Group #9

Initial Project and Group Identification

3D Laser Scanner Motorized System

Project Members:

- Gabriel Akenten (EE)
- Franco Zavagnini (CpE)
- Naovfal Rihani (EE)
- Nirav Kotadia (CpE)

- **Project Narrative:**

3D Scanner that will make 3D model of everyday object with some precision. More accuracy is better (width, height, length). It increases the effectiveness working with complex parts. Also can be used for reversed engineering with precise digital model of the objects to be reproduced. Collected 3D data is useful for a wide variety of applications such as movies and video game. Also, it can combine use of 3D scanning and 3D printing technology which allows the duplicate of physical objects. Since the fields of application are many, there are different types of 3D scanners based on different technologies but most of them are too expensive. Our goal is to make inexpensive and reliable 3D scanner for small objects.

There are many different approaches to 3D scanning, what we want to build is ideal for short-range scanning (<1 meter). Also, known as Laser Triangulation 3D scanners. It uses a laser line to scan across an object. A sensor picks up the laser light that is reflected off the object, and using trigonometric triangulation, a computer (program) calculates the distance from the object to the scanner. By knowing the angle which lesser point to object and angle between camera and laser, we'll be able to calculate the distance from the laser source to the object's surface. By fixing the laser and camera to fix position. To get the 3D view of the object we have to rotate the object on its y-axis.

- **List of Specifications and Requirements**

  - **CONTROLLER SEGMENT:**

    Various functions exist for the controller including sending informational data to computer for processing and data to the motor in order for the circular platform to rotate about its center.

    For appropriate input combination an analyzer is introduced and connected to the controller as an output. For accuracy, more inputs are introduced to check the correct match on the logic analyzer and consistent high data check is done using the analyzer.

  - **MOTOR SEGMENT:**

    Obviously the motor needs enough power to turn it on and have the ability to rotate the object of interest. 200-300mA of current and ±10-11 V of voltage is an ideal requirement. Angle of rotation is varied by 1.6 to 1.8.

A voltmeter is used to find the output voltage from the motor. This is achieved by placing the voltmeter to the motor leads. The current is measured from the ammeter in series with the motor

A critical stage is connecting the function generator to the motor driver part. Doing this, determines angle of rotations from the stage (object to be placed on for rotation). Noted spots are made on the stage with varying objects. Angle of rotations are achieved after running the function generator with respect to the noted spots.

- **LASER SEGMENT:**

With varying length, the laser beam is scattered onto a vertical line. Approximate single layer beam spread could be from 30cm to 80cm.

Visible line is highly achieved over the 80cm line. Reflected LASER signals are collected and sent through a fire wire card to the computer and by means of Sensor Image Outputs.

- **POWER SEGMENT:**

Optimum power supply must be achieved to supply enough power to all the parts.

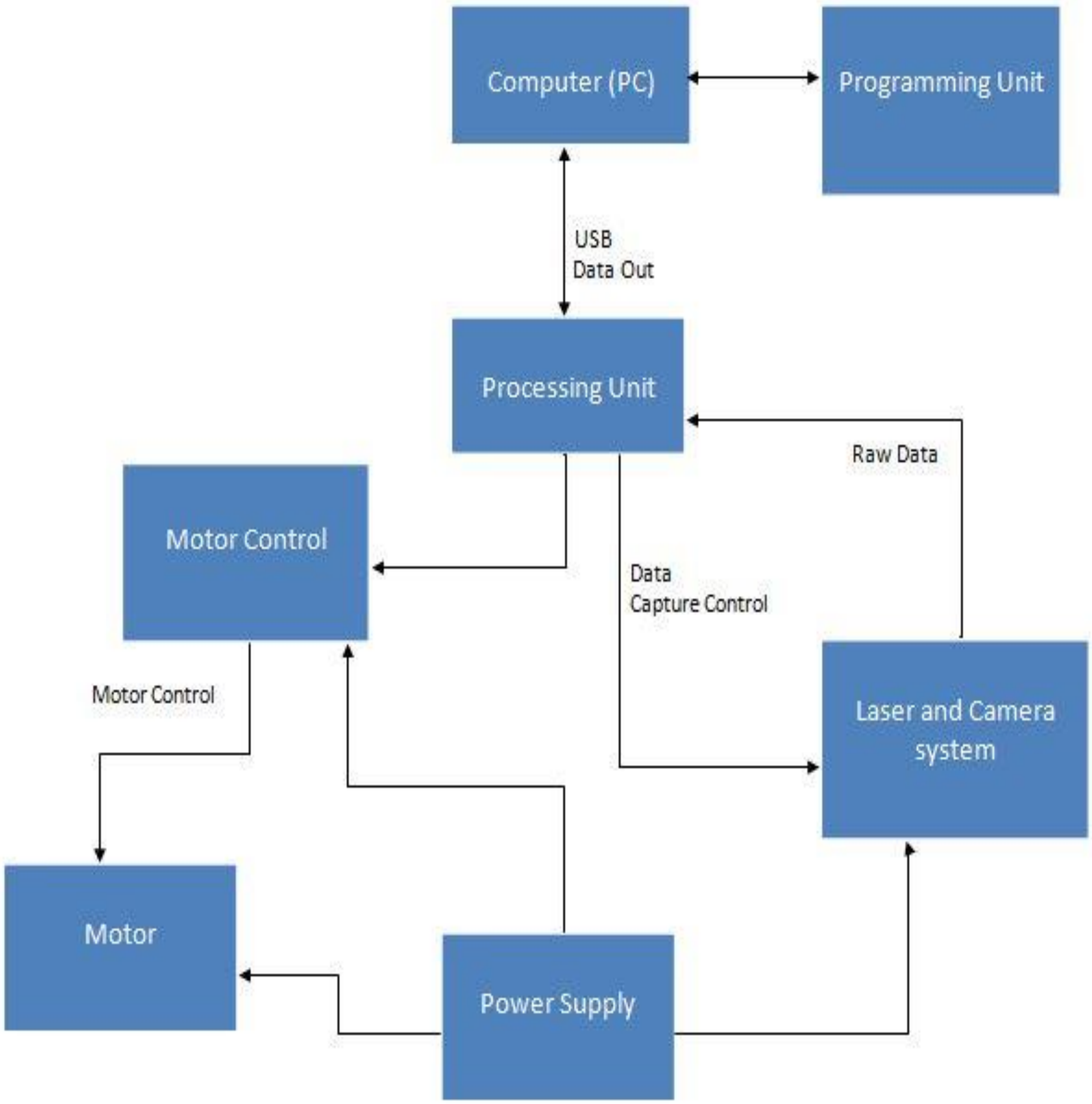
1. 3-4V and 2.5-3.3mA for LASER
2. 2.3-3V and 7-9mA for camera analog power
3. 1.5-2.0V and 9-12mA for camera digital core
4. 10-30V and 350-400mA for motor driver supply

To achieve sufficient voltage and current supplies, the voltmeter is connected to the power segment and adjusted till the required measurements are achieved. This step is done for open circuit analysis.

For the closed loop analysis, a resistor is connected across the laser power segment and using a voltmeter, the voltage is determined. From Ohms law, the closed current can be achieved.

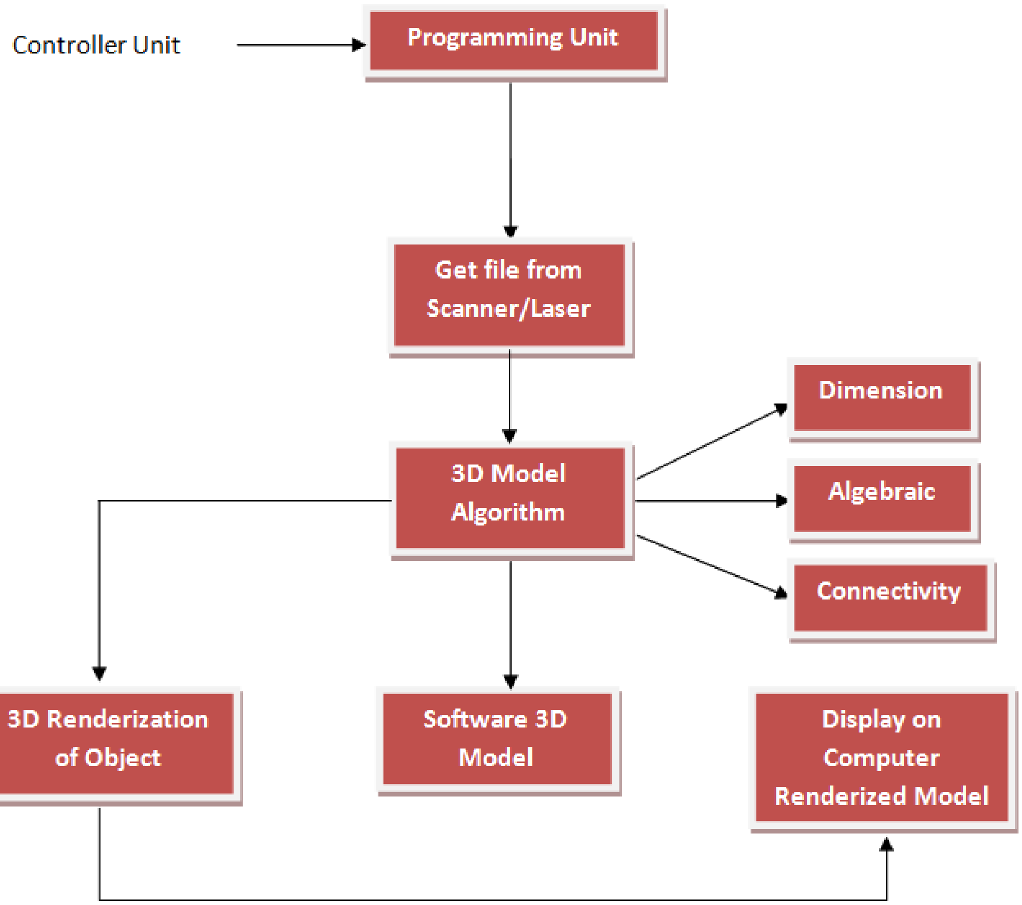
Using the same analysis, the open circuit voltage and closed circuit current can be achieved when the voltmeter is connected across the camera segment. Same steps are used for motor supply power and the motor driver logic power.

- **Block Diagram**



- **System Block Diagram**

➢ The Control and Processing Unit is in charge of getting the images from the camera and sensor in order to process them. We plan to process the images in a computer software which can model 3D objects like Autodesk Maya or Autodesk 3ds Max. The Data Capture Control will be in charge of getting



- The Motor System Unit will be in charge of moving or rotating the platform in order to get every possible angle of the object to be scanned by the laser/camera.

- The Laser and Camera Sensor Unit will be in charge of scanning the object and send it to the Control and Processing Unit in order for it to process and output it to the computer software.

- **Project Budget Estimate and Financing**

Budget and Financing

First, the base of our budget and finances discussion starts with the initial amount of money we want to put into this project. Based on the regular book budget for textbook in the two semesters of the senior design class, we get about $200 each, totaling $800 for all four of the members. This is an arbitrary amount, and only after our cost analysis we can talk about allocating a higher or lower amount. This analysis will be mainly focused on the parts we will need for this project.

- **Parts**

First, our main mechanical component would be the platform and the outer casing which will be around $40 and a stepper motor connected to the rotating disc/platform. An adequate model can be found for about $15 on hobbies stores for the stepper motor. It's of the type of bipolar rotating motor, using two-phase induction to provide a high enough torque for our needs. Also, this is the part of the final device that will be the most power consuming, the LASER and camera, and control module needing a much lower power input. The safe bet is then to choose a power supply that is the most adequate to our rotating device.

After some research, it is found that a 40watt, 12Volt classic power supply, of type PS1, is enough to fully power the stepper motor and have extra power for the rest of the components. It is again sold for about the same amount of $15 in multiple online stores. The next thing to think about is the LASER. One of the requirements are, like in most projects of this kind, a bright red LASER color. This makes the point-camera detection easier, both for initial accuracy and later for testing and calibrating the device. The wavelength for this would then be 650nm according to a standard spectrograph. The laser will be stationary so we will not worry about controlling or sending information for now, so the requirement will be stability and enough power. Knowing that a standard "fun" laser pointer is about 5 mw power, a 20 mw 650nm is a good choice for our application, powerful enough no matter what size our final model will be. LASERs of this caliber can be found online for about $30 for an industry-reliable model.

Next up is the camera. While we taught of using a regular webcam to have a quality product to provide reliability to our project. A more generic, hobby-oriented camera will provide more options when it comes to hands-on installing and testing. The extensively used OV7670 is a VGA camera that would do the job of detecting a red line in the dark, and for now the resolution is optimal. If we do well with this resolution in the testing phase, we may want a higher quality product and increase the resolution, and we would then think about getting a more sophisticated camera. But for our initial needs, this standard camera that we can acquire for about $10 online will be enough.

Additionally, we taught about adding another camera to improve efficiency of our module, and in this case we would just get another camera of the same type, but this again will be decided on a later stage of our design project. To control all of this, we have the choice between analog controls and digital. While we still haven't decided which one to use, the members experience in embedded systems will lead us to opt for a digital microcontroller for our project. We will need to control the mechanical rotating part, which should be an extensive job, as well as processing out images captured before sending them over to a laptop for calculations and 3D model creation. A medium scale microcontroller of the Atmel At mega type will be enough processing power and a good challenge to program. The microcontroller itself would be about $10, which would go into our custom PCB. We can get a good Printed circuit board for about $80 including shipping with companies like 4PCB.com.

Different circuit elements would be available through the various university's labs that we have access to, but we would allocate a variable amount, predicted at $40, for different parts of out circuit, like special capacitors, transistors, digital modules like flip-flops, voltage regulators and such elements. We also predict various hardware and connectors like USBs and wires to not exceed $20 in total cost. Last, we have the casing and esthetic elements Now for the parts that members most likely already have and do not require extra budgeting include a soldering iron and a dedicated laptop that runs MATLAB, a necessary program that will be extensively used for prototyping and testing as well as multiple steps of 3D model processing.

- **Other Expenses**

Besides parts, others things that would require budgeting include software. While most of us have access to MATLAB, we will need extra programs for 3D modeling to take us from point clouds to 3D models. A safe bet allocation for purchasing these programs would be about $250, although we will try to find ways to minimize that. Another aspect to consider is training. These specialized programs might require dedicated and complicated ways of operation that could go beyond regular coding skills. These could also be just an accelerated way to master the programs to move on with optimizing our project. Training one or two members of the team can be very roughly estimated at $150.

- **Financing**

The money we will come up with is expected to be from the personals funds of the four members of the group as discussed earlier, like if it was regular textbook money to dedicate to college classes. Although, an option not to ignore completely is to be sponsored by a company that could finance our project in exchange for improved university relations or extensive publicity, that could attract potential clients and qualified employees. This is however an option not to rely on for now, but to definitely keep in mind as our project goes on.

Part	Cost
Circular Platform	**$40**
Stepper Motor	**$15**
Camera	**$15**
Laser	**$30**
Power Supply	**$15**
Cables	**$20**
PCB/Controller Unit	**$90**
Resistors/Capacitors/Transistors	**$40**
Software	**$250**
Training	**$150**
Computer	**Varies**
Total:	**$635**

So we come to a total estimate of $635 which will bring up to a total of $158.74 per person. Hopefully, we will not have to spend more than $800 which was our initial thought. However, this can vary as we go along the two consecutive semesters.

- **Project milestone for both semesters (Summer 2014 - Fall 2014)**

EEL 4914 – Senior Design I

Idea Finalization	05/23/2014
Initial Documentation	05/27/2014
Research Platforms	June
Stepper Motor Research	June
Camera Research	June
Laser/Controller Unit Research	June
Power Supply Research	June
Subsystem Integration	End of June
Design/Write	July
Finalize Design	2nd and 3rd Week of July
Paper Due	07/31/2014

EEL 4915 – Senior Design II

Design Confirmation	Third Week of August
Order Parts	Third Week of August
Build and Test Platform	September - October
Build and Test Stepper Motor	September - October
Install and Test Camera	September - October
Test Laser/Controller Unit	September - October
Install Power Supply	September - October
Subsystem Integration Testing	October - November
Testing/Debugging	November
Final Testing and Debugging	Early December
Presentation	December