C&E Development Group
5500 Campanile Dr,
San Diego, CA 92182

OMUS the Autonomous Mini-Sumo Robot

OMUS.sdsu.edu

Engineers:
Adrian Alonzo
Burcin Caliskan
Ryan Dill
Nick Kelley
Mohamed Nagibulla
Sahathep Saysanapanya

Submitted to:
John Kennedy and Lal Tummala
Design Co. Ltd, San Diego CA

TABLE OF CONTENTS

ABSTRACT

For more than a decade teams from all around the world have been squaring off in robot competitions. Though designs have changed during those years winning robots tend to follow a form, fast speed and a front facing wedge plate. In order to compete with these winning designs our robot will be built to emulate the form factor of more recent winners. Our focus on speed, torque, low profile frame, and sensor layout will give our bot the best chance at winning competition. In addition to the form factor parameters, our robot will have other design elements that will set us apart from the competition and increase our advantage in the match.

PROJECT DESCRIPTION

The robot competition in mini-class sumo is held between two autonomous robots each of which must fit within a 10cm by 10cm frame and weigh at most 500 grams. These self contained bots compete in an arena, called a Dohyo, consisting of a black disc 77cm in diameter including a 2.5cm white border. Following the rules posted by Robogames Unified Sumo Rules an autonomous robot is declared the winner when successful at achieving 2 Yuhkoh points in a round against another robot gained when pushing the opponent out of bounds. The next competition occurs December 11th 2015 at SDSU.

Our team will design, integrate, and implement the various locomotive, power electronics, embedded control and navigation, mechanical design, and sensor arrays that perform the necessary functions to defeat the opposition using a reliably operating system all while conforming to sizing constraints.

Goals of our design:

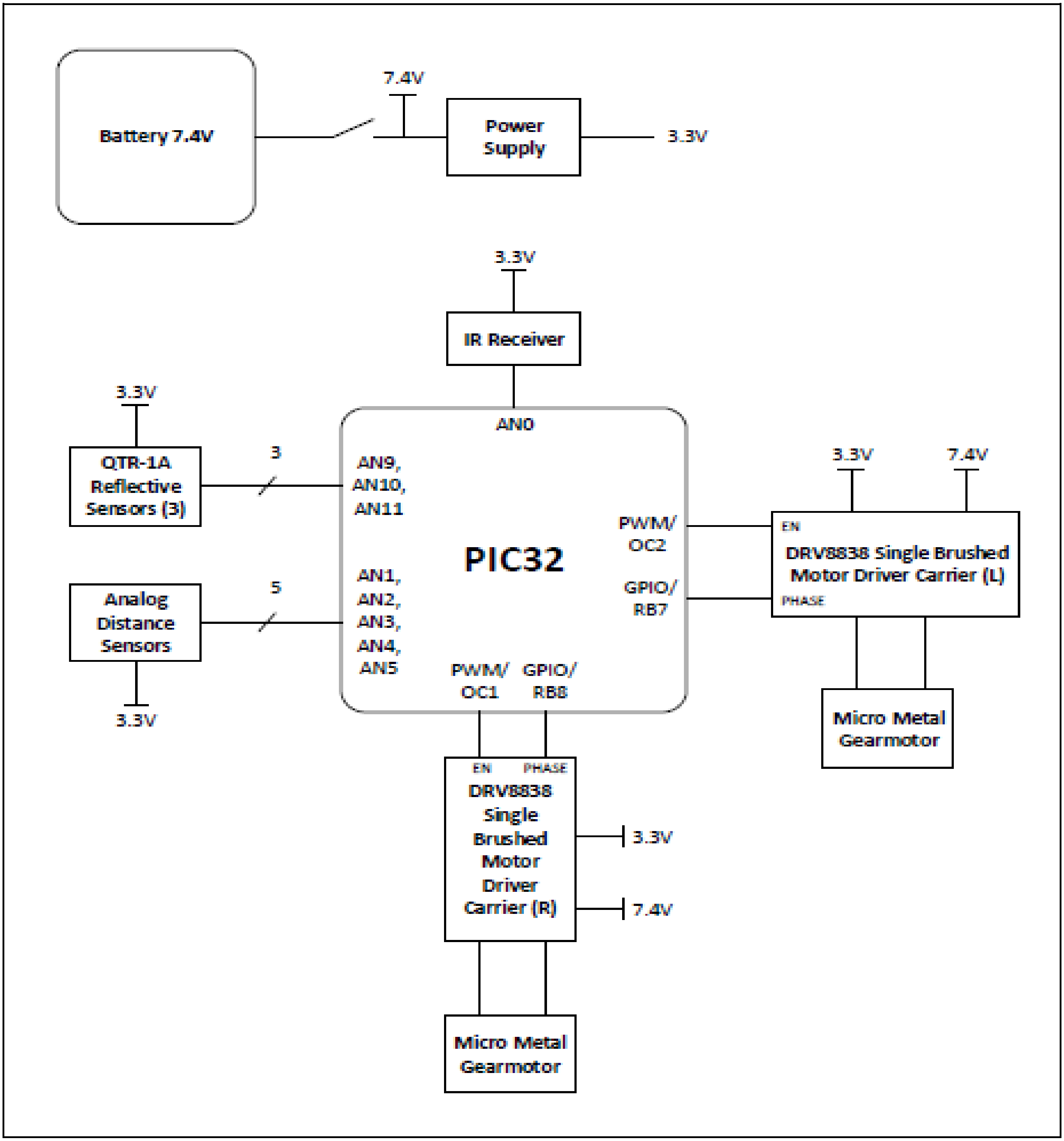
1. Meet specifications - Frame within 10cm by 10cm weighing at most 500 grams.
2. Stay in ring - Detect the white border and change direction accordingly.
3. Detect an object in the ring - Find an opponent and push them out of the ring.
4. Competition Ready mini-sumo robot - Obtain autonomous operation.
5. Defeat other robots - Defeat the robots in the Design Co. Lab (at a minimum)

Functions of OMUS:

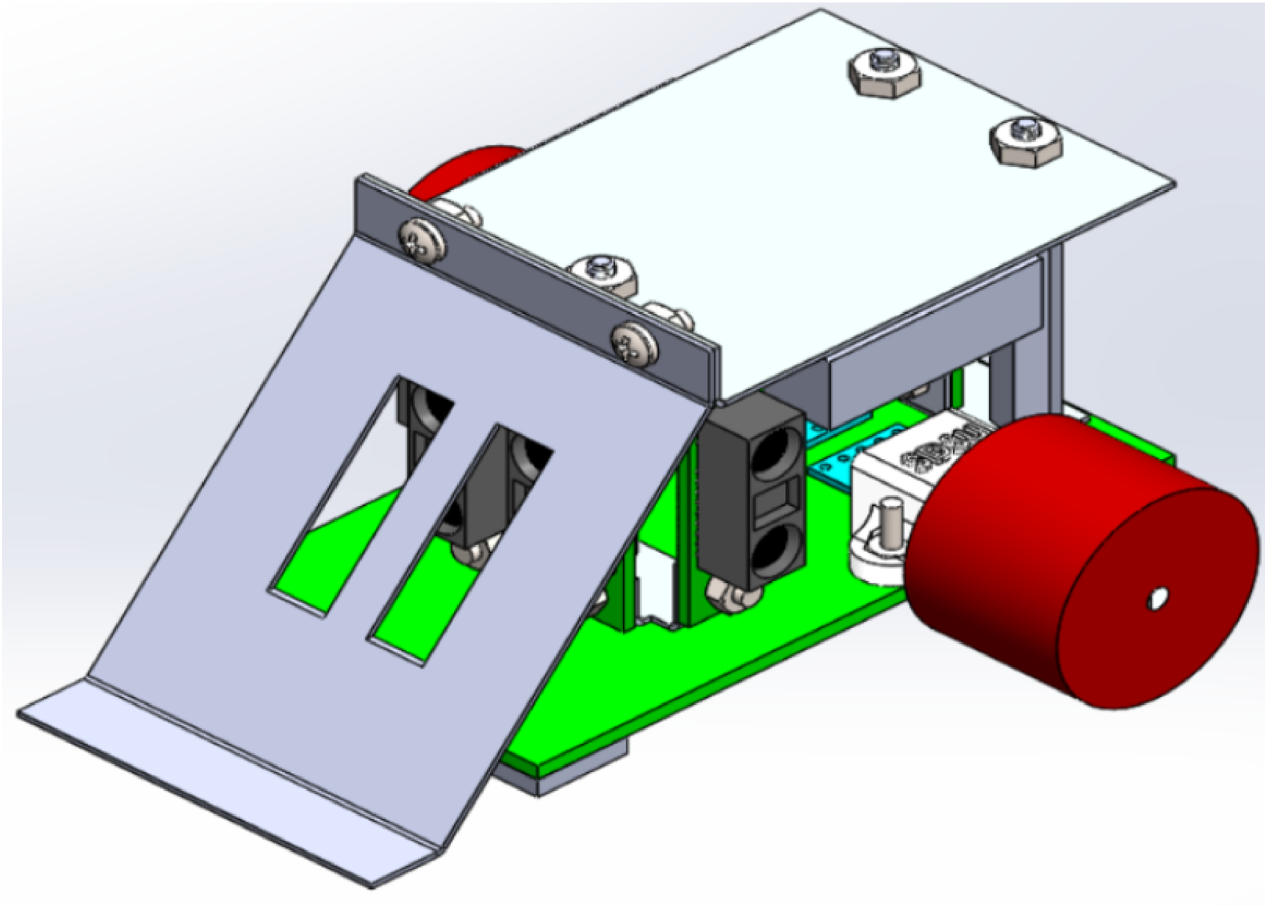
1. Read IR signal
2. Obtain Sensor Array Data
3. Process Data
    1. Calculate PWM
    2. Control motors
4. Detect opponent
5. Push object (at least 1200 grams) out of ring
6. Operate autonomously

DESIGN

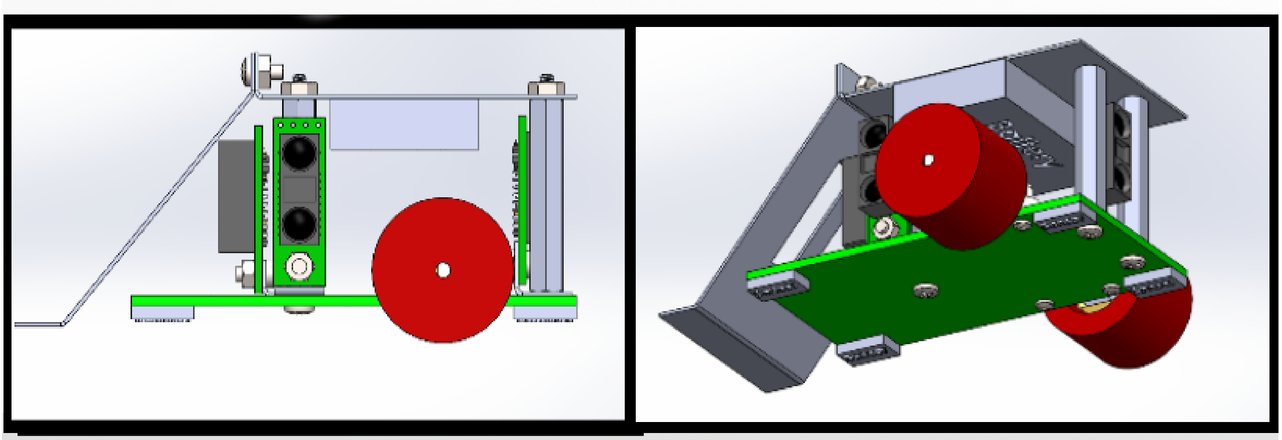
The block diagram of OMUS is included here to reference the components and systems necessary for building our design.



OMUS Version 1



OMUS ALPHA



PERFORMANCE REQUIREMENTS AND BENCHMARKS

As show previously with the block diagram and Solidworks renderings, important minimum characteristics must be met for our design to be successful. The following criteria summarized below serve as a marker for the progress of the robot.

Motors	
Speed :	70cm/s
Torque:	1.6kg/cm per motor, 3.2kg/cm for both Overall

Sensors	
Proximity Sensitivity:	0 – 80cm detection range - output voltage range 3V - 0V measured every 1ms.
Line Sensor:	Output voltage 3V - 0V and measured every 1ms from mounted height < 2cm.

Power System	
Battery:	Minimum Output Voltage 6V Minimum Capacity 610mAH Provide 10 min @ max current (max Round = 3min) Max Current < 4A Supply 2 Levels – 7.4V, 3.3V

TESTING AND VERIFICATION

The testing procedures for our components will be listed here, along with the equipment used during the trials.

Motors

- Using a laser Tachometer, the RPM can be measured.
- Connecting the motors to a Power Supply and Function Generator
  - Power Supply for input voltage.
  - Function generator supplies the PWM.
  - Wheel Spins
- Speed can be plotted against PWM percentage.

Sensors

Line:

- Use Power Supply to operate sensor.
- Mount sensor to rig at 2cm.
- Measure voltages on oscilloscope
  - Black surface
  - White surface
  - Transitions between surfaces

Proximity:

- Use Power Supply to operate sensor.
- Mount sensor at orientation
  - Vertical detects Left and Right
  - Horizontal detects Above or Below
- Use DMM for voltage readings
  - Within 10cm
  - Within operating range
  - Beyond Range
- Plot on construction paper
  - Measurement of detection Cone Angles
  - Measurement of detection Distance

Power System

- Use Power Supply to Simulate Battery Voltage.
- Connect Capacitors to LDOs.
- Measure Ripple Voltage with Oscilloscope.
- Measure LDO current draw with Load Generator.
- Add fuses to circuit to
  - Limit excess currents

- Prevent damaging components
- Limit the cost of replacement parts

PROJECT MANAGEMENT

Project Plan

In this section we explore the project timeline in the form of a Gantt Chart. This lists the major tasks necessary to complete the project, provides the scheduling for each task, allocates the resources necessary for completion, and provides incremental goals in the form of Milestones all in one self contained file. The OMUS Gantt chart follows on the next several pages.

Milestones

Here is a list of the Milestones for Project OMUS, the dates to test the status, and a brief description of the goal.

10/16/15: Prototype robot is complete and ready for coding. The robot is able to function on it's own accord without an external function generator or power supply. Wheels and sensors are mounted. Robot is self-powered with a battery and controlled by microcontroller.

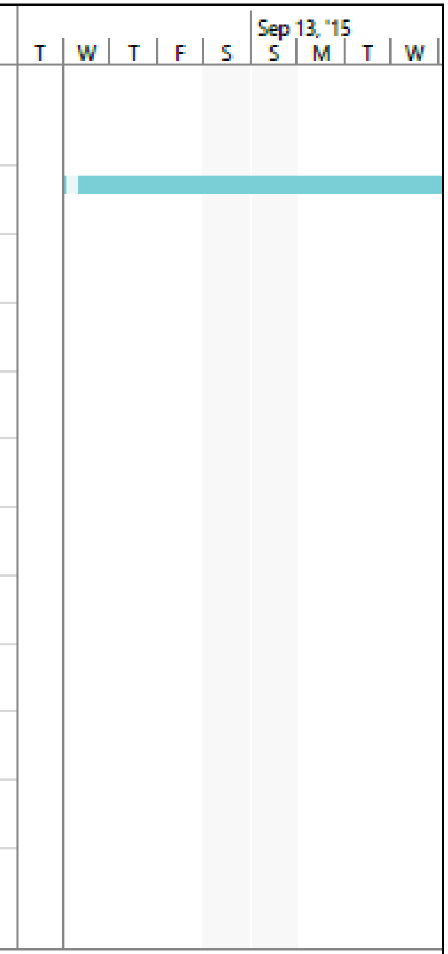
10/30/15 Preliminary coding for robot movement within the doyho, without leaving the boundary. The code logic interprets the sensors and send the correct PWM signals to the motors to remain within the ring.

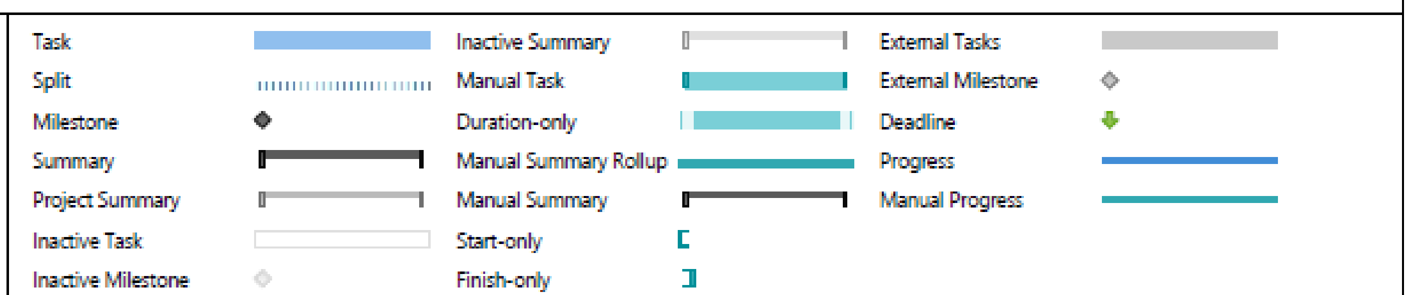
11/1/15 OMUS is able to detect objects in the ring and can actively seek the object. The object will be pushed across the boundary.

11/25/15 Defeat mini sumo-bots in the Lab.

12/11/15: Defeat Robo-Ronin in head-to-head Design Day Mini Sumo Competition.

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1			Robot Function Autonomously without falling out of	0 days	Sun 10/18/15	Sun 10/18/15		
2			Preliminary Design	2 wks				
3			Cost Estimate	5 days	Mon 9/21/15	Fri 9/25/15		
4			Power electronic/voltage	1 wk	Mon 10/5/15	Fri 10/9/15		
5			Sensor Testing/Characterizati	1 wk	Mon 9/28/15	Fri 10/2/15		
6			Micro Controller	1 wk	Mon 9/28/15	Fri 10/2/15		
7			Motor Control/Testin	1 wk	Mon 9/28/15	Fri 10/2/15		
8			software PWM	1 wk	Mon 10/12/1	Fri 10/16/15		
9			Working Model Design/frame	2 wks	Mon 9/28/15	Fri 10/9/15		
10			Integration/Testing	2 wks	Mon 10/19/1	Fri 10/30/15		
11			Beat Professor's robot	0 days	Wed 11/11/1	Wed 11/11/1		
12			Robot Able to Seek The Other Robot and Push the Other Robot	0 days	Sun 11/1/15	Sun 11/1/15		

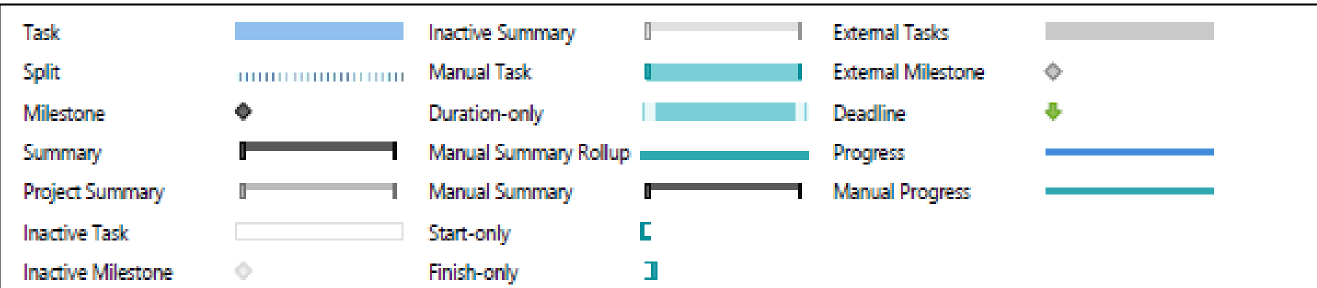


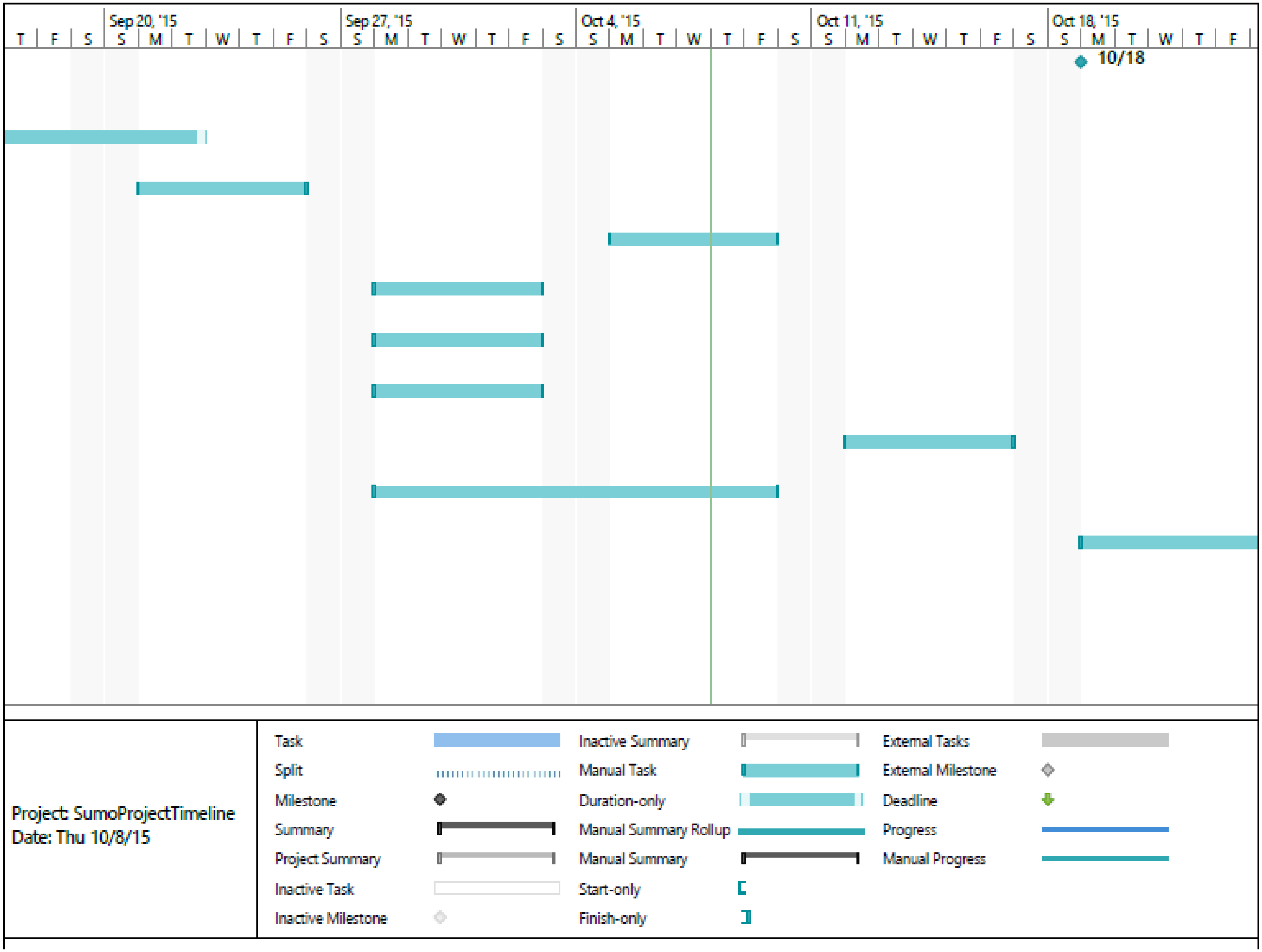


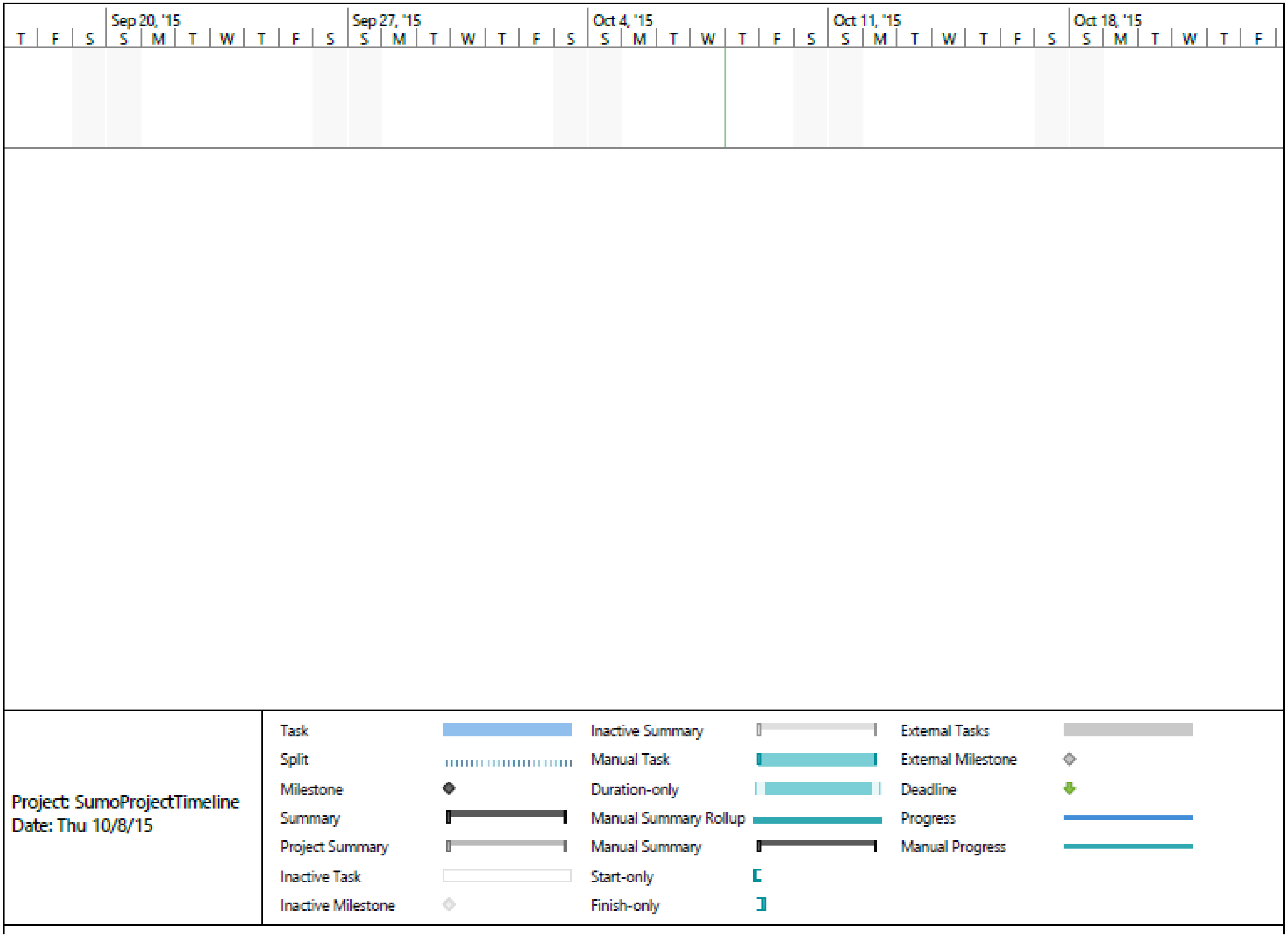
Project: SumoProjectTimeline
Date: Thu 10/8/15

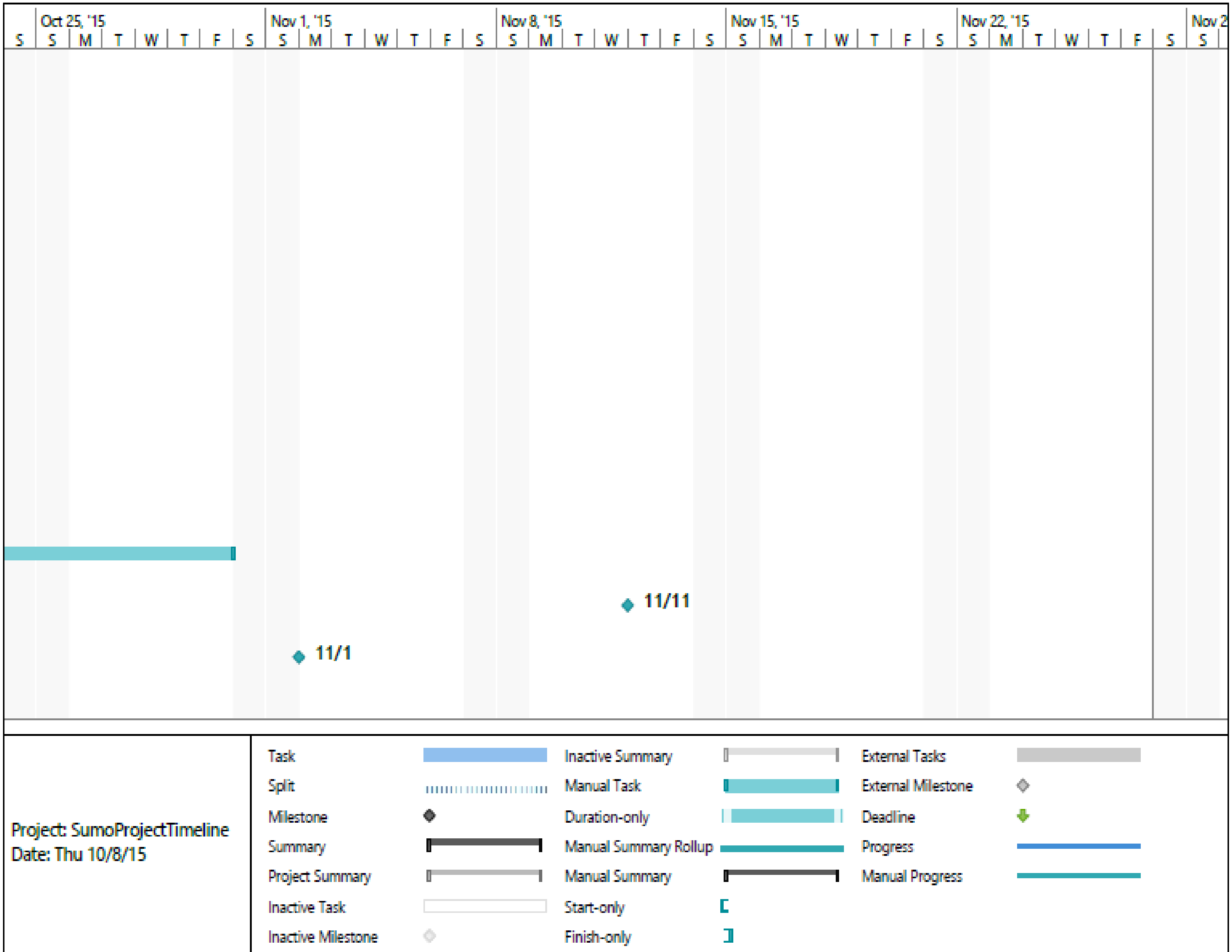
ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	Sep 13, '15 T W T F S S M T W
13			Final Design	2 wks	Mon 11/2/15	Fri 11/13/15			
14			Integration/Testing	2 wks	Mon 11/16/1	Fri 11/27/15			

Project: SumoProjectTimeline
Date: Thu 10/8/15

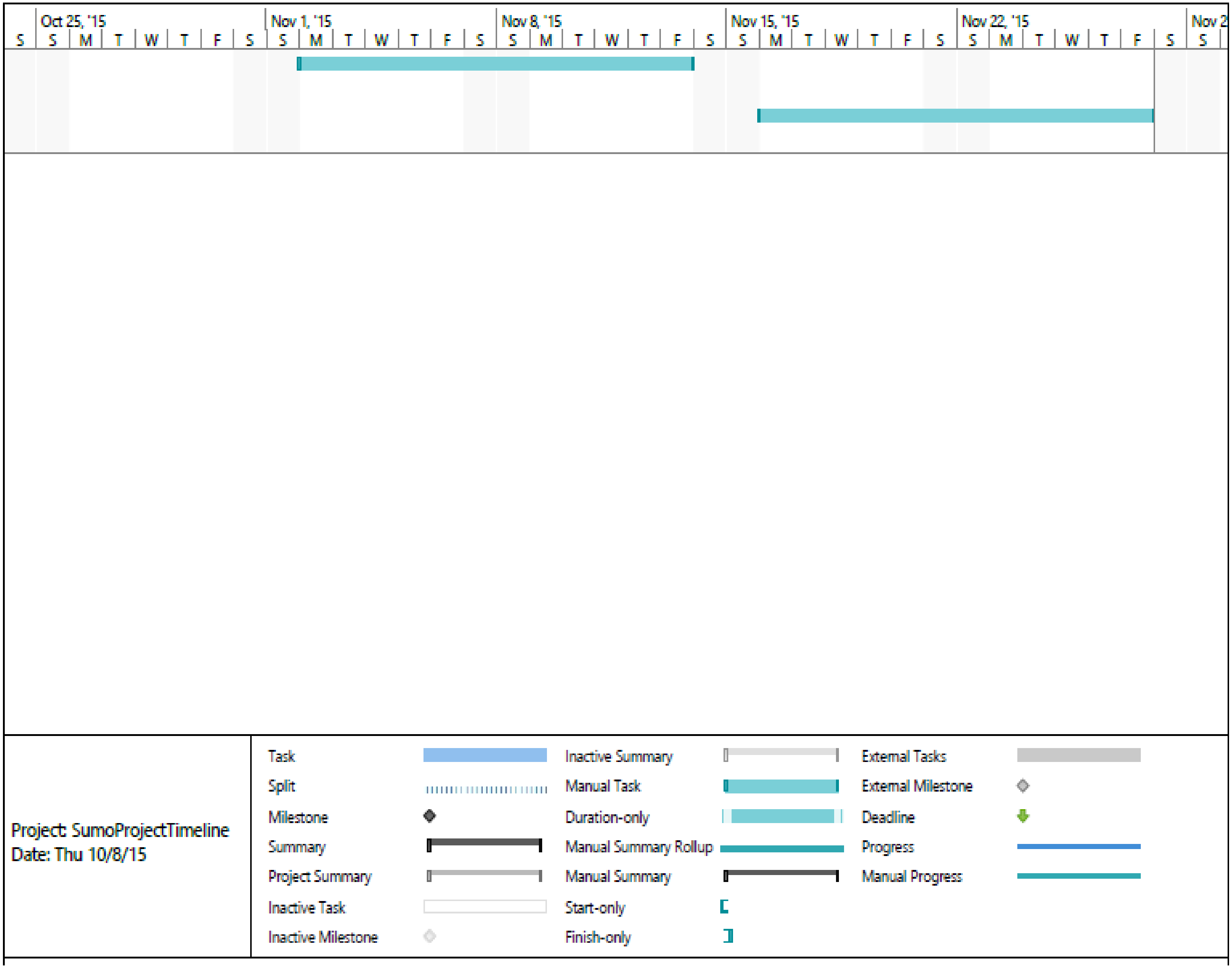



Sep 20, '15
Sep 27, '15
Oct 4, '15
Oct 11, '15
Oct 18, '15
T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F
10/18
Project: SumoProjectTimeline
Date: Thu 10/8/15
Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress


Sep 20, '15
Sep 27, '15
Oct 4, '15
Oct 11, '15
Oct 18, '15
T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F
Project: SumoProjectTimeline
Date: Thu 10/8/15
Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress



Oct 25, '15
Nov 1, '15
Nov 8, '15
Nov 15, '15
Nov 22, '15
S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S
11/11
11/1
Project: SumoProjectTimeline
Date: Thu 10/8/15
Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

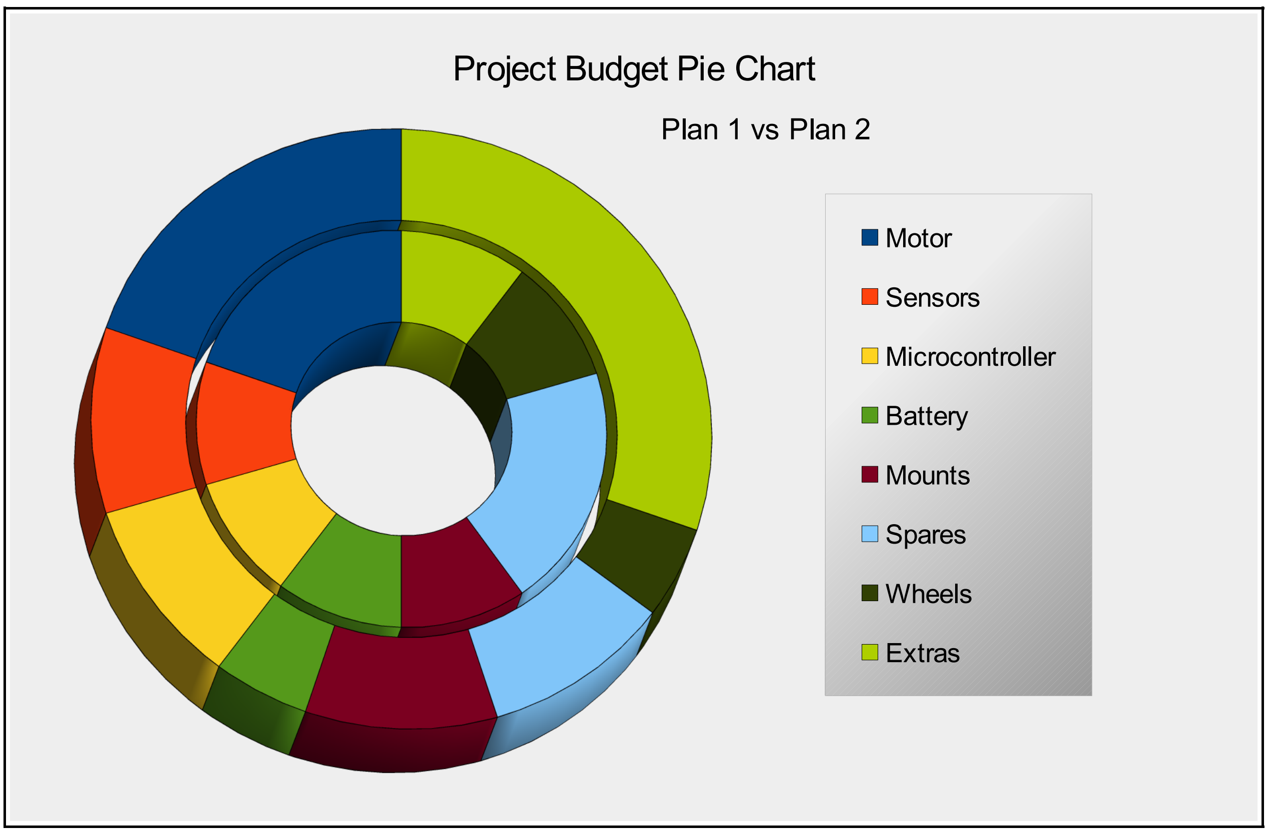

Oct 25, '15
Nov 1, '15
Nov 8, '15
Nov 15, '15
Nov 22, '15
Nov 2
S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S
Project: SumoProjectTimeline
Date: Thu 10/8/15
Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

BUDGET

Using the required funding of $500, our team must provide results meeting the minimum criteria listed in the previous sections. To do this we must budget enough funds for testing, replacement parts, and duplicate items used by multiple engineers. Below is a figure showing the relative allocation of funds to the various needs of the project.

Allocations

1. Motor - 20%
2. Sensors - 10%
3. Microcontroller - 10-15%
   - PIC Stick
   - Chip
4. Battery - 5-10%
5. Mounting Material - 10%
6. Replacement Parts - 10-20%
7. Wheels - 5-10%
8. Incidentals - 10-40%
   - Shipping
   - Extra Expenses



OMUS

Adrian Alonzo

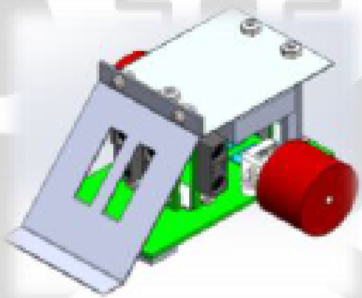
Burcin Caliskan

Mohamed Nagibulla

Nick Kelly

Ryan Dill

Sahathep Saysanapanya



OMUS is an autonomous miniature sumo robot designed by students of the Electrical and Computer Engineering Department of San Diego State. Our team of design engineers handled the layout and sensor system while our firmware engineers were responsible for the embedded systems programming. A mini-sumo competition will be held in the Senior Design Lab on December 10th, 2015.

OMUS Sumo Bot

omus.sdsu.edu

omusbot@gmail.com