FIRE FIGHTING ROBOT CHALLENGE

Micro Fire Extinguisher

PROJECT PROPOSAL

THE ENGINEERS:

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SPONSORED BY:

SAN DIEGO STATE UNIVERSITY
SENIOR DESIGN PROJECT

SAN DIEGO STATE UNIVERSITY

TABLE OF CONTENTS

1 | INTRODUCTION

1.1 | ABSTRACT

Three SDSU ECE Senior Design teams will partake in the Fire Fighting Robot Challenge. The challenge entails designing an autonomous robot that finds and extinguishes a lit candle located within the provided course - the first floor of the Engineering building - amidst decoys made from LEDs. The team can deploy 100mL of water by any method to put out the flame. However, the water must not come in contact with the decoys. Our desired result is to design the fastest robot that will reliably complete the tasks autonomously within the restrictions.

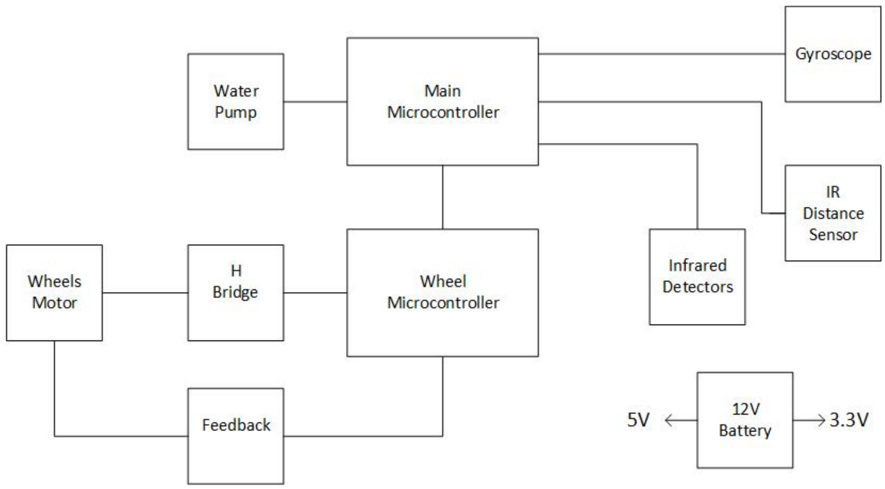
1.2 | PROJECT DESCRIPTION

The main goal of the project is to build, test, and design a robot that will autonomously navigate through the course, find the candle flame, and extinguish it. The Fire Fighting Robot Challenge is modified from Trinity College's renowned event. The challenge consists of two phases. In the first phase, each team will have three runs to complete the course. The location of the candle in phase one will not be changed during the three runs. Scoring will be based on the time taken to extinguish the flame; the best time of the three runs will be kept. A run will not be recorded in the event that the robot bumps into a decoy or sprays water onto it. In phase two, all three teams will compete simultaneously. The winning team of phase two will gain a multiplier coefficient to their score from the first phase. In this phase, the interaction with the decoys is allowed without penalty. In addition, aggressive robotic behavior against competitors will be tolerated with the exception of offensive weapons. In the end, the team with the highest score will be announced the winner.

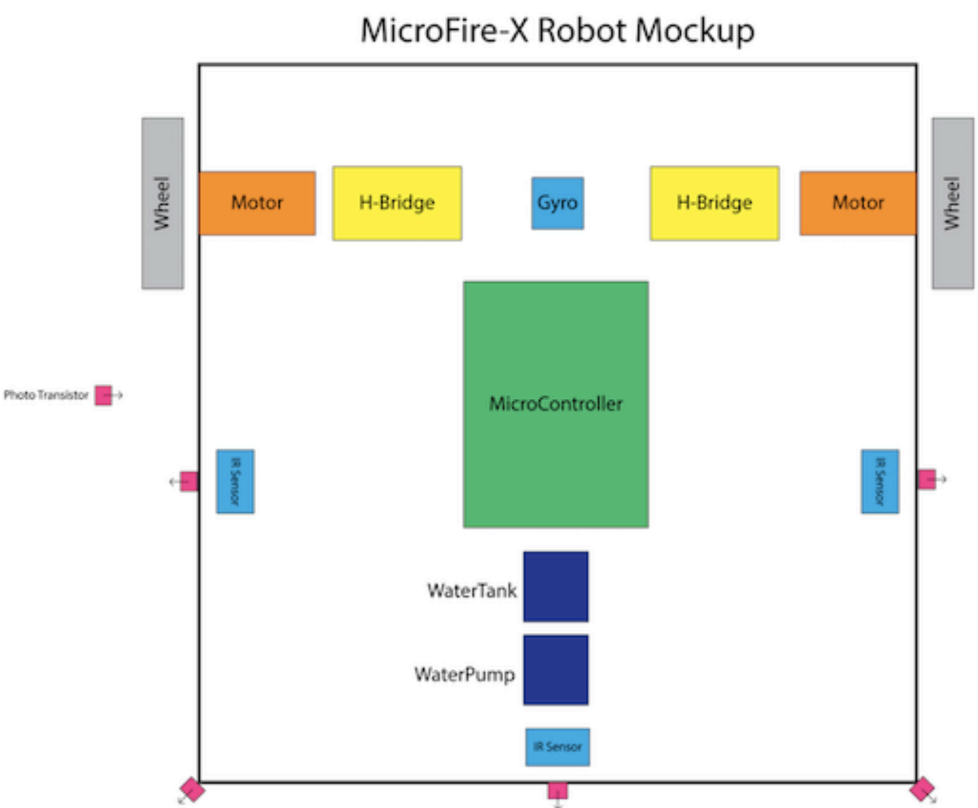
The highest priority in our design is to optimize the robot's speed and sensing precision. To achieve an autonomously fast moving robot, our team will utilize two 12V dc motor with encoders while simultaneously ensuring a design as lightweight as possible. In addition, a ball bearing pivot and gyro will help with stability and rotational maneuvering. The robot will also consist of multiple sensors to efficiently maneuver through the course, precisely sense the flame, and differentiate it from the LED decoys. To extinguish the flame, our team will implement a 12V motor to pump the water via a tube and spray nozzle. Our setup will include two microcontrollers that will control the peripherals - motor encoders, sensors, gyro, h-bridge, and water pump motor – to achieve an autonomous robot.

2 | DESIGN

2.1 | BLOCK DIAGRAM



2.2 | MOCK-UP ILLUSTRATIONS



<u>NOTE:</u> The ball bearing pivot will be placed underneath the front IR sensor. The robot will be fitted on a 420mm x 420mm plate. Blocks are made to scale according to data specifications.

2.3 | PERFORMANCE REQUIREMENTS

The following performance requirements listed below state what our team hopes to achieve:

Navigation:

- The robot must avoid collision with the walls, candle, and other obstacles.
- The ball bearing pivot and gyro must support robot balance and rotational maneuvering.
- The motors must provide a speed of 1.5 meters per second with no load.
- The motors must run at the same speed to go straight.
- The encoders will calculate the distance travelled through the motor tics.

Sensing:

- The IR distance sensors must be able to sense the walls and other obstacles within 500cm.
- The infrared detectors must be able to differentiate the candle flame from the LED decoys.

Extinguishing:

- The water pump motor of 12V must extinguish the candle ten cm away.
- The motor must successfully deploy the water through the tube and spray nozzle.
- There will be no water leakage from the water storage vial to prevent water from spilling onto our electronics.

Brain and Power:

- The 3000mAh 12V battery must power the robot.
- The motors will intake the same current for equal rpm.
- The robot must run autonomously.
- The robot must remember the location of the flame in the first run.
- The voltage regulators must convert the 12V to 3.3V and 5V to supply the microcontrollers and the motors.
- The microcontrollers must extract data from the motors, sensors, and gyro.
- The microcontrollers will provide the necessary actions by following a programmed algorithm.

3 | TESTING & VERIFICATION

3.1 | TESTING PROCEDURES

The hardware components will be tested individually to ensure their functionalities towards our projected goals. For testing purposes, we will begin with the specifications provided from the components' data sheets. Afterwards, we will fine-tune the components according to our design needs. The components will be tested as soon as they arrive.

Motors:
The motors will be connected to a variable voltage source to observe the different rpm based on the voltage input. We will measure the no load voltage and current and the stall current. This will allow us to measure the amount of current being drawn from the motors. We will also observe the effects of increasing the load onto the motor by adding friction, by using a 5-inch diameter wheel and placing in on the ground. The motors will also be tested in conjunction with the H-bridge. The H-bridge will allow us to re-route current to the motors and ensure that they intake the same current for equal rpm.
Sensors:
We will test both the IR distance sensors and infrared detectors according to their data specifications. Tests will be conducted to measure the approximate analog distance that the sensors detect. We will use a sample infrared emitting LED in the test procedure. Afterwards, we will adjust them to meet our design specifications.
Water pump motor:
We will test the motor and see how efficiently water is being outputted with the tube and the spray head connected to reach the 10cm distance mark.
Gyro:
We will test the gyro according to the manual data specifications and fine-tune it to our needs.

3.2 | BENCHMARKS

1. Maximum travelling velocity of 1.5 m/s with no load.
2. Consistent pivot turn (90 degrees right and left and 180 degrees).
3. Capable of detecting oncoming wall and implement deceleration at X distance.
4. Weigh less than ten pounds.
5. Capable of travelling straight for X distance
6. Gyro accurately measures its rotations.

4 | PROJECT MANAGEMENT

4.1 | PROJECT PLAN

Because the project has to be completed within the span of 3 months, efficient management of the project has to be implemented in order to meet our team goals. Thus, it is imperative to maintain a Gantt chart so that the team members can have an overview of the project progress along with its associated tasks and deadlines.

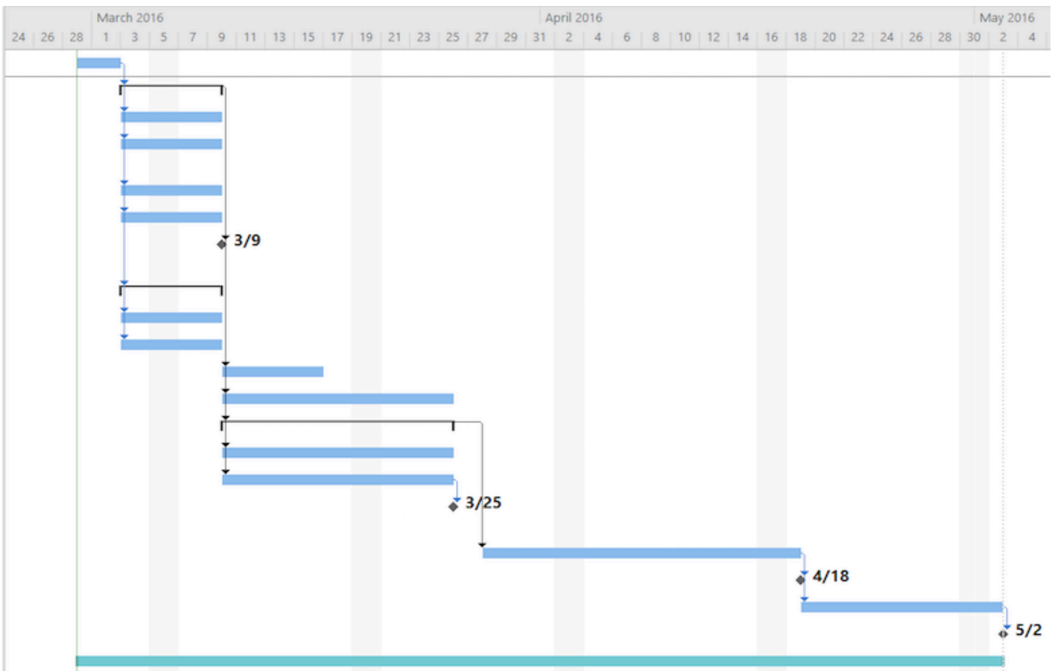
Alejandro will oversee the whole project to ensure that the project goes according to plan. In addition, he will help with any problems that may occur with the process. Andres and Richie will mainly work with the motors and H-bridge. In addition, Andres will work with the sensors. Ed will be in charge of power management. Seimon will ensure a working motor water pump is available. Everyone will contribute to the overall design of the robot. Lauren will be the main programmer for the robot. Although each member is responsible for a component or two, we are free to help each other out, as this is a team project.

Tasking:

	Task Mode	Task Name	Duration	Start	Finish	Predec
1		System design	3 days	Mon 2/29/16	Wed 3/2/16	
2		**Main board design**	**5 days**	**Thu 3/3/16**	**Wed 3/9/16**	**1**
3		IR sensor code	5 days	Thu 3/3/16	Wed 3/9/16	1
4		Distance detector code	5 days	Thu 3/3/16	Wed 3/9/16	1
5		Gyro code	5 days	Thu 3/3/16	Wed 3/9/16	1
6		Wheel decoder	5 days	Thu 3/3/16	Wed 3/9/16	1
7		MC sensor code Complete	0 days	Wed 3/9/16	Wed 3/9/16	2
8		**Power supply design**	**5 days**	**Thu 3/3/16**	**Wed 3/9/16**	**1**
9		12 to 5	5 days	Thu 3/3/16	Wed 3/9/16	1
10		5 to 3	5 days	Thu 3/3/16	Wed 3/9/16	1
11		Water Pump design	5 days	Thu 3/10/16	Wed 3/16/16	2
12		Navigation design	12 days	Thu 3/10/16	Fri 3/25/16	2
13		**Packaging design**	**12 days**	**Thu 3/10/16**	**Fri 3/25/16**	**2**
14		Frame	12 days	Thu 3/10/16	Fri 3/25/16	2
15		Housing	12 days	Thu 3/10/16	Fri 3/25/16	2
16		Housing & navigation completed	0 days	Fri 3/25/16	Fri 3/25/16	15
17		Integrate & test	16 days	Mon 3/28/16	Mon 4/18/16	13
18		Integration Complete	0 days	Mon 4/18/16	Mon 4/18/16	17
19		Finalize design	10 days	Tue 4/19/16	Mon 5/2/16	17
20		Robot Complete	0 days	Mon 5/2/16	Mon 5/2/16	19
21		Project Management	46 days	Mon 2/29/16	Mon 5/2/16	

4 | PROJECT MANAGEMENT

Timeline:



4.2 | MILESTONES

03/09/2016

MC Sensor Code completed

-When all the sensors are functioning operationally according to design needs.

03/25/2016

Housing and Navigation completed

-Robot is fully designed and is navigating operationally.

04/18/2016

Integration completed

-Robot is completed tested and verified to complete the necessary tasks.

05/02/2016

Robot finalized

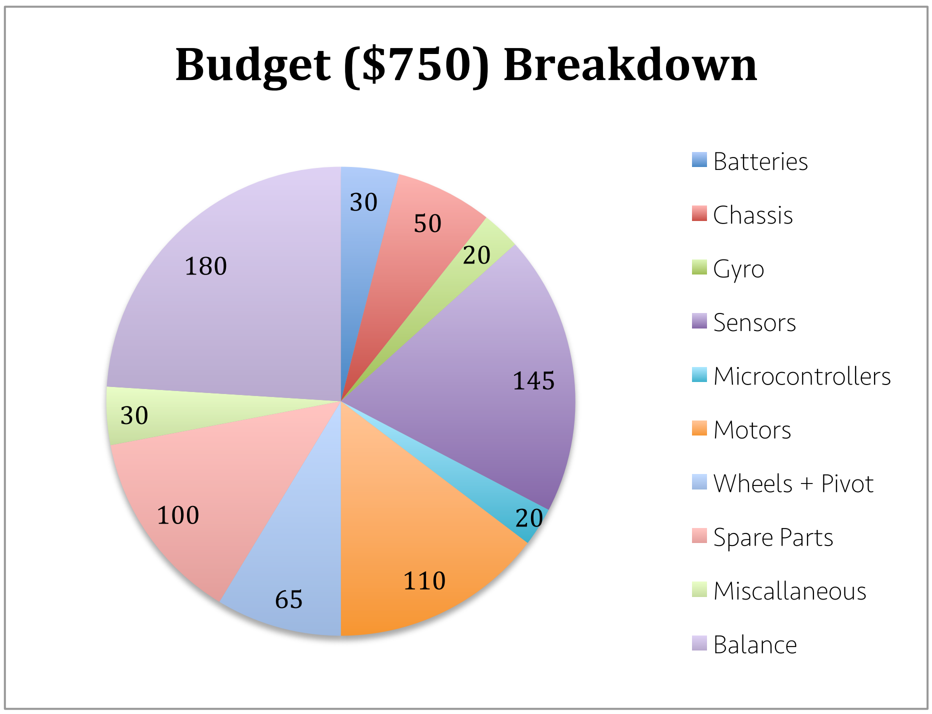
-Robot is fully operational and can successfully complete the tasks autonomously.

5 | BUDGET

5.1 | COST ANALYSIS

The allocated budget for the Fire Fighting Robot Challenge is $750. The following list below is our projected spending. Most of our budget went towards the sensors and motors, as they were the priority components in achieving a fast robot with high precision sensing. Furthermore, our leftover money of $180 will be later utilized for a possible back-up robot.

PARTS	COST
Batteries	$30
Chassis	$50
Gyro	$20
IR Distance Sensors	$100
Temperature Sensors	$45
Motor Water Pump	$30
Motor with Encoder	$80
Ball Bearing Pivot	$15
Wheels	$50
Microcontrollers	$20
Spare Parts	$100
Miscellaneous	$30
TOTAL:	$570
BALANCE:	$180



6 | PROMOTIONAL FLYER

MICRO - FIRE

Micro Fire Extinguisher

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