SEDS Chapter Grant Proposal

Section I: Chapter Information and Project

Chapter: University of North Carolina at Chapel Hill

Members: 60

Semester Technical Project: Design, build, and program a rover to navigate through our Physics and Mathematics building completely autonomously.

Motives: Because UNC does not offer an official engineering program, we wanted our SEDS chapter to serve as the platform for our members to not only develop, but implement, appreciable technical skills that are actively used within the scientific and engineering communities. Specifically, this includes learning AutoCAD and microcontroller programming with Arduinos. By hosting a semester technical project, we are able to create an environment of mutual learning for skills like designing, prototyping and programming. Besides these specific skills, our independent and time-strict project requires our members to develop general skills including self-teaching, time management, group-work collaboration and division, all aimed at ultimately helping members to better understand the real-world nuances of engineering.

Meeting Structure: Officially, our organization meets twice a month each for two hours. The meeting structure is outlined below:

1. Our meetings begin with a president-lead, 30-minute educational lecture dedicated to some technical facet of the space science industry. Former topics have included the history of NASA, the mechanics and theory behind rocketry, and the science of LIGO. The lectures are designed specifically to cater to both a technical and non-technical audience to ensure we are advocating the space sciences to the broadest audience possible.
2. Following the technical lecture, our chapter hosts a “This Week in Space” mini-series, where a member from the executive team presents a 10-minute presentation of approximately three-to-five popular science articles detailing current developments in the space science industry. Our most recent segment included the recent announcement of SpaceX’s spacesuits for those to board the Dragon capsule, and a recent study highlighting the increased resistance of bacteria aboard the International Space Station.
3. Our meetings then enter its one hour and fifteen minute technical breakout sessions where our members divide into two technical groups--hardware and software--to work on our semester technical project (outlined below).
4. We reserve the last 5-10 minutes our meetings to bring the technical groups back together and discuss their accomplishments and outline what they hope to accomplish in their next session. This allows the teams to communicate information about timelines and logistical matters.

Section II: Project Teams

This project is broken down into three technical teams: Software, Hardware, and Executive. The hardware team is tasked with the design and prototyping of the physical rover. The software team dedicates its time to writing the individual processing algorithms for sensors aboard the rover as well as scripting the specific locomotion routines. The executive team serves as the intermediary and logistics team ensuring the other technical teams have similar goals and timelines.

Hardware

Goals: Our hardware team is tasked with first learning the basics of AutoCAD, and then applying those skills for first developing a prototype rover design that can be used as a frame basis for the software team. Specifically, at the third meeting, individual subgroups will each design their own prototype rover that will be 3D printed in UNC's MakerSpace. Pending successful prototypes, the hardware group will then move to determine how to best build a modular rover capable of expansion in future semesters.

Tasks:

1) Teach the outline and basics of AutoCAD to the members of the Hardware team, focusing in on specific abilities to develop a rover. These skills will be used to produce a digital prototype that can then be constructed/printed into the final product once the digital product has been been debugged sufficiently.
2) Determine the best way to integrate each part of the rover coded for by the Software team into a the structure of the prototype. The base will be builded upon to efficiently and effectively contain the aims of the final product.
3) Work with the university Makerspace to develop the constructed prototype in the most price-effective manner. By limiting the number of pieces that need to be made/printed professionally, the cost of the rover can be distributed to other parts of the project.

Software

Goals: The software team is tasked with taking Arduino compatible equipment (boards, servo-motors, ultrasonic sensors, accelerometers, etc.) and designing appropriate locomotion procedures based on the output of this equipment.

Tasks:

1) Design a differential drive routine for this rover. Based on independently operated motors, the team will investigate how to program the rover to appropriately maneuver over predetermined environment or path.
2) A separate tasks involves interfacing with the ultrasonic sensor to determine the distance between the rover and a given object and determining at what point the rover needs to formulate an alternative trajectory. This task also involves the sequential checking and interfacing between multiple sensors potentially controlled by separate arduinos to determine not only an alternative

trajectory but the most productive one. A similar process is to be developed when the object is potentially movable; therefore leading the rover to attempt to push the object out of its path.

3) Familiarize those that identify as beginners and those that have little to no programming experience with the basics of programming. This includes variable declarations, variable types, introduction to logic, loops, etc. This will be done through active learning using a test Arduino. After this, the beginners will be integrated into the more advanced group to begin prototyping.
4) An advanced subgroup is tasked with interfacing with a Raspberry Pi camera, which will be our first attempt at incorporating as SLAM algorithm into the locomotive capacities of the rover. This will allow the rover not only to use object classification schemes to determine viable pathways, but also means for the rover to retain information about the environment it has previously traversed.
5) Our final subgroup is tasked with using the accelerometer to determine at what threshold the rover needs to reverse its motion and consider an alternative path such that it will not rotate or fall over.

Mentors

Each team is lead by three interviewed mentors who were selected based on a technical interview where they were asked to teach a beginning lecture on the software their team would be using (AutoCAD for hardware, and Arduino for software). Their selection was based on the following criteria:

1) Teaching Capability
2) Enthusiasm
3) Accuracy of Information
4) Dedication
5) Personability

The mentors' purpose evolves over time. Specifically, at the onset of the technical project, the mentors aim is to equilibrate the members on the team to the same level of familiarity of the respective software. Once all members are operating on similar levels of proficiency, the members are partitioned into subgroups each tasked with a specific goal for the rover and mentors serve as general advisors and as resources for the member-run subgroups. They are also heavily involved in the logistical planning for the official meetings.

Section III: Project Timeline

Each stage of the project is primarily guided by the progress of both the Software and Hardware teams as they complete and progress through their independent tasks. The Executive team, while managing the administrative aspects of the team, also work with both teams to maintain the pace to ensure the completion of the final product. The present timeline, as follows, is a set of expectations decided upon by all teams collectively through a balance of desired results for the bi-weekly meetings of both teams.

Date	Software	Hardware
August 31st	Interest Meeting	

September 13th	Compiling list of desired supplies to begin prototyping. Introduction to rover project.	Introduction to Hardware team and scope of rover project. First lesson on AutoCAD
September 27th	Work on interfacing with Arduinos, features that are relevant to the rover build, and how to integrate those features into the rover. Start experimenting with motors and sensors and how they will work on the rover.	Small, 3D printed rover body for testing with the software team. Work on mounting motor drives and wheels and outline changes to be made for the next iteration.
October 11th	Complete working with motors and sensors to determine what kind will be used on the final product. Begin working on specific parts of the rover software and how all parts will be integrated together.	Design a rough draft of the rover using AutoCAD. Split into groups designing different modular pieces (i.e. frame, motor mounts, sensor mounts, computer/battery housing, etc.). Troubleshoot rover draft with software team to finalize design requirements.
October 25th	Make the individual pieces of the software more functional with for the rover and begin developing each subgroup program together.	Hardware team will design the final robot components on AutoCAD or in the Makerspace. Once reviewed by the executive team and software team, the design will be sent to be printed/machined.
November 8th	Finalize the single, working program for the rover and begin testing with the hardware prototype.	Assemble rough draft of rover using pieces machined during the previous two weeks. Test for functionality and note any tweaks to be made in the next two weeks.
November 29th	Complete final debugging and integrate the code with the final rover.	Finish all corrections that were noted during the previous meeting. Assemble rover with all final additions and test with software team.
December 6th	Final Project Completed – Presentation to Department	

Section IV: Chapter Leadership

John Martin: Currently serving as President of UNC SEDS for the 2017-2018 school year, John Martin is a rising senior at UNC studying Astrophysics and Music. He currently conducts research with Dr. Dan Reichart developing radio data analysis software for Skynet, UNC's international robotic telescope network. Outside research, John volunteers at the NC Museum of the Natural Sciences and as a teacher for UNC Splash teaching classes on cosmology, relativity, and quantum mechanics.

Gibson Bennett: A rising senior studying Astrophysics and Computer Science, Gibson will be serving his fourth-year on UNC SEDS Executive Board, serving as Vice-President for the 2017-2018 school year. Having conducted research under Dr. Fabian Heitsch and Dr. Dan Reichart, Gibson's prior research includes simulations of the interstellar medium and building a polarimeter to be deployed on one of Skynet's telescopes at Cerro Tololo Observatory. Gibson also serves as a co-president for the UNC Society of Physics Students chapter.

Roark Habegger: UNC SEDS Treasurer for the 2017-2018 school year, Roark Habegger is a second-year studying Astrophysics and Math. Also an active researcher under Dr. Dan Reichart, Roark earned the NC Space Grant to develop the robotic components and software for a polarimeter to be deployed on one of Skynet's robotic telescopes in Chile. He is also a member of Honors Carolina.

Patrick Gorman: The new Council of Chapters Representative Patrick Gorman, is a rising second-year at UNC in Honors Carolina. Studying Biomedical Engineering, Patrick conducts research in data analytics and software development for the biology department. Patrick is excited to work with the SEDS National and local chapters to find new ways to collaborate.

Chase Roycroft: Chase Roycroft is a rising second-year serving as the Outreach Chair for UNC SEDS this year. He is a Physics major with experience in robotics and programing. His goals for the 2017-2018 school year include broadening the spectrum of majors present in SEDS meetings and finding teaching opportunities for SEDS members to share what they have learned with the local community.

<u>Mentors: Hardware</u>

Dan Hirst is a sophomore Astrophysics and Math student from Essex, England. He is acting as Mentor Teacher for the hardware team. He has spent the previous summer teaching Astronomy in Hong Kong, and has led projects in amateur building competitions. As well as this, he is currently doing research with Professor Chris Clemens. He hopes to be an astronaut, but is painfully aware of the state of the British Space Industry.

Mark Tierney is a senior Astrophysics major at UNC that will be commissioning into the Air Force following graduation. With a deep love for all things space exploration, he joined SEDS this year, and jumped at the ability to mentor for the rover project. He has been on robotics teams before and has experience with the impressive products that students can create. He has demonstrated significant engagement and excitement with SEDS' semester project and is dedicated to a physical, functional, final product.

Shengjie Xu is a first-year, first-generation student intending to be a computer science major, while also interested in both electronic and mechanical systems. He's made a hobby out of playing, assembling, and dismantling a lot of of RC/electric vehicles since he was very young, and is excited to build the rover this year with the rest of the hardware team.

Mentors: Software

Nolan Scobie is a Sophomore transfer student majoring in Computer Science. Before coming to UNC, he worked with software company Efficiency Lab in Asheville, NC to develop augmented reality applications for the Microsoft HoloLens. Nolan was a member of an FTC robotics team for four years in high school, and went on to mentor the team for another year after graduating. He prefers to take a hands-off approach to mentoring, and strives to facilitate self-directed learning.

Dylan Dutton is a Senior Astrophysics major whose research is based in radio data processing. He also has a deep rooted interest in instrumentation and robotics, as demonstrated by his two years of software engineering with Skynet. Dylan is excited to work with as one of the primary liaison between the hardware and software teams to ensure all parts will be manufactured in accordance with the software team's needs.

Michael Palumbo is a Senior Astrophysics major at The University of North Carolina at Chapel Hill. He has experience in astronomical data analysis and modeling in Python, MATLAB, and IDL. He is currently completing an Undergraduate Honors Thesis which seeks to examine the evolution of a class of dwarf regime galaxies in the nearby universe. As a mentor of the software team for UNC's division of SEDS, he hopes to expose other young scientists to the incredible usefulness of programming in a variety of disciplines ranging from pure science to robotics. In his free time, he enjoys swimming with UNC's Club Swim Team, of which he is President.

Section V: Budget

Software

Total Cost	**$427.38**		
Category	**Part #/Specifications**	**Price Per Unit**	**Quantity**
Neverest DC Motor	am-2964a	$28	2
DC Brushless Motor		$12.72	4
Wheels		$2.66	8
IMU	Bosch BNO055	$35	1
Ultrasonic sensor		$5.95	4
Arduino Uno		$22.00	2

Arduino Mega		$38.50	1
Adafruit Motor Shield		$17.00	2
M to M Cables		$3.95	3
F to M Cable		$3.95	1
Connector Cable		$3.95	5
Micro Server motor		$5.95	2
Raspberry Pi Zero W		$10	1
Pi Power Supply		$7.50	1
MicroSD 16GB		$8.00	1
Breadboards		$7.99	2
Uno kit		$34.99	1

Hardware

Total Cost	**$500.41**		
Category	**Part #/Specifications**	**Price Per Unit**	**Quantity**
Metal Pegboard Sheet	M-D Building Products 56062 2-Feet by 3-Feet .020-Inch Thick Lincane Aluminum Sheet	$28.75	4
Motors	Dayton 3K771, 1/4 HP, 60hz, Belt	$84.98	2
Phillips Drive Sheet Metal Screws	140 Pieces	$7.99	2
High Performance 50Ft Retractable Extension Cord Reel.		$59.27	1
Wheels	Shepherd Hardware 9613 10-Inch Semi-Pneumatic Rubber Replacement Tire, Plastic Wheel,	$10.10	2
Machine Shop Time		$40.00	3

Total Requested: $927.79