Open Source LIDAR

Project Proposal

Light Seekers

Gaurav Bhalla

Yile Chen

Aamhish Rao

Paul Roy

Department of Computer Science

Texas A&M University

02/22/2022

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1 Executive summary (1 page; 5 points)

We are working with a research group to create a novel LIDAR system. LIDAR is a new technology that has many applications in various industries such as automotive, forecasting and GIS/GPS modeling. It uses time of flight principle to map out the surrounding areas. A laser is shot out and then sensed on the way back; based on the time difference we try to create a model of our surrounding environment.

The problem is that the research group is having issues with the MEMS mirror used in their LIDAR system. Commercial products do not have non-uniform sampling rate, so the research group has tasked us with creating a LIDAR system that can be programmed to have non-uniform sample rates and also be re-configurable. In all the various LIDAR sensors we looked over in our literature review none had the capability of non-uniform sampling. Being reconfigurable means that the system can be configured to work with a motorized spinning mirror or a MEMS mirror. The MEMS mirrors create low and high speed areas of sampling. Since the research group's mirror is not working properly, our main goal is to copy the MEMS mirror capability without using the MEMS mirror.

Overall, we want to help the research group to create novel LIDAR that can be configured and programmed to suit their research's needs. The first objective is to recreate a working LIDAR system based on the OpenTOFLidar project. We will follow the designs and schematics in that open source project to build the LIDAR from scratch and test its capabilities, and practice non-uniform sampling. Then we will develop a final design that is reconfigurable to work with a MEMS mirror or motorized spinning mirror system in addition to the non-uniform sampling capability.

2 Introduction (1 page; 20 points)

LIDAR stands for Light imaging detection and ranging. The technology uses varying light waves and the times it takes for reflected light to come back to the sender to create an image of the surrounding areas. There are various use cases for this technology; creating high resolution maps, navigating spaces for self-driving vehicles and even measuring the dimensions of large objects.

The most common use case for LIDAR is creating large high resolution maps of large space. One instance of this is using bathymetric systems to map out sea floors. This is done by shooting two different rays which map both the ocean surface and also piercing the water to map out the seafloor. Using various wavelengths of light we can map out agricultural fields in order to find specifics about the field; including insect activity, estimated yields and weed control. This is especially useful because we are able to take metrics of large spaces and directly measure soil metrics without having to only sample subspaces and also to not damage specific landforms. LIDAR can also be extended to the atmosphere and determine information about cloud cover, humidity, ice crystals and so on.

Another common use case for LIDAR is for autonomous vehicles. For instance, LIDAR sensors can be used in tandem with the conventional camera sensors in order to detect obstacles during driving. This can be especially effective as the use of two sensors covers the "blind" spots of either individually. This method of using both 2d and 3d imaging together has been proven to work better than when only the 3d score is used.

Finally the technology can be used for measuring or mapping large objects. This can be used to measure and study older growth forests and has several future applications in preservation of older forestry. Another use case is in archeology. LIDAR can be used to create digital maps of archeological sites revealing measurements that other models such as aerial photography cannot measure.

LIDAR is generally measured from a variety of crafts. This can be a sensor strapped to a drone in order to measure large swaths of land, or a set of sensors on a moving car. Another example is using a stationary scanner to create point clouds of the area around. This can be paired with conventional cameras to create a full mapping of surroundings.

2.1 Needs statement (5 points)

We are given a repository with a schematic for how to create the LIDAR scanner. Our first goal is to recreate this system first resulting in a working model of the open source LIDAR.

The research group uses a MEMS mirror which is difficult to use. Yet the MEMS mirror is useful as it can move in a manner which creates low and high sampling areas. We aim to try to mimic the MEMS mirror to create a non-uniform sampling rate.

2.2 Goal and objectives (10 points)

The primary goal of this project is to work off of an open source repository to create a working LIDAR scanner and to use the data collected to map out the surroundings. Our secondary goal is to improve upon the working model on sampling and access.

In terms of sampling we aim to mimic the MEMS mirror using a rotating mirror of some sort. This will create a non-uniform sampling of the environment. On the other hand we also aim to better access. This can be done by creating a reconfigurable system; in which we can easily swap out the MEMS mirror for a spinning mirror.

2.3 Design constraints and feasibility (5 points)

We have around four to five months to finish this project. The largest bottleneck that we can foresee at this point is the one brought on by the need to ship for parts from various suppliers due to the supply chain being backed up. This can further contribute to issues as if we have an error in the parts we order we will need to reship before we can begin work again.

Financially we have allocated a budget of 700 dollars, which we can adjust if necessary. We don't foresee needing to update this budget.

3 Literature and technical survey (1-2 pages; 10 points)

- Luminar Iris [10]
    - https://www.luminartech.com/products/
    - 120 degree FoV, 26 degree dynamic vertical FoV
    - 600m max range, 250m at <10% reflectivity
    - High data fidelity, 1cm range precision, high precision reflectance
    - camera like resolution, >300 points per square degree
    - Detection and tracking
        - road & drivable space: 80m
        - lane markings: 150m
        - objects & vehicles: 250m

- Environmental
    - dust&water ingress: IP69k
    - Vibration: ISO 16750-3
    - Shock: IEC 60068-2-27

- Ouser OS0 [11]
  - https://ouster.com/products/scanning-LIDAR/os0-sensor/
  - All-weather performance
  - 3D perception in fog, rain, dust, and snow
  - Ingress protection
  - Low temperature cold start function
  - Shock and vibration specifications
  - Designed for 100,000 hours of continuous use
  - IP 68/69K rugged, waterproof
  - robust to shock and vibration, and temperature rated from -40 ºC to +64 ºC.
  - Vertical resolution: 32, 64, 128 channels
  - Horizontal resolution: 512, 1024, 2048
  - range: 120m
  - vertical FoV: 45 degree
  - precision: ±0.7 – 5 cm
- Velodyne Alpha Prime [12]
  - https://velodyneLIDAR.com/products/alpha-prime/
  - Best horizontal (360°) and vertical (40°) long-range sensor
    - 10% targets >300m typical
    - 5% targets >180m typical
    - Ground plane hits >90m typical
  - High resolution (0.2° x 0.1°) and point density at full frame rate
  - Strong performance with retro reflectors & sunlight
- Innoviz Innoviz360 [13]
  - https://innoviz.tech/innoviz360
  - Detection Range: 0.3m-300m
  - Maximum Angular Resolution (HxV): 0.05°x 0.05°
  - Maximum Field of View (HxV): 360°x64°
  - Programmable Frame Rate: 0.5-25 FPS
  - Configurable Scanning Lines: 300-1280 Lines per Frame

- Ingress Protection: IP6K6K, IP6K9K, IP6K7
- Operating Temperature: -40°C to 85°C

- Quanergy M1 LIDAR Sensor [14]
  - https://quanergy.com/products/m1/
  - angular resolution of 0.033°
  - 360 degree coverage
  - Range: Detect objects up to 200m at 80% reflectivity,
  - Point Cloud: Up to 75% more data per second
  - Rated up to IP67 against dust and water ingress

Compared to the commercial products mentioned above, our design may not be the best in terms of technical specifications. These products were designed and developed by professional engineers with abundant time and resources provided to them, therefore exceeding the performance of our LIDAR design in terms of resolution, range, point cloud density, and ingress protection. However, our proposed design is sufficiently complex for the scope of this project and should be able to meet the expected goals. It can provide programmable sampling rate, it is re-configurable for testing and can be used to emulate other commercial products.

4 Proposed work (35 pts)

4.1 Evaluation of alternative solutions (1 page, 10 points)

- OpenSimpleLIDAR [15]

Designed by the same creator of the OpenTOFLIDAR of which our group is basing our main product design based off of. However, the OpenSimpleLIDAR does not meet the structure requirements of the design for the LIDAR system we need to design. Specifically, the structure does not allow for us to place the MEMs mirror and the motorized spinning mirror easily with modifications to the design. In the OpenTOFLIDAR's design, the motorized spinning mirror provides a desired design to redirect the laser light source in different directions. With the OpenSimpleLIDAR, spinning the laser and the sensor itself would not meet the design requirements to mimic the MEMs mirror movements to spread the laser's light in different areas. In the OpenTOFLIDAR project, we are able to easily modify the 3d printed platform and PCB to allow for placement of the MEMs mirror and a motorized spinning mirror. The system with the motorized spinning mirror can be configured by Mr. Di Wang and his fellow researchers to mimic the sample rates of different commercial sensors for testing purposes.

- Xaxxon's OpenLIDAR [4]

While the Xaxxon's OpenLIDAR has a clean and compact design, it does not allow placement of the motorized spinning platform in its smaller design. So, we would need to significantly modify the 3D printed platform. The photodiode and the laser components appear to be attached to each other. In order for the design to be used, we would also have to replace the laser and photodiode parts used in the design. This could take significantly more time than with the OpenTOFLIDAR as we would need to manage great changes in the PCB and 3d printed platform design.

- OSLRF-01 [3]

The OSLRF-01 is an open source photodiode sensor and laser module. Creating a PCB and 3d printed platform from the ground up to work this open source TOF sensor would take much more time than modifying the OpenTOFLIDAR design.

- TIDA-01187 [5]

The TIDA-01187 is a Texas Instruments LIDAR distance processor but does not include the laser and photodiode sensor. So, while it can process the return signal bounced off the object into a distance measurement that can be read in a laptop, it does not have the actual laser and sensor to send and receive the light. Choosing the specific laser and sensor to work with the TIDA-01187 system would take time. In general, the TIDA-01187 system is more appropriate and cost worthy for commercial applications and not for the testing scope of our project.

- Open Source LIDAR - Unruly [2]

The design of the Unruly Open Source LIDAR is too small and does not allow for flexibility like the OpenTOFLIDAR design. The photodiode sensor and the laser are attached to each other and would need to be replaced with another photodiode and laser modules that can be separate and configured correctly with a MEMs mirror, the motorized spinning mirror on a 3d printed platform. Moreover, creating the 3d printed platform would take significant time in comparison to modifying the existing 3d printed platform from the OpenTOFLIDAR design.

In general, the commercial LIDAR TOF sensor modules were not considered because a non-uniform sampling rate to mimic other TOF sensors for testing purposes cannot be achieved with them.

4.2 Design specifications (3-4 pages, 20 points)

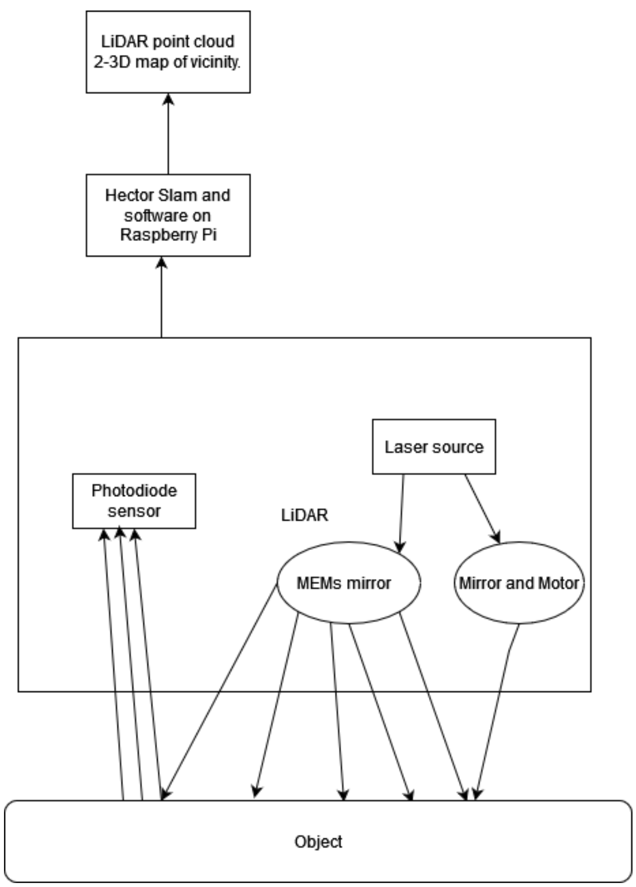
The following is a list of components that are on the block diagram below:

LIDAR Point Cloud: The LIDAR Point Cloud would essentially be the final product of our project, this would be a point cloud that would show the objects surrounding our LIDAR system and could then be used for systems such as autonomous driving or other autonomous motion.

HectorSlam/ROS Software: This layer would take the data from the LIDAR system and convert it to the LIDAR Point Cloud mentioned above using the HectorSlam software.

Laser Source: The laser source is the main component of the LIDAR and is used to track the object.

MEMs Mirror: The MEMs Mirror is an alternate to the traditional mirror and motor method of LIDAR



and is electric and has the motor built into the mirror.

Mirror and Motor: The Mirror and motor are used to move the module around so that the laser can capture all of the objects in the environment. The motor will continuously be moving around so that new objects will be detected in real time with little to no blind spots.

Object: The objects we are trying to track in the environment. The system will come together as one in order to track the objects in the environment.

Photodiode sensor: The photodiode sensor is used to detect the light being reflected from the laser upon contact with the objects that are being detected in the environment.

The electronic components such as sensors and power components will be soldered together using a service, while the physical components will be 3D printed and constructed together. We also plan on using a Raspberry Pi and have the LIDAR module that we are constructing to be wired to that. The software will all be running on the Raspberry Pi and we will have the data readable on a screen or through a laptop with VNC enabled to see the Raspberry Pi display.

We have two alternate methods for the mirror and motor aspect to the project, we can either use a MEMs mirror which would essentially have the two components together or use a traditional motor and have a 3d printed mount which would mount the mirror to the motor and spin around. We will be using both methods and testing out which one would be better.

The overall system will have a fair amount of room for flexibility as we can add components as needed to the LIDAR module and additional motors if needed to the 3d printed design. The only issue is the processing time for getting components and having them assembled through the service as that is done in China and so due to this we are not planning on making many alterations upon the initial send off.

4.3 Approach for design validation (1 page, 5 points)

Validation is a very important part of our process in order to make sure that our sensors are properly functioning. Our validation approach will be to check the performance of our system against another LIDAR sensor. We will let two LIDAR systems measure the same room and cross check the dimensions created.

Another potential way to validate our system is to directly measure an object and validate the LIDAR system using the base truth physical model. This way of validation is best for our initial prototype rather than whatever we create later on. We can directly measure the length of a wall and the crosslist against the measurements the LIDAR sensor decided.

In terms of benchmarking the system, there are certain specs we aim to meet in order to be satisfied with our product. For instance we would like to meet a certain sampling rate and scan speed. This is based on the

We can also in general try to approach our mentors for guidance and check through them in an informal manner. Due to their specific domain knowledge they can comment on the quality and legitimacy of our work. In addition they can also give us pointers or corrections on our evaluation process.

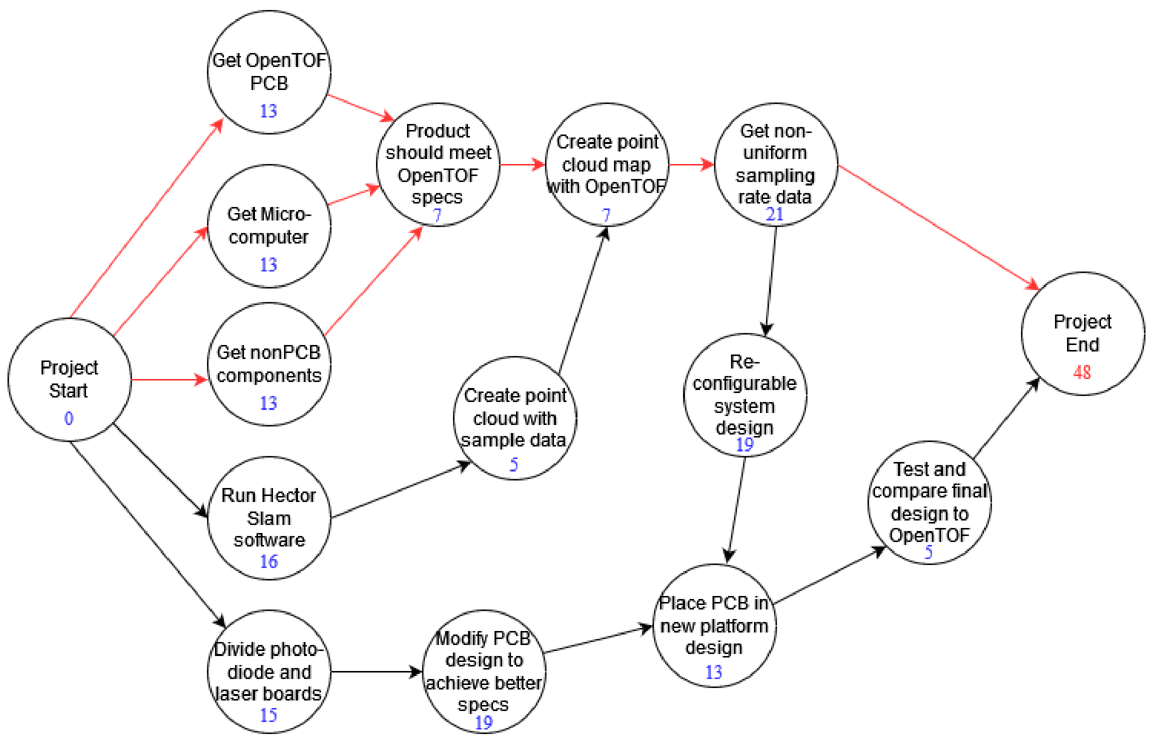
5 Engineering standards (25 points)

5.1 Project management (1 page, 10 pts)

- Gaurav Bhalla has a specialization in Electrical Engineering and has experience in competitive robotics teams and so has opted to be the Electrical Lead for the project
- Aamhish Rao has spent time working on Robotics projects both in competitive and noncompetitive environments in the past and also has industry experience in sensor fusion and has experience with 3D printing and CAD so has opted to be the Mechanical Lead but has also would like to work with the data signal processing and aid with electrical work as necessary later in the project
- Allen Chen has industry experience working in software development and competition experience with Robotics so has opted to work primarily in the software scope for the project and serve as the co-lead.
- Paul Roy has industry experience working in software development and so has opted to work primarily in the software scope for the project and serve as the co-lead.

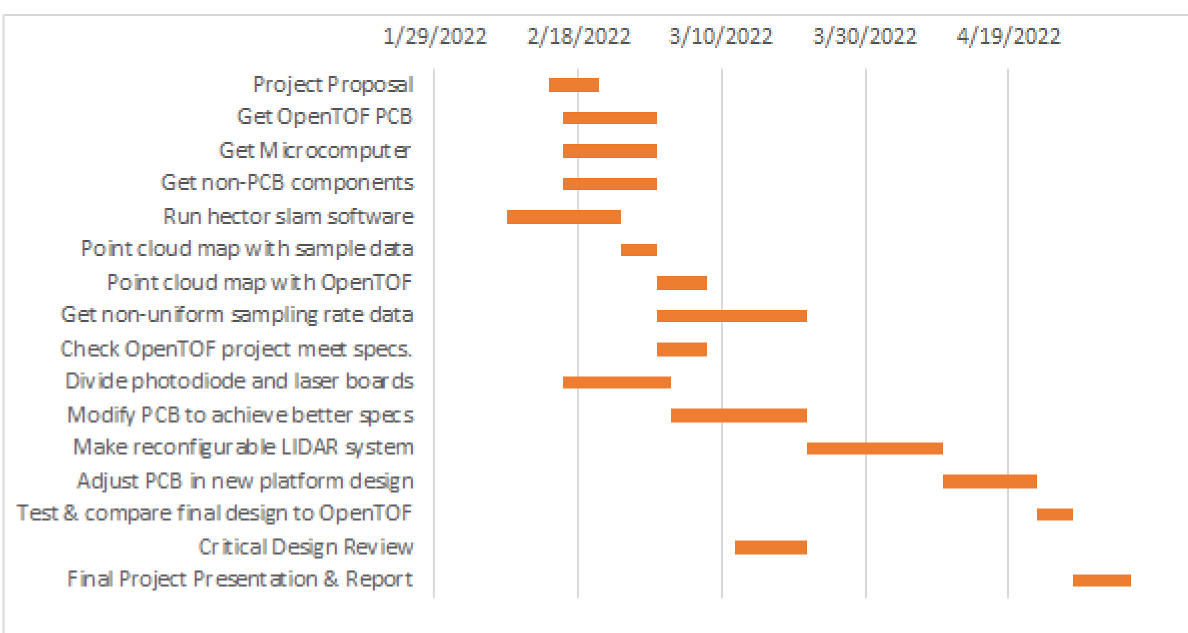
5.2 Schedule of tasks, Pert and Gantt charts (1 page, 5 pts)

<u>Critical Path Method:</u>



Please note the numbers in the tasks represent the approximate number of days needed to complete it. The red arrows indicate the critical path.

<u>Gantt chart:</u>



5.3 Economic analysis (1/2 page; 3 pts)

Currently, it would be a lot more expensive to manufacture our project due to the fact that we are just making one board, and we have to get it shipped out to vendors outside of the country to get them manufactured, however if we were to have a deal with a plant either overseas or within the country and to order bulk quantities of the PCB and plastic components then it would be far cheaper for us to manufacture each sensor. We are also currently using a Raspberry Pi, but we can also switch to a cheaper system when we learn about the specifications that we need for the project and work accordingly and if we have something off-brand then we would also be able to save money as the Raspberry Pi name itself is expensive by itself. The motors can be bought from a cheap vendor as well, as nothing is specific to our project and any old motor would do the job. Overall, the only components that would be looked into are the PCB and plastic components as those need to be customized for our exact purpose but if we order in bulk, it should be fairly scalable and relatively cheap and the other components can be bought cheaply from various vendors that can be found all around the world.

5.4 Societal, safety and environmental analysis (1/2 page; 2 points)

Having an open source LIDAR is impactful for society as it opens up a new way to attain autonomous driving. Currently many automakers rely on either camera or radar driven systems which are not that reliable which has called for many to think of alternatives that may be more accurate which draws into question the usage of LIDAR for these systems. Now this would actually be better in terms of privacy as LIDAR can not record video as vision systems can.

Potential safety concerns may be accidentally hurting oneself with the electrical shock and the motor but both can easily be avoided.

Environmentally speaking, we may run into some pollution issues when making the PCBs and other boards but to minimize it, we can ensure to only produce the sensors in bulk to minimize wastage and pollution concerns.

5.5 Itemized budget (1 page; 5 pts)

	No.	Name	Retail Price $	Description	Taobao Price ¥	Note
PCB components	1	AD500-8	$10.00	Chinese Avalanche photodiode (proved	65	
	2	SPL PL90_3	$12.00	Pulsed Laser Diode	59	
	3	MAX3658	$4.40	Transimpedance Amplifier (22$ for 5 pcs)	30	
	4	ADCMP600 x 2	$9.40	Fast Comparator, two IC	20	
					38	
	5	UCC27511DBVR	$1.50	Mosfet Driver	23.8	10 pc
					100	
	6	TDC-GP21	$6.60	Time-to-Digital converter IC	12.5	
	7	STM32F303CBT6	$5.20	MCU	53	
	8	DRV11873PWPR	$3.50	DLDC driver DRV11873	40	
				DLDC driver DRV11873 (China, 1$)		
	9	BSZ165N04NS G	$1.30	Fast MOSFET	2.5	
	10	Additional PCB components	$7.00		50	
	11	PCB Itself	$2.00	4 Layer PCB, price for 5 boards (<50x50mm)	15	
	12	Photodiode Lens	$9.00	Lens, CS mount, 25mm focal length, F1.2	28	
	13	CS lens holder	$2.00	Holder for CS lens	1.5	
	14	BLDC motor	$2.00	BLDC, outrunner, 20mm diameter, KV > 200	4	

15	Scanning Mirror	$3.00	Customized shape, Alum, front surface mirror (12$ for 4 mirrors)	10	
			soft mirror	30	
16	Stand-offs	$3.50	25mm M3 Hex Stand-off x 8, price for 20pcs	8	10 male
				1.5	5 female
17	Laser lens	$7.00	25mm M12 F2.0 lens (Free delivery)	30	
				18.5	
				18	
18	Laser lens holder	$3.00	Plastic holder, 10mm height, 20mm hole distance (price for 10pcs)	1	
				1	
19	M12 lens adapter	$1.00	Price for 1pcs	1.2	
				3	
		$93.40	**Note - this total price is calculated without delivery price**		
		$62.90	PCB components including PCB, without delivery	664.5	
_1_	[AD500-9 TO52S1F2	$27.00	Chinese Avalanche photodiode (NOT proved but similar to AD500-8), TO-52 package, interated interference filter	149	with filter
				108	without filter

_1_	[MTAPD-07-013]	$23.65	Original Avalanche photodiode (proved), 3-LCC package	205	
	Interference Filter	$8.00	Optional Interference Filter, 905 +-10nm		
	Interference Filter	$13.00	Optional Interference Filter, 905 +-5nm, Free delivery	120	diameter 11.5 mm, thickness 1mm
				20	alternative
				602	

Detailed budget of all costs expected to be incurred during the project (e.g., parts, fabrication services).

6 References (4 points)

[1] iliasim, “OpenTOFLidar.”https://github.com/iliasam/OpenTOFLIDAR. (accessed Feb 02, 2022).

[2] L. Developer, “Open source lidar - unruly,” Hackaday.io, 20-Jan-2019. [Online]. Available: https://hackaday.io/project/163501-open-source-lidar-unruly. (Accessed Feb 20, 2022).

[3] LightWare LaserRangeFinder Manual.”https://www.documents.lightware.co.za/OSLRF-01%20-%20Laser%20Rangefinder%20Manual%20-%20Rev%203.pdf. (Accessed Feb 12, 2022)

[4] Xaxxon, “Xaxxon OpenLIDAR,” *Xaxxon OpenLIDAR sensor*. [Online]. Available: http://www.xaxxon.com/xaxxon/openlidar. (Accessed Feb 20, 2022).

[5] Texas Instruments TIDA-01187 LIDAR-Pulsed Time-of-Flight Reference Design Using High-Speed Data Converters https://www.ti.com/tool/TIDA-01187 (Accessed Feb 15, 2022)

[6] ROS Robot Operating System https://ros.org/ (Accessed Feb 17, 2022)

[7] Iliasam. “Homemade lidar: OpenTOFLidar” https://habr-com.translate.goog/ru/post/485574/?_x_tr_sl=auto&_x_tr_tl=en&_x_tr_hl=en (accessed Feb 17, 2022)

[8] ROS Wiki. “hector_slam”. http://wiki.ros.org/hector_slam .(Accessed Feb 20 ,2022)

[9] STMicroelectronics. “Datasheet - STM32F303xB STM32F303xC”.https://www.st.com/resource/en/datasheet/ stm32f303vc.pdf .(Accessed Feb 12, 2022)

[10] Luminar Tech. “Products”. https://www.luminartech.com/products/ .(Accessed Feb 7, 2022)

[11] Ouster. “Os0 Sensor”. https://ouster.com/products/scanning-lidar/os0-sensor/ .(Accessed Feb 7, 2022)

[12] Velodyne Lidar. “Alpha Prime”. https://velodyneLIDAR.com/products/alpha-prime/ .(Accessed Feb 7, 2022)

[13] Innoviz Technologies. “ Innoviz360”. https://innoviz.tech/innoviz360. (Accessed Feb 7, 2022)

[14] Quanergy. “M1 Lidar Sensor”. https://quanergy.com/products/m1/ .(Accessed Feb 7, 2022)

[15] iliasim, “OpenSimpleLidar.” https://github.com/iliasam/OpenSimpleLidar. (accessed Feb 02, 2022).

7 Appendices (1 point)

7.1 Product datasheets

https://github.com/iliasam/OpenTOFLIDAR [1]

https://www.ti.com/tool/TIDA-01187 [5]

https://www.documents.lightware.co.za/OSLRF-01%20-%20Laser%20Rangefinder%20Manual%20-%20Rev%203.pdf [3]

http://wiki.ros.org/hector_slam [8]

https://habr-com.translate.goog/ru/post/485574/?_x_tr_sl=auto&_x_tr_tl=en&_x_tr_hl=en [7]

https://www.st.com/resource/en/datasheet/stm32f303vc.pdf [9]

7.2 Bios and CVs

Gaurav Balla

Gaurav Balla is senior at Texas A&M currency pursuing a degree in Computer Engineering with a minor in Mathematics . He has a wide variety of experience in robotics, chip design and software design. He has worked as a software engineer at Parkland Center for Clinical Innovation and as a ASIC validation researcher at Texas A&M. This wide berth of experiences have given him a large range of skills and expertises to draw from. Most Recently he placed in the Aggies Invent competition hosted by the NSA for a solution for pedestrian and cyclist accidents using artificial intelligence, infrared sensors and microcomputers. Currently he is a resident advisor at A&M creating a safe and welcoming environment for all students.

Gaurav Bhalla

Email: gauravbhalla990@gmail.com | Phone: (972) 363-6331 | LinkedIn: www.linkedin.com/in/gauravbhalla9

Personal Website: https://gauravbhalla990.github.io

EDUCATION

Texas A&M University, College Station, Texas

Bachelor of Science in Computer Engineering - Electrical Engineering Track — *May 2022*

Minor in Mathematics — *Cumulative GPA: 3.5*

Related Coursework

Electricity & Magnetism, Circuit Theory, Analog Design, Radio Frequency (RF) Design, Digital Design, Advanced Computer Architecture, Operating Systems, Microprocessor System Design, CMOS VLSI design, Data Structures & Algorithms, Communications & Cryptography, Programming in ARMv8, C, C++, Java, Python, and MATLAB.

Skills Summary

Extensive experience with electronic test bench equipment; doing analog and digital design on a breadboard; electron microscopes parts and techniques; analyzing Printed Circuit Board (PCB) layout files through Autodesk EAGLE; doing PCB connection validations with a multimeter; soldering, and welding; using embedded systems such as ST Microcontroller boards; using LTSpice, PSpice, NI Multisim, Cadence, Verilog HDL, Google Sketchup, Tinker CAD, Linux, C, C++, Java, Python, SQL, HTML, JavaScript, CSS, Git, and GitHub for projects; and basic RF engineering practices.

Practiced collaborating, documenting and presenting for projects with Microsoft Office, and Google Drive tools. Maintained good driving record since high school. Also, participated in leadership, logistics, mentoring and conflict resolution experiences as an Engineering Peer Mentor and then Resident Advisor. Lived and studied globally, and learned conversational French, intermediate Hindi, and basic Spanish.

TECHNICAL EXPERIENCES

Aggies Invent NSA 3rd Place Winner, Team Sensory Overload — *Sep. 2021*

https://engineering.tamu.edu/news/2021/09/first-in-person-aggies-invent-in-two-years-hosted-by-national-security-agency.html

- Developed a solution for pedestrian and cyclist accidents at a 48-hour hackathon in a 6-member team.
- Designed a model that detects objects through sensors and informs the user through vibration motors on the user.
- The model applies artificial intelligence, real-time data from users and Google Maps to predict dangerous areas.
- Built working prototype with only materials from team: Arduino, wires, 2 Piezo buzzers, 2 breadboards, 1 infrared sensor, 1 ultrasonic sensor and a battery pack.

Application Specific Integrated Circuit (ASIC) Validation Researcher — *Aug. 2020 – Mar. 2021*

- Graduate student previously designed ASIC designed to detect alpha particles.
- Validated a custom Printed Circuit Board designed to interface the ASIC to a computer via an Arduino Mega.
- Analyzed the PCB layout file with EAGLE and addressed functional issues.
- Developed an Arduino program to provide stimulus to and receive data from the ASIC.
- Solved logic-level voltage compatibility issue with 74LVC245 Logic Level Voltage Shifter chip.

Software Engineering Intern, Parkland Center for Clinical Innovation — *Jun. 2020 – Aug. 2020*

- Developed a full-stack MVP web application with Flask, HTML, CSS, and JavaScript.
- Followed the OAuth2.0 protocol to implement the Azure AD REST API which authenticates company users.
- Deployed on an Azure Linux VM with the Gunicorn WSGI and Nginx reverse proxy servers.

W5AC Amateur Radio Club — *Oct. 2019 – Present*

- Passed FCC Technician licensure exam so am licensed to communicate over certain frequency bands.
- Currently working on testing for the amateur radio general and extra licenses.
- Building gradually more advanced iterations of a crystal radio.
- Introduced to Radio Frequency (RF) concepts at a Keysight Technologies seminar and from a club textbook.

LEADERSHIP

Resident Advisor — *Aug. 2021 – Present*

- Creates inclusive community on 1st floor of a dorm through planned events and individual mentoring.
- Monitor halls, performs room inspections, and ensure residents' compliance with dorm policies.

Engineering Peer Mentor — *Aug. 2019 – March 2020*

- Collaborated with Resident Advisors to mentor 1st year engineering students in a dorm.

Corps of Cadets — *Aug. 2018 – May 2019*

- Learned time management, perseverance, self-discipline, rational thinking and leadership skills.

Aamhish Rao

Aamhish Rao is a student at Texas A&M currently pursuing a degree in Computer Engineering. Aamhish began attending A&M in 2018 and quickly became involved in the department by becoming a Peer Teacher for some early level classes and instructing students on learning programming. Soon he joined the 12th Unmanned Auto Drive Team and used technologies such as RoadRunner to help map out and simulate for testing purposes. In addition, he has done research at the Real Time Distributed Lab working on a flask app and web page visualization. He soon became the VEX U Team's software lead and sponsor chair, helping to write software for the robots that won the State competition and was a World semifinalist in 2019 and 2021. Most recently he has worked at both JP Morgan Chase and Tesla as an intern, working on both autonomous driving systems and chatbots respectively.

AAMHISH RAO

aamhish@gmail.com | 908.635.3816 | Looking for Full Time Roles

EDUCATION

Texas A&M University — College Station, TX

B.S. in Computer Engineering (**Cumulative GPA: 3.2/4.00**) — May 2022

Relevant Coursework:

CSCE 221: Data Structures & Algorithms | **CSCE 313**: Computer Systems | **CSCE 451**: Reverse Software Engineering
ECEN 248: Intro to Digital Systems | **ECEN 350**: Computer Architecture | **ECEN 325**: Electronics
CSCE 314: Programming Languages | **CSCE 315:** Programming Studio | **ECEN 314**: Signals & Systems

SKILLS

Java, C/C++, Python, JavaScript, Swift, Bash/Git, OpenCV, ROS, ARMv8, System Verilog, Solidworks, Soldering, Latex, JIRA

EXPERIENCE

Tesla Inc. — Palo Alto, CA

Hardware Engineering Internship – Data Signal Processing — September 2021 to December 2021

- Developed an **evaluation pipeline** to handle vehicle clips and **translate** raw sensor readings to **meaningful** graphs and numbers
- Conducted **data analysis** using **Python** and **sensor fusion** for object detection and tracking systems present for **Autopilot**
- **Integrated** software stack into the Tesla vehicle and address **integration** issues
- Tested vigorously to ensure peak performance by the vehicle's **autonomous driving** system

J.P. Morgan Chase & Co. — New York City Metro, NY (Remote)

Software Engineering Internship – Consumer & Community Banking — June 2021 to August 2021

- Developed **Python RASA** chat bot with integration for internal APIs to serve as an aid for developers on the firm
- Utilized **UML** Diagrams and flowcharts to map out the structure of the bot and different paths that the user can follow
- Integrated chat bot with **Java HUGO** websites for ease of access from common webpages that they would be on
- Participated in daily stand up meetings with the team to discuss changes with the project and update **JIRA** tickets accordingly.

Software Engineering Internship – Global Technology Infrastructure — July 2020 to August 2020

- Created a **React, Flask,** and **MySQL** driven website in a four-person **Agile** development team for ECDI, a small business incubator
- Ran server and front end on a **Linux** server using **AWS** and made app accessible on the Internet for those authorized
- Attended meetings and socialized with members of the firm and also presented my project to a group of ~**25** JPMC employees

VEX U Team WHOOP — College Station, TX

Software Lead / Sponsor Chair — September 2018 to Present

- Helped write the software for the two VEX **Robots**, which **won** the States in 2019 and was the **finalist** in 2020 and was a Worlds **semifinalist** in 2019 and 2021
- Worked on a state-machine **C++** API for the robot, and code for both an autonomous period and remote-control period of the robot
- Calibrated and helped develop **Computer Vision** software for an auto-aim feature of the robot, ran on a **Linux** microcomputer
- Created and configured **PID** loops for the Robot for both **precise movement** using **encoders** as well as to keep the robot **straight** using a **gyro**
- Documented robot software development, which was about **45 pages of a 110 page book**, and won the **Excellence Award** in 2019
- Communicated with different companies including **Texas Instruments** to present to our organization and provide **sponsorship**

Real Time Distributed Lab @ Texas A&M University — College Station, TX

Student Technician — April 2021 to August 2021

- Managed Web Server **Python Flask App** for Research Project involving **Blockchain encryption** and its application in the real world
- Contributds with teammates on odd tasks involving other components of the project including **webpage visualization** of I/O

Texas A&M University — College Station, TX

Peer Teacher for ENGR 102 — August 2019 to Decmber 2019

- Taught **50** students the basics of **Python** by supplementing professor instruction throughout the duration of the semester course
- Held office hours in which students asked for help on comprehending course material and programming assignment guidelines
- Graded weekly homework, written quizzes and programming assignments as well as the written final examination for the course

12th Unmanned AutoDrive Team — College Station, TX

Researcher | Team of 10 — August 2020 to May 2021

- Researching autonomous cars paths and algorithms and simulating them on the **Carla** autonomous car simulation platform
- Created maps using **RoadRunner** to test out different situations and then exporting to **Carla** for testing purposes.
- Created a **RoadRunner** map for the Texas A&M RELLIS Campus, which is in use by the school's **AutoDrive** team

Yile Chen

Yile Chen is a student at Texas A&M currency pursuing a degree in Computer Engineering with a minor in Mathematics. Yile began attending Texas A&M in 2018 where he quickly became involved in various projects. He created a Robot Perception System with the Robomaster Robotics Club which consisted of creating and training machine learning models to detect robots and then accelerating performance on the hardware. As a personal project he created a pipeline which recognized basketball poses based on shooting pose similarity. He has done research in two different universities; at A&M he researched Time Series Outlier Detection Systems, and at the Hong Kong university of Science and Technology he researched heart rate modeling using machine learning on multiple different exercises. Most recently he has worked as a software engineering intern for Nvidia accelerating their facial recognition pipelines.

YILE CHEN

yilechen17@tamu.edu | 415-341-5851 | yileallenchen1.github.io
305 Marion Pugh Dr, College Station, Texas, 77840

EDUCATION

Texas A&M University — August 2018 – May 2022
B.S. in Computer Engineering — GPA: 3.97/4.0
Minor in Mathematics

Selected Coursework: Machine Learning, Computer Graphics, Artificial Intelligence, Robotics, Operating Systems, Computer Architecture, Data Structures and Algorithms, Linear Algebra, Differential Equations

PROFESSIONAL EXPERIENCE

Nvidia — September 2021 – December 2021
Software Engineering Intern, Drive IX Team — *Santa Clara, CA*

- Accelerated training speeds by **8x** by implementing PyTorch multi-GPU training for face identification pipeline.
- Optimized evaluation pipeline to run **90%** faster, debugged issues in pipeline and brought to running state.
- Investigated correlation of training data size and model performance, discovered ideal range for best trade off.
- Developed a pipeline to generate synthetic images containing depth information of simulated driving scenarios.
- Generated **10x** more synthetic depth images for research/product teams to train 3D depth perception models.

Arm — June 2021 – August 2021
Software Engineering Intern, Infrastructure Performance Team — *Austin, TX*

- Learned JavaScript/React and developed web app for convenient visualization of performance benchmarks.
- Implemented frontend/backend API calls, visualized performance benchmarks with Jupyter Notebooks.
- Learned to use Node JS and JSON server middleware to develop mock backend for testing frontend.

RESEARCH EXPERIENCE

DATA Lab — May 2020 – May 2021
Texas A&M University — *College Station, TX*

- Advised by Professor **Xia Hu**
- Research focus: **Anomaly Detection, Data Mining, Machine Learning Systems**
- Developed and tested data processing and ML modules for Time Series Outlier Detection System (TODS).
- Scripted automated unit tests and achieved near 100% code coverage in responsible portions of code.
- Designed and implemented pipeline module APIs for easy and efficient user access.
- Utilized Orange data mining toolkit to design GUI and integrated backend pipeline with frontend interface.

HKUST-DT System and Media Laboratory(SyMLab) — June 2019 – August 2019
Hong Kong University of Science and Technology (HKUST) — *Hong Kong, China*

- Advised by Professor **Pan Hui**
- Research focus: **Data-driven Systems Design, Data Mining, Bioinformatics**
- Researched heart rate modeling and prediction of running exercises using machine learning methods.
- Performed experimental comparison and analytics on 5 different models on outdoor running dataset.
- Performed comprehensive evaluations of models with single step, multi-step, and whole session prediction.

Paul Roy

Paul Roy is a student at Texas A&M currency pursuing a degree in Computer Engineering. He began attending A&M in 2018 where he quickly joined various projects to work on. First he joined the sketch recognition laboratory where he worked on detecting the behavior of people based on telemetry data from smart watches. As a personal project he also created several machine learning models which would detect whether or not a patient had Oral Cancer based on histopathological images. He has also worked with Essentium 3d printing to research the market for PCBs for quick modeling and prototyping. He also worked for a startup company called Ostrum tech and helped create their cloud pipeline. Most recently he worked for a company called Credera in developing applications which can analyze user interaction in real time to provide statistics to the main client.

PAUL ROY

Computer Engineering (2022) Searching for Full-Time/Internship

CONTACT

PHONE:
832-263-1571

LINKED-IN:
www.linkedin.com/in/paul-mathew--roy

EMAIL:
Paulmathew.roy@gmail.com

COURSEWORK

Data Structures and Algorithms
Artificial Intelligence
Machine Learning
Computer Systems
Statistics
Design Process

AWARDS

1st Place FBLA Statewide Conference
2nd Place Regional Orthodox Speaking Competition
1st Pl Coding Wars Ranch
National Merit Scholar and Honors
Honor Roll (4)

CITZENSHIPS

-US Citizen
-Canadian Citizen
-Indian Oversea Citizenship

HOBBIES

Programming(Personal Projects)
Long Distance Running
Backpacking

EDUCATION

Texas A&M (GPA 3.3)
August 2018 – May 2022

SKILLS

Various Programing Languages (**C++**, **Python**, **Java**, HTML, CSS)
Certified in **Google Analytics, AWS Certified Cloud Practitioner**
Experience with Linux/Unix, FPGAs and ARMv8
Proficient in Microsoft Office (**Excel**, SharePoint, PowerPoint, Outlook)

WORK EXPERIENCE

TXON CLOUD SYSTEMS/Ostrum Tech
June 2021 to Dec 2021
Worked on various start-up projects using AWS tech. Designed and deployed websites for start-ups. Worked on solutions to make air travel more accessible for older and disables passengers.

SEC Direct Internship (Essentium 3d Printing)
June 2020 to Aug 2020
Reviewed and researched potential markets in electronics for a 3D – Printing company specifically working with graphene inks used in PCBS and embedded electronics.

Aspire College Station – Leasing Agent
June 2021 to Dec 2021
Presented and leased properties to a variety of clients, achieving an above market occupancy rate. Led a team of maintenance staff during property turning.

PROJECTS

CPU Ray Tracer
Created a fully functional multi-threaded ray tracer which supports multiple lights and various shapes. Has support with attenuated lights, multiple lights, reflections, and refractions.
Sketch Recognition Research
Worked with a team of researchers on using human-computer interactions (sketching, movement, biodata) to make inferences on people's actions. Various data and machine learning tools such as Pandas, JSON, Seaborn.
Neural Networks
Created various prediction models in **Python.** These were implemented for a variety of projects including breast cancer analysis and sentiment prediction of tweets.