Initial Project Document

The University of Central Florida

Department of Electrical Engineering and Computer Science

Dr. Samuel Richie

Senior Design I

Portable 3D Scanner

Group 10

Members and Sponsor:

1. Jean Cestin (Computer Engineering)
2. Sergio Arciniegas (Computer Engineering)
3. Rayan Hamada (Computer Engineering)
4. John Paszynski (Electrical Engineering)

1. Introduction

With the introduction of automated vehicles, celestial observations and many other ventures in which humans must begin to rely on sensors in order to not only understand the world better around us, but also to interact with it. The use of sensors and cameras are beginning to be imperative for our development and progression as a society and species. The ability to drive a vehicle in and of itself was a major feat for humans, going to space and landing on the moon was even more monumental. All of these feats would have been impossible without the use of sensors and being able to model our environment in a 3d manner in order to be prepared to navigate the world around us. Currently the production of automated vehicles has become somewhat of a fashionable trend, but underlying it, is the necessity to begin to find ways to optimize our interactions with the environment and find a way to understand it better. Currently a major advancement in the industry is the use of lidar sensors, which enable us to develop a 3d model of the targeted area. This is imperative when it comes to automated vehicles as it allows the vehicles central computers to model the surrounding environment relatively as accurate, and even better, than what a human eye would be able to determine. This is also very interesting as lidar uses light, in order to model these areas which results in a very fast collection of data which is needed especially if it is for a vehicle that will be traveling upwards of 70-80 mph for most places in the US. This is especially noted by Velodyne CEO, Anand Gopalan, that “If lidar can become small and low-cost, [it will help] create a safe system." (Writer, 2021)

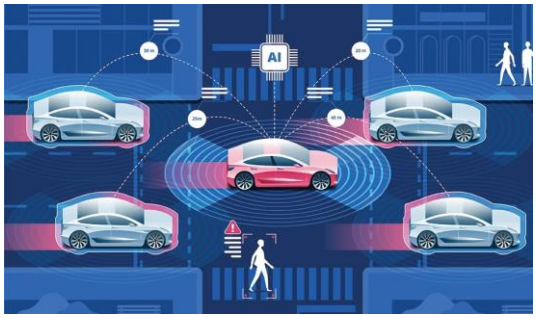


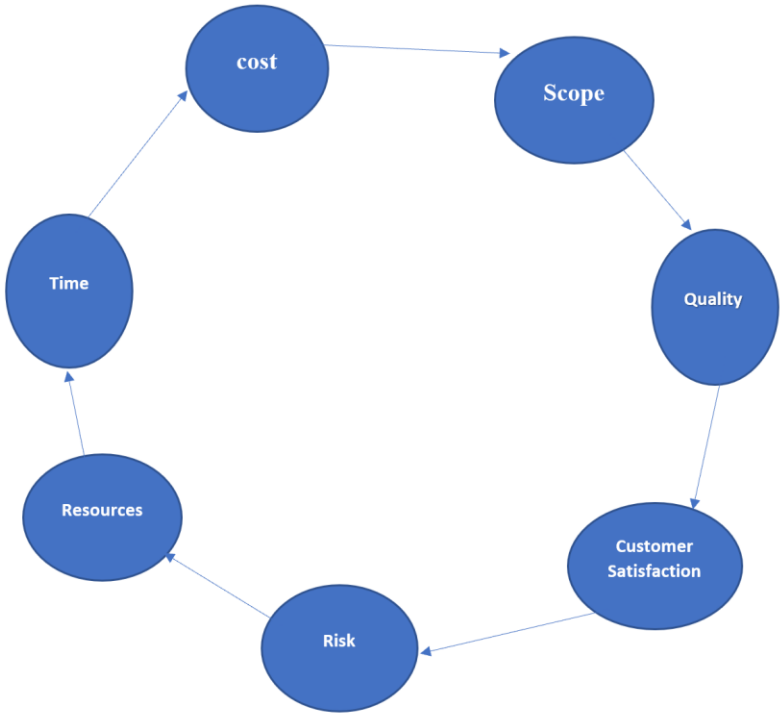
Figure 1 demonstrating the use and interaction of sensors in a self driving vehicle. (Taylor-Smith, 2019)

Currently the market for scanners that can create a 3d model can cost easily up to $3000. Our group is motivated to find a way to build a reliable and efficient scanner that can also model 3d, but with a way lower cost. We feel that this is important as it can allow a lower barrier of entry for people that are interested in this area of study, which would deem positive for the overall advancement of modeling. This would allow for advancements in space exploration, automated vehicles and even in certain medical practices with nanotechnology.

2. Specifications

- The device should operate handheld and transmit data wirelessly to a PC.
- The device should be no longer than 15 inches in length.
- The device should not weigh more than 10 pounds.
- The device should not cost more than $400.
- The device shall contain a power supply, wi-fi transmitter, and microcomputer.
- The power supply must supply more than 2.4W of power given the power consumption of the camera.
- The device must have an interactive button to capture images as well as an I/O switch for power.
- The device shall not capture during server upload.
- The device may be semi portable (e.g backpack power)
- The software should include:
    - Web IP address interface
    - Depth slider manipulation
    - Data Storage
    - Delete/Export images files
    - Remote capture

3. Project Constraints



As shows in the block diagram above we can say the constraints are the live cycle of our project. Therefore, if there is a change in any of the constraint, we have that will affect the others. So, our project will have 7 constraints to follow.

1. **Cost:**

   This constraint is our main key to the project because the device has a maximum price which is $400. That is why as sponsors of the project we have a budget maximum which is $400. We will try to find a way to incorporate as much functionality, in the most optimal microcontrollers and sensors we will find. Additionally, one of the motives for this project is to combat the already expensive existing 3d scanners that exist in the market which run well into the thousands of dollars range.

2. Scope:

For scope of our Project, this device should be able to capture a physical object in 3-dimentions and shape it into the computer. The user should be able to store this on a secure host, where they will be able to edit/delete scans that are taken and have a way to export them for use on external applications as well.

3. Quality:

The high quality of the device will be expected to be very user friendly, light weight meaning less than 11 pounds, and cost no more than $400. The device will be expected to be durable, as we understand the fact that the sensors and MCU could be prone to damage due to the extensive use that the device will have. We will also be focusing on safety, as the device will have electrical components and we will ensure that our focus will prioritize a user-friendly and safe device.

4. Customer Satisfaction:

This is one of the most important part for our project. Our devices should meet all the requirements that the customers expected. The device should satisfy all the qualities mentioned above another to satisfy the constraint of the customer satisfaction.

5. Risk:

Risk, another to be successful with the project there are some risks we should assume and prepare for those risk, for example, getting the parts delivery late, losing team member of the project, losing parts while testing them. Trouble-shooting our programs and test the device extensively to have a clear understanding of its limits, and whether those will be appropriate enough for the final product or if we must modify it so that there is a less of a risk of the device to stop working for whatever reason and is long-lasting.

6. Resources:

The resources will user for this project are the internet, us as the developers, microcontroller, camera, and electricity. We will also attempt to utilize a server, whether it will be an AWS or google cloud platform to initialize a host to receive the scans and allow the client to be able to view their scans, but also export them. The group will also utilize messaging services like discord and zoom in order to communicate, and we will also be sharing a google drive and a GitHub repository in order to ensure efficient modifications to our work and be able to have our work streamlined to one another.

7. Time:

As for time, it is the length we must compute the project, test the device and get it ready for the presentation. Therefore, this device should be ready for presentation by the end of the fall semester which is mid-December 2021.

Timeline:

Month	Milestone
May-June 2021	Form Groups Decide on topic/project scope Get approval for project Submit initial 10 page paper
July-August	Research project info Create Project report Finalize Project Documentation Begin Senior Design Project
September-October	Initial production of the device Develop software connecting device to a PC Create user interface for device
November-December	Implement 3D rendering to the Interface Debug and product test Finishing Touches

4. Design

4.1 Block Diagrams

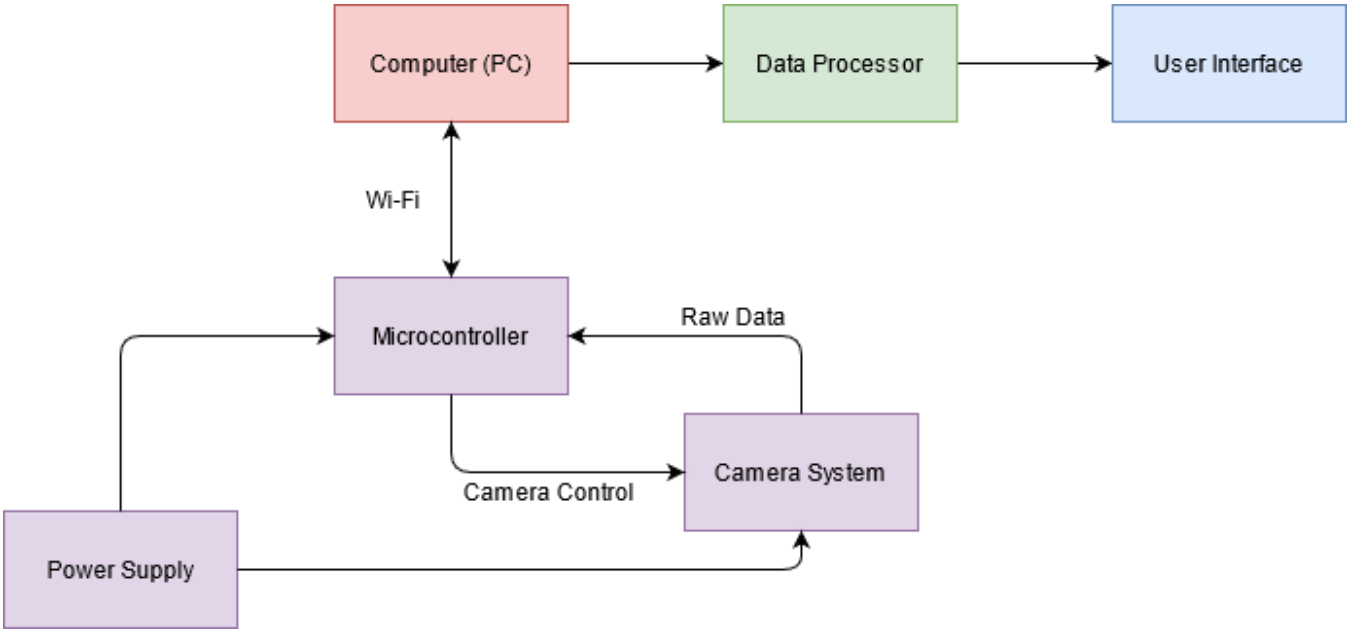


Figure 2: Block diagram for 3D scanning device

Jean Cestin	
Sergio Arciniegas	
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Figure 2: Team Responsibilities for Block Diagram

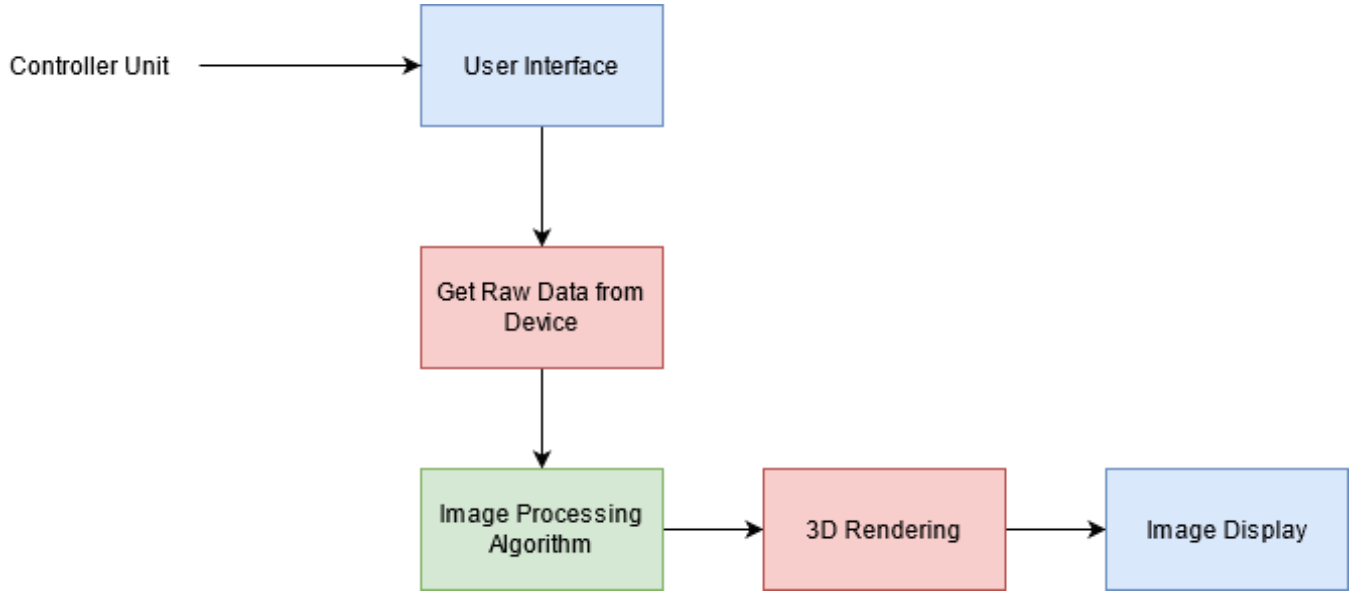

Figure 4: Software block diagram for 3D scanning device

4.2 Block Descriptions

Microcontroller: The microcontroller controls 2 parts of the system. First and foremost, it interacts with the user to allow them to start/end the scanning process using an interactive button. Once scanning is initialized and completed, the data is sent back from the camera to the microcontroller where it is sent to a remote PC via Wi-Fi

Power Supply: The power supply unit is a simple DC power supply that provides power to the camera, microcontroller, and any hardware components so that it may operate independently as a handheld device.

Camera System: The camera system uses a 3D camera that is able to provide depth image as well as color imaging. Therefore, it is possible to use these features for background removal for the purpose of 3D modeling objects.

Data Processor: The use of the data processor is to collect and manipulate the raw data provided by the device/hardware so that it can be interpreted by the software. The data processing unit separates images, removes background and noise, and then reconstructs the image into a 3D model.

User Interface: The user interface is a software package that permits the user to manipulate depth sliders within the captured image so that it may be cropped from in front or behind the object to get an accurate scan. The interface will have an interactive 3D viewer as well as a file manager for unwanted captures.

5. Budget

Description	Model Number	Quantity	Estimated Cost	Total Cost
Micro-controller	STM32F4DISCOVERY	1	$19.50	$19.50
Wi-Fi	STM32F4DIS-WIFI	1	$30.00	$30.00
Camera	Orbbec Astra	1	$149.99	$149.99
Power Supply	Tenergy 31003	1	$18.49	$18.49
Power MOSFET	2N6756	1	$3.00	$3.00
			Grand Total:	$242.97

Sources:

Taylor-Smith, K. (2019, April 19). *What is a LiDAR Sensor?* AZoSensors.com. https://www.azosensors.com/article.aspx?ArticleID=1110.

Writer, S. (2021, May 30). Cheaper lidar sensors brighten the future of autonomous cars. Nikkei Asia. https://asia.nikkei.com/Business/Automobiles/Cheaper-lidar-sensors-brighten-the-future-of-autonomous-cars.