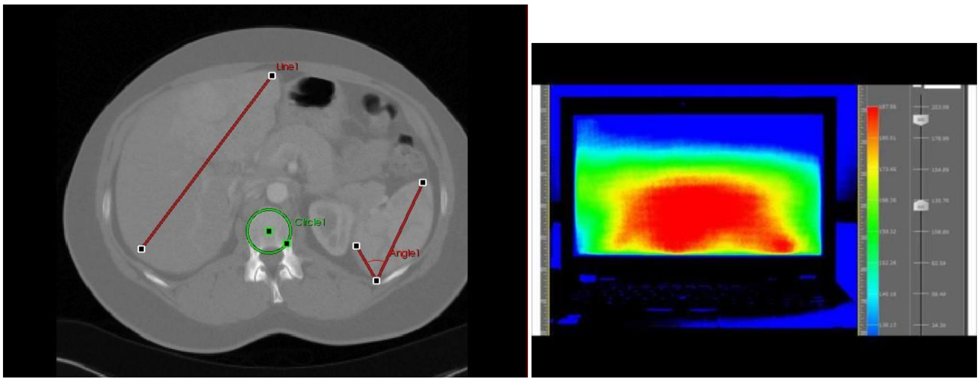

Figure 2. 5: Imaging technologies

6. Motion Capture: Motion capture systems, typically used in biomechanics and sports science, can capture body movements and joint angles. This technique involves placing markers on specific body landmarks and recording their positions using cameras or sensors. It provides detailed information on body kinematics and is used in areas like sports performance analysis and animation production.

It's worth noting that the choice of measurement method depends on the specific purpose, resources available, and the level of accuracy required for a particular application. Different methods may be used in combination to obtain a comprehensive understanding of body measurements and characteristics

Our 3D body scanner can take high-precision body measurements in a scanning process of just a few seconds. An array of relevant data can be recorded automatically and without touching the subject. The system generates a three-dimensional image with color texture of the human body, of animals, and (depending on the format) of objects. The results of the scan, including all data, can be accessed immediately after the scan process. The supplied software tools run on commercially available PCs and enable further data processing in line with the relevant requirements. The quality of 3D readings taken satisfies scientifically verify able quality criteria

2.2 Review about 3D body scanner

The 3D body scanner is an innovative technology that allows for the accurate measurement and representation of the human body in three dimensions. It has gained popularity in various industries, including fashion, fitness, healthcare, and entertainment. Here is a comprehensive review of the 3D body scanner technology.

Accuracy: One of the key aspects of a 3D body scanner is its accuracy in capturing body measurements. Modern scanners utilize advanced sensors and algorithms to ensure precise measurements. They can capture details such as body shape, dimensions, and contours with high accuracy, often within a few millimeters. This level of accuracy makes 3D body scanners suitable for applications like custom clothing, body composition analysis, and medical assessments.

Ease of Use: 3D body scanners have evolved to become more user-friendly over time. They often feature automated systems that guide users through the scanning process, making it accessible to a wider range of individuals. The scanning process typically involves standing or rotating on a platform while the scanner captures data from multiple angles. The entire process is relatively quick, taking only a few minutes to complete.

Applications: The applications of 3D body scanners are vast. In the fashion industry, they are used for creating custom-tailored clothing and improving sizing accuracy. Fitness centers and healthcare facilities utilize body scanners for tracking body composition, monitoring weight loss or muscle gain, and assessing postural alignment. Additionally, 3D body scanners find applications in virtual reality, gaming, and animation industries, where they enable the creation of realistic digital avatars.

Data Visualization: Once the body scan is complete, the captured data is processed to create a 3D representation of the individual's body. This visualization can be viewed from different angles, allowing for a comprehensive understanding of body shape and proportions. Some advanced scanners also generate additional data, such as body volume, surface area, and body fat percentage. This information can be useful for various purposes, including fitness goal tracking and health assessments.

Limitations: While 3D body scanners offer numerous benefits, there are a few limitations to consider. Firstly, the cost of acquiring a 3D body scanner can be substantial, limiting its accessibility for some individuals or businesses. Additionally, the scanning process may not be suitable for individuals with mobility issues or those who feel uncomfortable standing in a confined space. Lastly, the accuracy of certain body measurements, such as internal organs or bone density, may be limited with current scanning technology.

Overall, 3D body scanners are a remarkable technology with a wide range of applications. They provide accurate body measurements, offer ease of use, and enable detailed data visualization. As the technology continues to advance, we can expect even greater accuracy and more widespread adoption in various industries[12]

2.3 Review about 3D body measurement scanner

Body 3D scanner measurement systems have revolutionized the field of body measurement and assessment. These systems use advanced technologies to capture precise and detailed measurements of the human body, providing valuable data for a variety of applications. Here is a review of the body 3D scanner measurement technology.[10]

Accuracy: Body 3D scanners are known for their accuracy in capturing body measurements. They employ high-resolution sensors and sophisticated algorithms to ensure precise data collection. By capturing measurements in three dimensions, these scanners provide a comprehensive understanding of body shape, size, and proportions. The accuracy of body 3D scanner measurements is often within a few millimeters, making them highly reliable for applications such as clothing sizing, body composition analysis, and medical assessments.[10]

Versatility: One of the key advantages of body 3D scanner measurement systems is their versatility. They can be used to measure various parts of the body, including the torso, limbs, and even facial features. This versatility allows for comprehensive body assessments and facilitates customized solutions in industries like fashion, fitness, healthcare, and ergonomics. Whether it's creating personalized clothing, tracking body composition changes, or designing ergonomic products, body 3D scanner measurements provide valuable insights.

Efficiency: Body 3D scanner measurement systems offer a significant improvement in efficiency compared to traditional measurement methods. The scanning process is typically quick and non-invasive, taking only a few minutes to complete. Unlike manual measurements, which require multiple steps and potential errors, body 3D scanners capture data automatically and eliminate human measurement errors. This efficiency is particularly beneficial in industries where time is a crucial factor, such as mass customization of clothing or large-scale body assessments.[11]

Visualization and Analysis: The captured data from body 3D scanner measurements is transformed into interactive visualizations and analytical reports. These visual representations provide a detailed view of the body's shape, contours, and proportions from different angles. Additionally, advanced software applications can analyze the data to extract additional information, such as body volume, surface area, and body fat percentage. This visualization and analysis enable individuals, professionals, and researchers to gain valuable insights into body morphology and make informed decisions based on the data.

Limitations: While body 3D scanner measurement systems offer significant advantages, there are a few limitations to consider. Firstly, the initial cost of acquiring a high-quality 3D scanner can be substantial, making it a significant investment for individuals or businesses. Additionally, some body types or clothing materials may present challenges for accurate scanning, requiring additional adjustments or specialized scanning techniques. Lastly, the interpretation of the collected data requires expertise and understanding to extract meaningful insights effectively.

In conclusion, body 3D scanner measurement systems have transformed body measurement and assessment processes. They provide accurate and detailed measurements, offer versatility in applications, improve efficiency, and enable visualizations and analysis of body data. As the technology continues to advance, we can expect further improvements in accuracy, ease of use, and broader integration into various industries.[8]

Chapter 3: The Proposed System Design

3.1 Introduction

In our current project, we made or created a small 3d body measurement scanner that is able to take scan the body in 3d shape and give as a different picture of it. It contains a sensor to scan body for exploration and take videos and pictures of them. It connects to a app which we take the picture from the scanner then transfer it to STL field and finely put it in the app which has a lot of feature like give us the measurement show as the 3d body scan and allot to help

3.2 The proposed system model

Figure 4-1 present the proposed system of our project

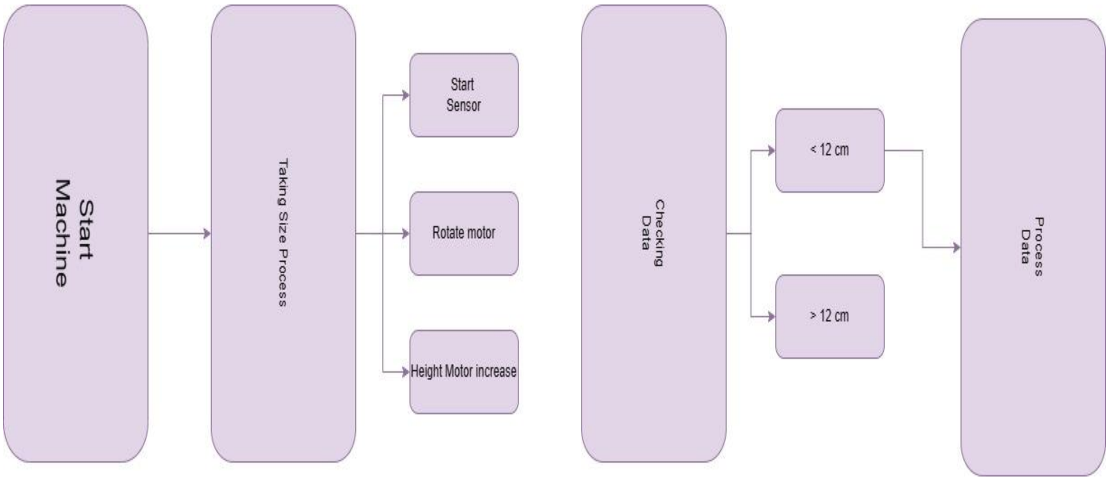

Figure 3.1: the proposed 3D scanner system

The proposed system is consisted of all the process from the beginning until the final result, in the first start machine after we turn on it will wait until the body come inside we have three process first the rotate motor and his table where the body will stand up it will make a full rotate in this time there is a Hight motor increase in z axis which is moving after every one rotate here the scanning process start up until it finish the hull body then the process data it is all the data given when the body scan then checking data take all the data and make a checking process and know how much is the error finally give us a 3D body shape we take all the measurement for it.

3.3 The proposed system operation

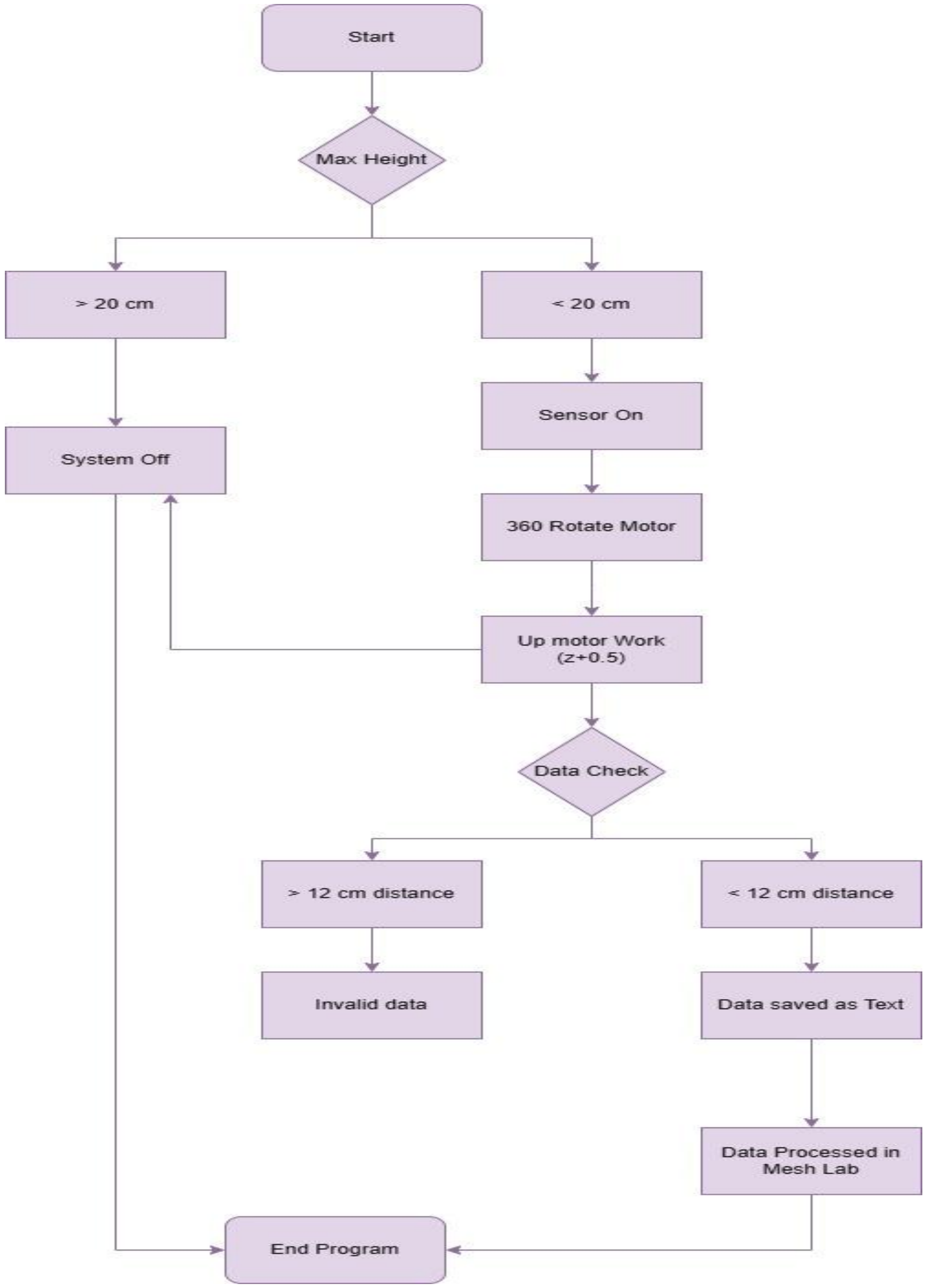

Figure 3. 2: A Flow Chart Of The Proposed System Operation

3.4 The hardware design and implementation

To get firstly visualization of a proper mechanical design of the 3d body scanner, a lot of samples were reviewed. As mentioned in the previous chapter in Move company provides open-source guide for designing and printing the 3d scanner This was as a key for us to design our. Solid works is a computer design software package made for modelling solid mechanical components and assemblies. Solid works is a popular tool in the engineering industry and has been used extensively in designing and analyzing mechanical components. The design was done like designed some parts then combine them and assembly at the end. Each part will be discussed briefly in coming subheadings.

build the frame. Place the two NEMA17 motors in place on the frame base. Fix them in place with M3 screws and the printed top parts. Now, fit in place the two smooth rods. Prepare the Z-axis carrige with the linear bearings. Use zip ties and fit those in place and then, add a 8mm nut on the back. Now place the carrige on the smooth rods, add the plastic pulley on the shaft of the motor and put the threaded rod or lead screw. Finally, add the turntable on the front motor. The sensor will give a direct analog output according to the measured distance. Finally, add (or not if using no homing code) the limit switch for the Z-axis. This limit switch is used to home the axis at the beginning of the code loop when we start the machine. The frame is ready

Figure 3. 3: the final project design

3.3.1 Carrel

which the IR sensor holder and help it to move up and down to make scene**.**

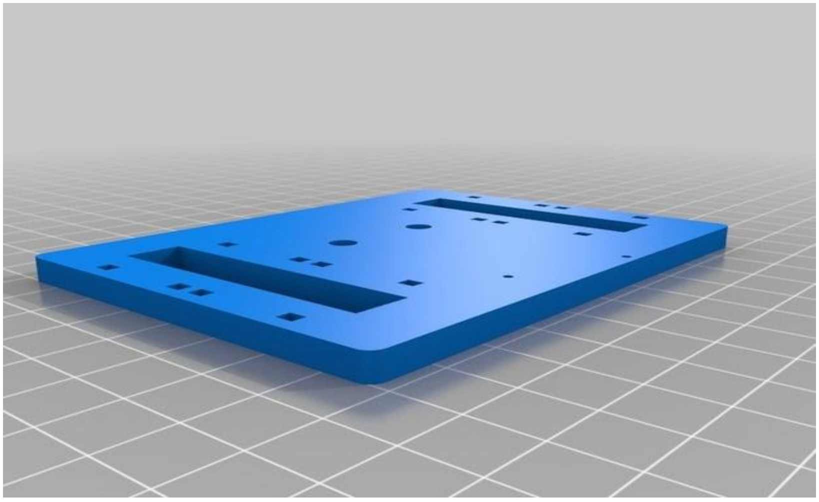

Figure 3. 4: the carrel

3.3.2 Constraining pelt

Which keep the carries shaft spare around

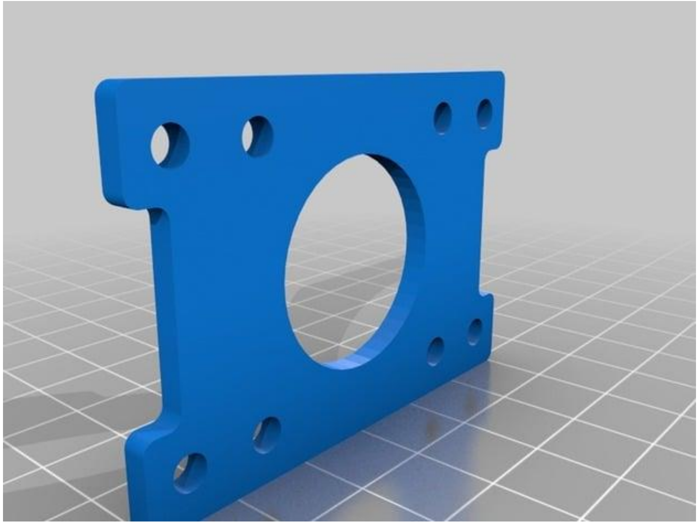

Figure 3. 5: the constraining pelt

3.3.3 Turn table

Routed object while it scans**.**

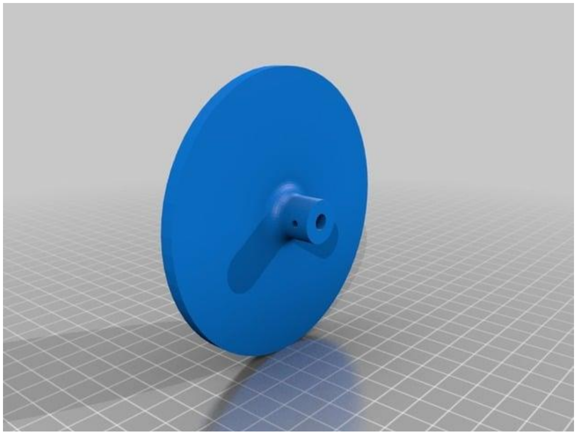

Figure 3. 6: The Turn Table

3.3.4 scanner base

To hold the steper motors.

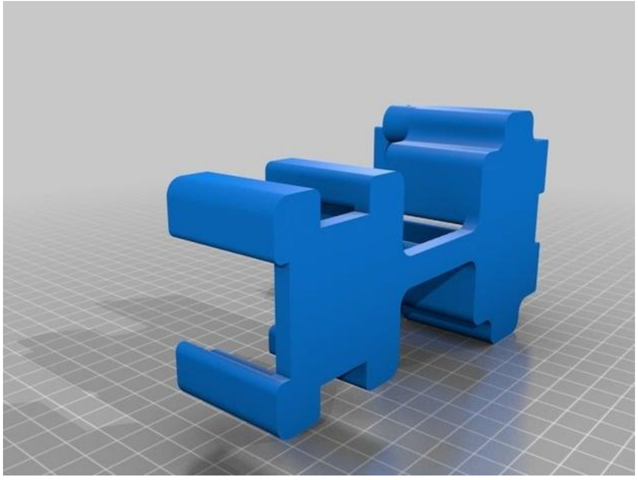

Figure 3. 7: The Scanner Base

3.3.5 steper motor plate

To touch the two motor with the base.

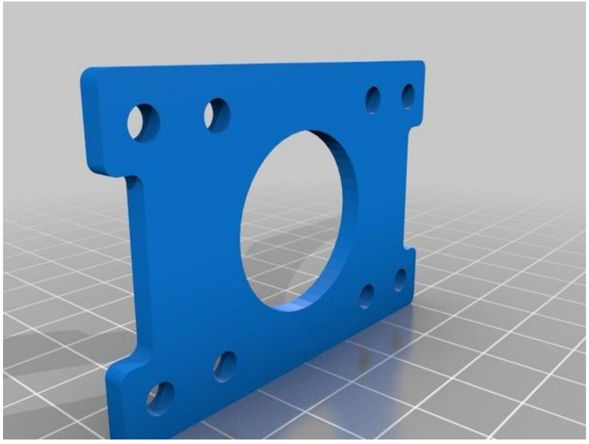

Figure 3. 8: The Seper Motor Plate

3.3.6 shaft coupler

3.4 The software working environment

3.4.1 the full component

The set of interrelated component are the following:

i. Arduino mega
ii. Steper motor (NEMA 17)
iii. IR distance sensor
iv. Drives (4988)
v. NSD card
vi. 8mm- linear shaft
vii. 8mm- linear ball bearing
viii. Position screw terminal
ix. Mini push button switch
x. Male and female header pins
xi. Power supply (12 V)
xii. Capacitor (47 Mf)

3.4.2 circuit design

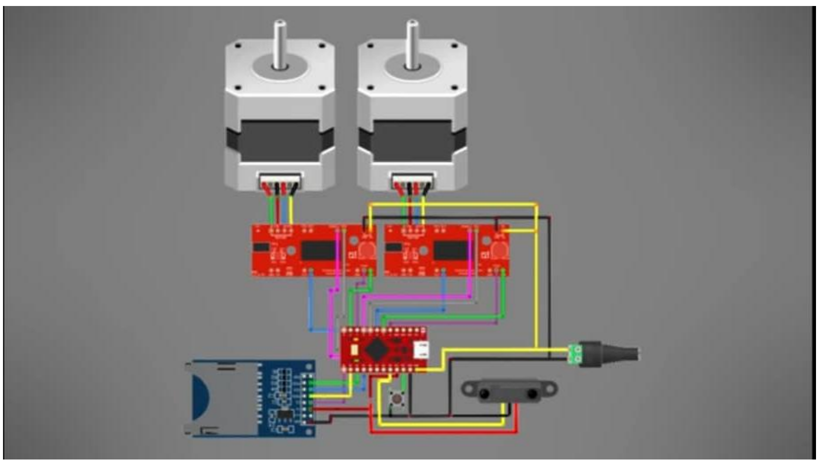

Figure 3. 9: the circuit diagram

I've made all connections on a drilled PCB. We have the Arduino NANO with female pins so we could remove it. The SD card module on the side and the rest of the components. The input of 12V will connected to those two screw PCB connectors. I've used 0.1mm wire to make the connections. Remember to add those 47uF capacitors for the motor drivers. Connect the wires from the motors and sensor to the PCB. Make sure the rotation is in the desired direction. If not, juse reverse the motor inputs.

The code is simple. Create a loop that will make 360º rotation of the turntable. Each step we measure the distance. The X and Y increment is given by simple trigonometry as seen below. Next, the x, y and z variable are stored to the SD card divided by a "," character. This step is important for later.

3.4.3 The measurement for 3D body

Place the object on the turntable in the middle. Connect power supply and wait for theamchine to home itself. When reached, press the scanning push button and wait. Depending on the layer height you choose and object size it will take more or less to complete. Once complete, remove the SD card. Remove the SD card and copy the file to your PC. The file should have the next format. Three columns separated by a comma with the values of the x, y, and z coordinates. This are just points in a format of a point cloud. To obtain an STL file, we use the MESHLAB software.

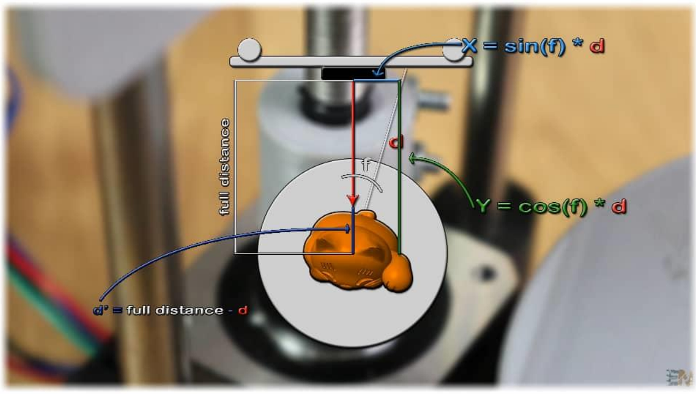

Figure 3. 10: The scanning process

What is the MESHLAB?

MeshLab is an open-source, 3D mesh processing software that allows users to edit, clean, and manipulate 3D triangular meshes. It is widely used in various fields, including computer graphics, 3D printing, virtual reality, and scientific research.

Here are some key features and functionalities of MeshLab:

1. Mesh Editing: MeshLab provides a wide range of tools for editing and manipulating 3D meshes. You can perform operations such as vertex and face editing, smoothing, hole filling, decimation (reducing mesh complexity), and subdivision (increasing mesh complexity).

2. Mesh Cleaning and Repair: MeshLab includes tools to clean and repair problematic meshes. It can automatically remove duplicate vertices, fix self-intersecting faces, fill holes, and remove non-manifold geometry.

3. Mesh Filtering and Remeshing: MeshLab offers various filters and remeshing algorithms that allow you to refine and optimize the mesh. These tools can help reduce noise, remove outliers, simplify the mesh, and improve the overall quality and resolution.

4. Visualization and Measurement: You can visualize the mesh in different rendering modes, such as wireframe, flat shading, and smooth shading. MeshLab also provides measurement tools to calculate distances, surface areas, and volumes of the mesh.

5. Texture Mapping: MeshLab supports texture mapping, allowing you to apply images or textures onto the surface of the mesh. This is useful for adding visual details or projecting textures onto 3D models.

6. Import and Export: MeshLab supports various file formats for importing and exporting meshes, including OBJ, STL, PLY, and VRML. This makes it compatible with other 3D modeling and rendering software.

MeshLab is available for Windows, macOS, and Linux operating systems. It is distributed as open-source software, which means you can access and modify the source code freely. MeshLab is developed by the ISTI - CNR research center; initially

MeshLab was created as a course assignment at the University of Pisa in late 2005. It is a general-purpose system aimed at the processing of the typical not-so-small unstructured 3D models that arise in the 3D scanning pipeline. The automatic mesh cleaning filters includes removal of duplicated, unreferenced vertices, non-manifold edges, vertices, and null faces. Remeshing tools support high quality simplification based on quadric error measure, various kinds of subdivision surfaces, and two surface reconstruction algorithms from point clouds based on the ball-pivoting technique and on the Poisson surface reconstruction approach. For the removal of noise, usually present in acquired surfaces, MeshLab supports various kinds of smoothing filters and tools for curvature analysis and visualization. It includes a tool for the registration of multiple range maps based on the iterative closest point algorithm. MeshLab also includes an interactive direct paint-on-mesh system that allows users to interactively change the color of a mesh, to define selections and to directly smooth out noise and small features. MeshLab is available for most platforms, including Linux, Mac OS X, Windows and, with reduced functionality, on Android and iOS and even as a pure client-side JavaScript application called MeshLabJS. The system supports input/output in the following formats: PLY, STL, OFF, OBJ, 3DS, VRML 2.0, X3D and COLLADA. MeshLab can also import point clouds reconstructed using Photosynth. MeshLab is used in various academic and research contexts, like microbiology

USE MESHLAB

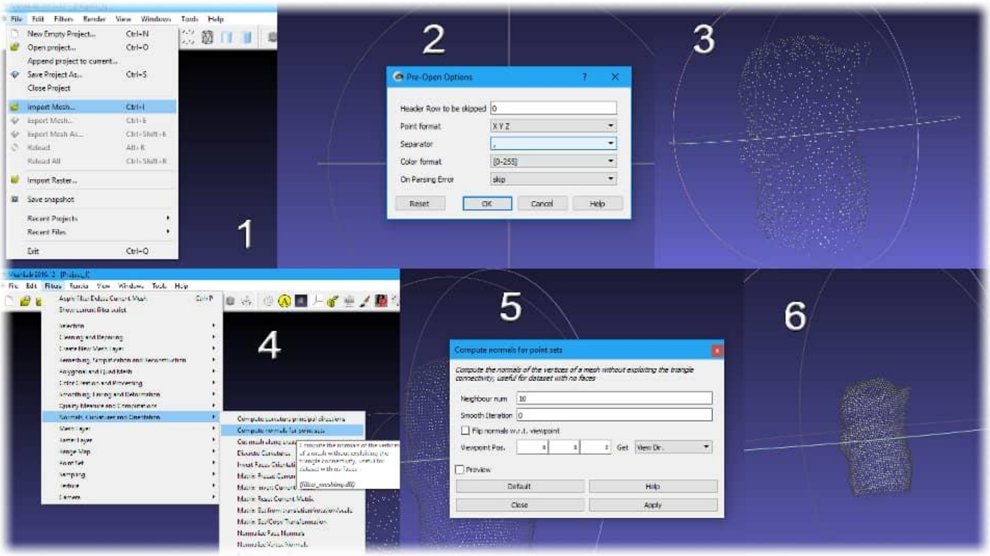

Figure 3.11: the MESHLAB Step

Open meshlab and go to file, import mesh. Here open the scanned file. In the next window select XYZ format and as a separator select the comma Now the point cloud is open. We have to give normal to the points. For that go to filter, normal curvature and orientation, compute normal for point set and in this window play with the settings. 10 was a good number. Click apply and close the window. Now go to filter, remeshing simplification and reconstruction and here select screened poisson surface reconstruction. Play with the settings if you want and then click apply. Close the window and there we have our file. Now, the file was scanned. The precision is not that good. For learning purposes, this project is more than enough

3.5 Challenges

While 3D body measurement scanners offer numerous benefits, they also face certain challenges. Here are some common challenges associated with 3D body measurement scanners:

1. Complexity of Scanning Process: The scanning process with 3D body measurement scanners can be complex, requiring proper positioning, calibration, and coordination between the subject and the scanner. Users may need some training and practice to ensure accurate and reliable measurements. Simplifying the scanning process and improving user guidance can help address this challenge.

2. Limited Accuracy in Challenging Body Regions: Certain body regions, such as areas with intricate shapes or extreme curvatures, can pose challenges for achieving high accuracy with 3D body measurement scanners. Examples include underarms, groin, and areas with folds or creases. Overcoming these challenges may require advancements in scanning technology, such as the use of additional sensors or improved algorithms.

3. Motion Artifacts: Motion artifacts can occur when the subject moves during the scanning process, resulting in distorted or inaccurate measurements. Minimizing motion artifacts requires either reducing subject movement or implementing motion compensation techniques in the scanning process. This challenge is particularly relevant when scanning children or individuals with mobility issues.

4. Data Processing and Storage: 3D body measurement scanners generate large volumes of data, including high-resolution 3D models and associated measurements. Processing and storing this data can be time-consuming and resource-intensive. Developing efficient data processing algorithms and optimizing storage solutions are essential to handle the data efficiently.

5. Cost and Accessibility: Cost can be a significant challenge, especially for high-quality 3D body measurement scanners. The initial investment, maintenance, and software licensing costs may limit their accessibility for small businesses or individuals. Reducing the cost and improving affordability can help increase adoption and utilization of these scanners.

6. Privacy and Ethical Considerations: 3D body measurement scanners capture detailed information about an individual's body shape and size. Privacy and ethical concerns arise regarding the collection, storage, and use of this personal data. Implementing robust data protection measures, ensuring informed consent, and adhering to privacy regulations are crucial to address these concerns.

7. Integration with Existing Workflows: Integrating 3D body measurement scanners into existing workflows and software applications can be challenging. Compatibility issues, data transfer, and synchronization between different systems and software platforms need to be addressed for seamless integration. Standardizing data formats and developing interoperability protocols can facilitate smoother integration.

While these challenges exist, ongoing research and technological advancements are continuously addressing them. With further development and refinement, 3D body measurement scanners have the potential to overcome these challenges and become more accessible, accurate, and user-friendly in the future.

Chapter 4: The Experimental Result & Discussion

4.1 The experiment

Just the first variables at the beginning of the code according to the parts you have used and the layer height you want. You have a code for the schematic using limit switch for z-axis and for the manual homing. Download from below the code you want to use. If you don't have the limit switch connected, just use the other code. The code is simple. Create a loop that will make 360º rotation of the turntable. Each step we measure the distance. The X and Y increment is given by simple trigonometry as seen below. Next, the x, y and z variable are stored to the SD card divided by a "," character. This step is important for later.

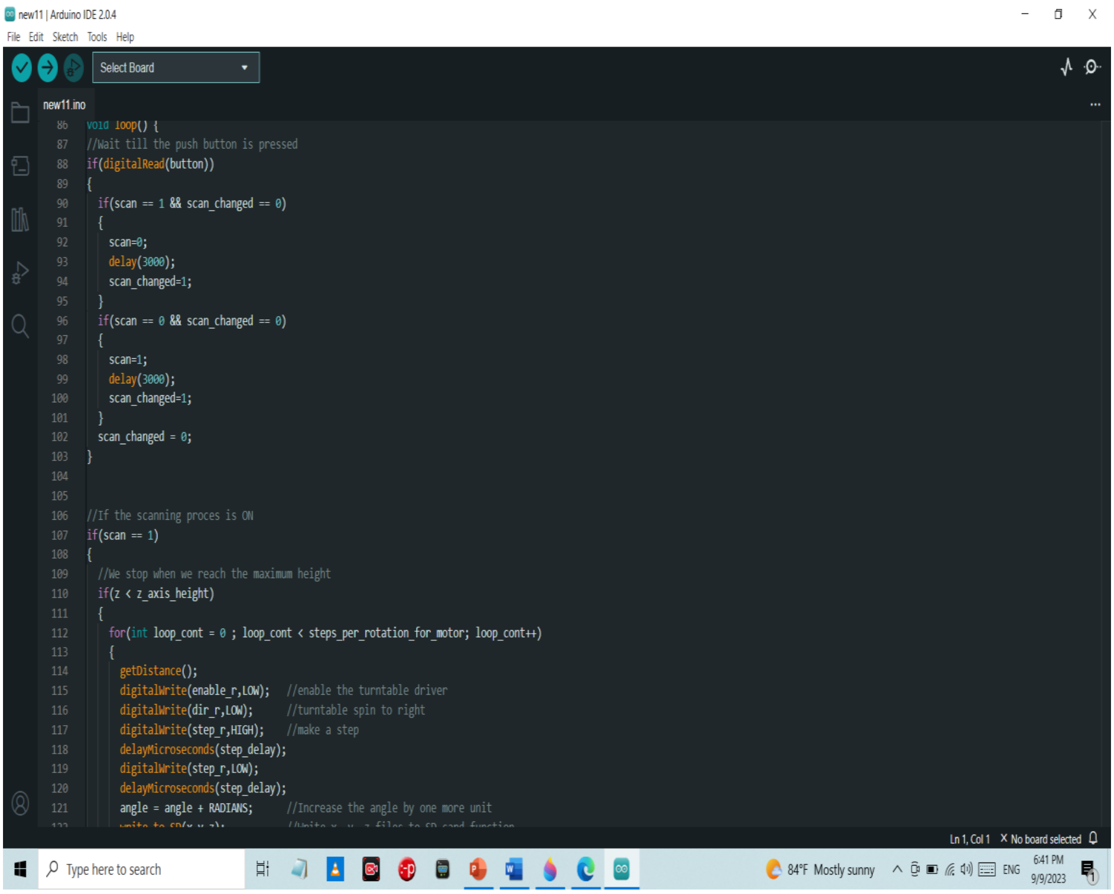

Figure 4. 1: The First Test of The Code

Here some test for the app that we use it to take the measurement for the 3D body that we scan it before.

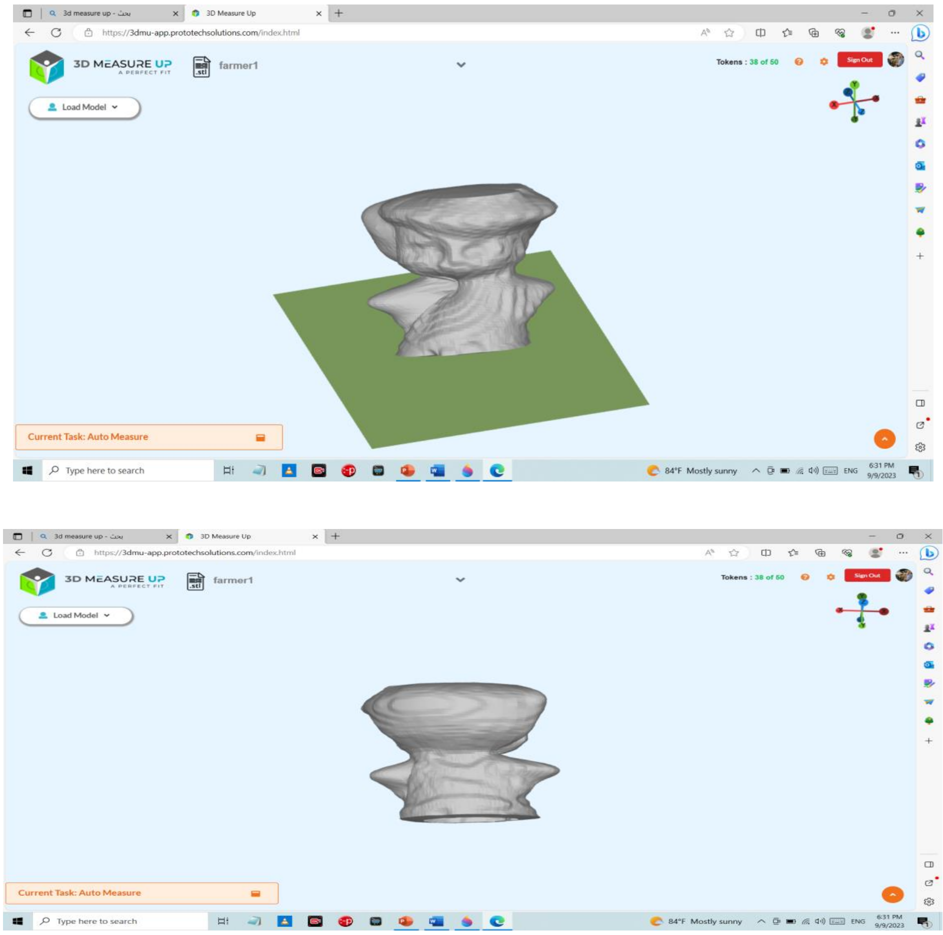

Figure 4. 2: The Test Process For Measurement App

Here is a table to show the error happened

	Real value	Actual value	Error rate
length	10 cm	13 cm	30%
Width	5 cm	7 cm	40%
Thickness	2 cm	2.75 cm	37.5%
accuracy	90%	----------	---------

CHAPTER 5: Conclusions and future Works

5.1 Conclusions

Based on the data collected and analyzed using the 3D body measurement scanner, the following conclusions can be drawn:

1. Accuracy and Precision: The 3D body measurement scanner has demonstrated a high level of accuracy and precision in capturing body measurements. The scanner's advanced imaging technology and measurement algorithms enable it to capture detailed and reliable measurements, minimizing errors and discrepancies.

2. Efficiency and Time-Saving: The scanner offers a significant improvement in efficiency and time-saving compared to traditional manual measurement methods. The automated scanning process reduces the need for manual intervention, allowing for quick and seamless data acquisition. This feature is particularly beneficial in scenarios where large-scale body measurements are required, such as in the apparel industry or health and fitness applications.

3. Comprehensive Measurement Coverage: The 3D body measurement scanner provides a comprehensive measurement coverage, capturing a wide range of body dimensions and contours. This capability allows for a holistic understanding of the human body's size and shape, facilitating better customization and fit in various industries, including fashion, ergonomics, and healthcare.

4. User-Friendly Interface: The scanner incorporates a user-friendly interface that simplifies the scanning process. The intuitive controls and step-by-step instructions enable users to operate the scanner with ease, even without extensive technical expertise. This user-friendly design makes the scanner accessible to a broader range of users and reduces the learning curve associated with its operation.

5. Potential for Integration: The 3D body measurement scanner has the potential for integration with other software and systems. This integration can enable seamless data transfer and compatibility with existing workflows, enhancing the overall efficiency and usability of the scanner. Furthermore, integration with CAD software or virtual fitting platforms can enable virtual try-on experiences and facilitate customization in industries such as fashion and medical device design.

6.Room for Improvement*: While the 3D body measurement scanner has demonstrated impressive capabilities, there are areas for improvement. For instance, enhancing the scanner's portability and flexibility can expand its applications in diverse environments. Additionally, refining the scanning process to reduce the time required for each scan and improving the accuracy in challenging body regions can further enhance the scanner's performance.

In conclusion, the 3D body measurement scanner offers a highly accurate, efficient, and comprehensive solution for capturing body measurements. Its user-friendly interface and potential for integration make it a valuable tool in various industries. However, further development and refinement can unlock even greater potential for this technology, expanding its applications and improving its performance.

5.2 The future of work

1. Create a virtual reality capable of scanning and taking measurements at the same time

2. The use of more accurate and smaller materials, controls and parts to make it less weight and more durable

3. It becomes possible to perform a scan of any shape and size at a lower cost

4. Adding the process of saving the data and measurements of the objects to make a comparison every time we measure the body.

Reference

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