Problem Definition Review

P16241 – AUTONOMOUS PEOPLE MOVER PHASE III

Team

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Agenda

- Background
- Problem Statement
- Stakeholders
- Use Scenario
- Customer Requirements
- Engineering Requirements
- Preliminary Schedule
- Potential Risks

Background

Rochester Institute of Technology is re-entering the field of autonomous vehicle research.

Research and development of autonomous vehicles are becoming more and more popular in the automotive industry. It is believed that autonomous vehicles are the future for easy and efficient transportation that will make for safer, less congested roadways.

Our project will follow the work completed by the Phase I and II teams.

Problem Statement

RIT would like to showcase the capability of its engineering students by creating a fully functional autonomous vehicle. It is believed that self-driving vehicles are the future for easy, efficient transportation that will make for safer, less congested roadways and a cleaner environment. The Autonomous People Mover (APM) at RIT would provide transportation for students and visitors across the campus at a moment's notice. With the APM, no human driver is necessary. There have been two phases of this project so far. The first phase focused on modifying a golf cart into a remote controlled vehicle. The second phase is working on adding autonomous functionality to the APM for highly restricted settings.

The goal of Phase III is to analyze the APM's current autonomous capabilities and to incorporate localization, path planning, path following, and object avoidance. The vehicle will provide a simple human-machine interface which will collect and display diagnostic information. To ensure the safety of the passengers and any bystanders, passengers will have the ability to take control of the vehicle at any time. The prototype will be showcased at Imagine RIT 2016 on a closed course with a trained backup driver on board for safety assurance.

Problem Statement

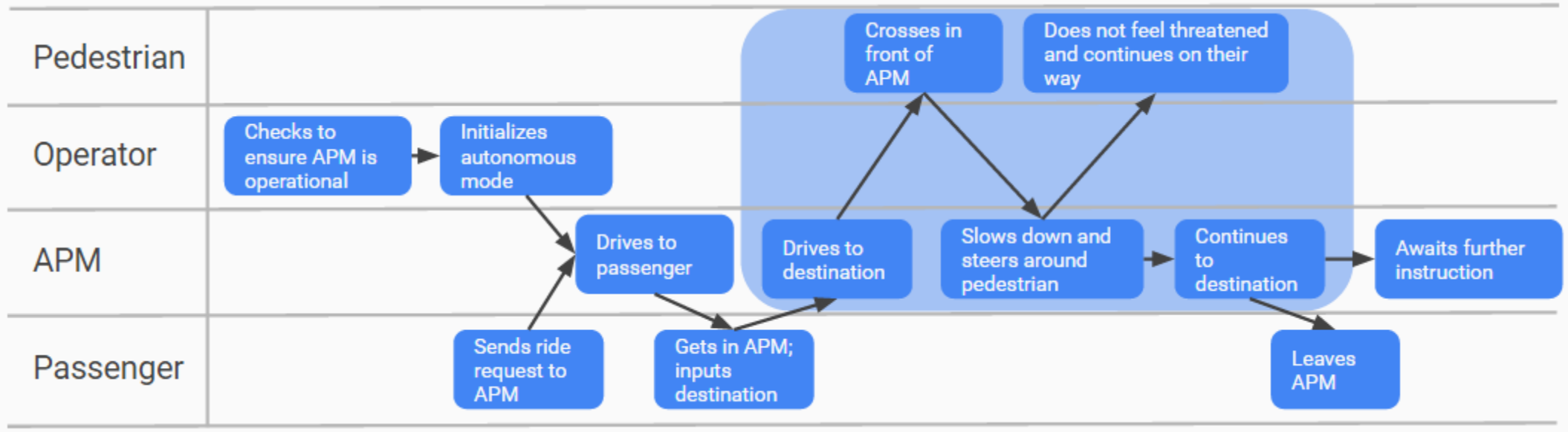
- Current State
  - There have been two phases of this project so far. The first phase focused on modifying a golf cart into a remote controlled vehicle. The second phase is working on adding autonomous functionality to the APM in highly restricted settings.
- Desired State
  - APM is capable of localization, path planning, path following, and object avoidance. APM provides a simple human-machine interface which displays diagnostic information. Passengers have the ability to take control of the vehicle whether it is moving or stationary.
- Project Goals
  - APM can drive autonomously on a closed course while avoiding static and moving obstacles, staying on the designated path, and maintaining the safety of passengers and bystanders
- Constraints
  - Phase II accomplishments; budget; time for research, testing, and debugging; maintaining the safety of passengers and bystanders

Stakeholders

- Primary Customer: Raymond Ptucha
- Faculty Guide: Michael Blachowicz
- RIT
- Passengers
- Bystanders
- Phase III Team
- Phase IV Team?
- D3 Engineering

D3 Engineering

Example Use Scenario



Customer Requirements

Customer Rqmt. #	Importance	Description
CR1	9	APM must, at a minimum, be able to operate within a closed course in autonomous mode
CR2	9	APM must move forwards in autonomous mode
CR3	9	APM must have intelligent vehicle control: driving
CR4	9	APM must have intelligent vehicle control: steering
CR5	9	APM must have intelligent vehicle control: braking
CR6	6	APM must re-route path to avoid obstacle
CR7	9	APM must be able to detect obstacles and brake
CR8	3	APM must exhibit localization
CR9	3	APM must have diagnostic data logging capability
CR10	1	APM will have a display which will show it's location on a map, as well as diagnostic information
CR11	9	APM destination must be input via Secure Shell Protocol (SSH) or remote desktop to the onboard PC
CR12	9	APM must perform an emergency stop when a passenger hits the emergency stop button, or when the remote control device activates the emergency stop
CR13	9	APM must have a way to switch between manual, remote, and autonomous modes

Engineering Requirements

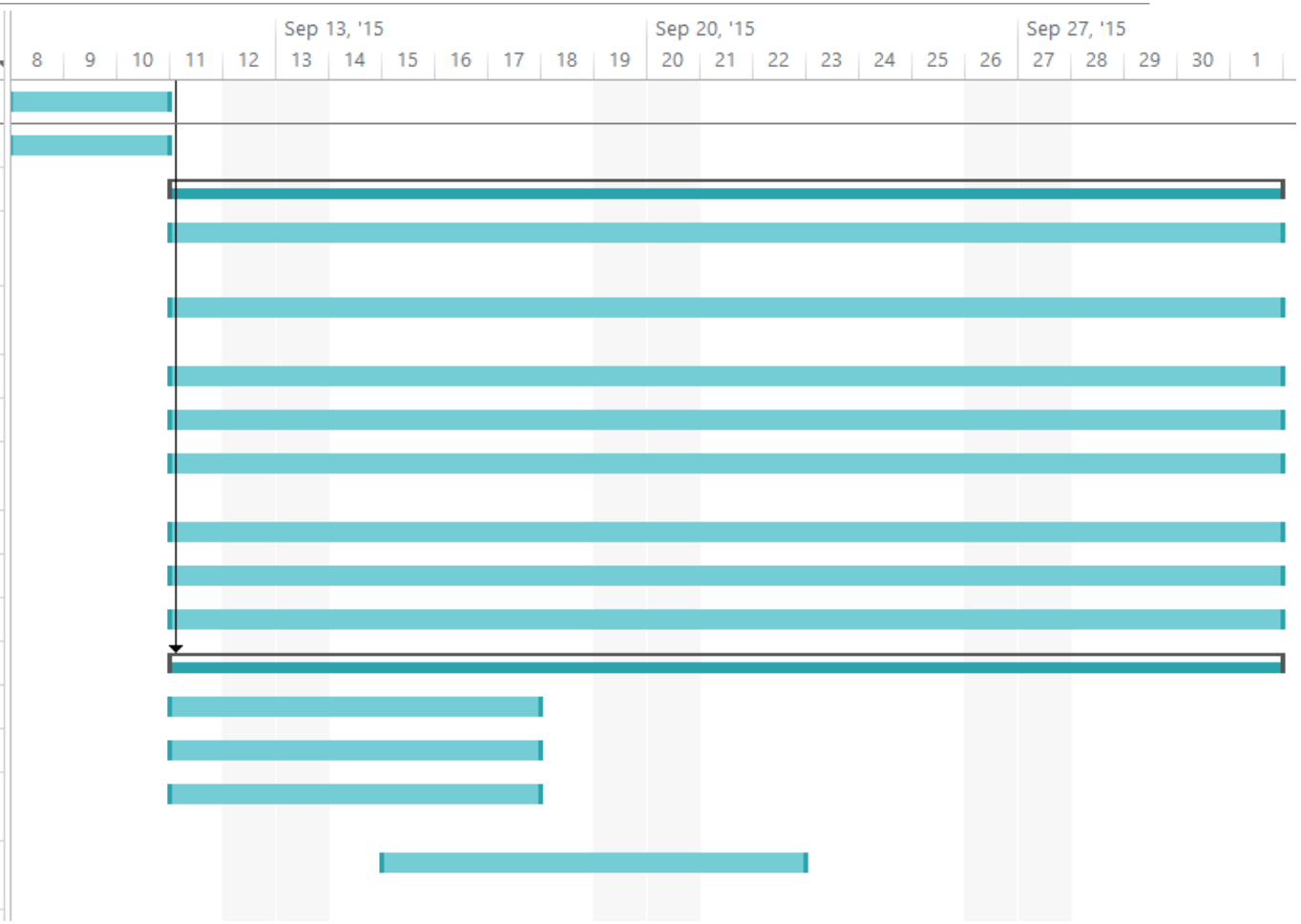
Rqmt. #	Engr. Requirement (metric)	Unit of Measure	Marginal Value	Ideal Value	Comments/Status
S1	Driving Modes (Manual, RC, Autonomous)	Pass / Fail			
S2	Steering Control Precision	Degrees	± 2	± 1	
S3	Steering Position Encoding	Degrees	± 2	± 1	
S4	Speed Control	MPH	± 1 (0.5)	± 0.5 (0.25)	
S5	Speed Encoding	MPH	± 1 (0.5)	± 0.5 (0.25)	
S6	Maximum Speed	MPH	10 (4.5)	12 (5.4)	
S7	GPS Positioning	Meters	± 5	± 0.25	
S8	Course: Arrive at planned destination	Pass / Fail			
S9	Course: Make turn when road turns	Pass / Fail			
S10	Course: Stop when stationary obstacle in way	Pass / Fail			
S11	Course: Stop when moving obstacle moves in way	Pass / Fail			
S12	Course: Slow down when approaching turn and speed up again after	Pass / Fail			
S13	Drive Forward Autonomously	Pass / Fail			
S14	Detection of Light Reflecting 10" x 10" Objects Within 3 Meters	Percentage	99	100	180 degrees in front of car
S15	Detection of Sound Reflecting 1' x 1' Objects Within 1 Meter	Percentage	99	100	180 degrees in front of car
S16	Minimum Stopping Distance (without hitting obstacle)	Meters	5	3	
S17	SSH Interface with onboard PC	Pass / Fail			

Engineering Requirements vs. Customer Requirements

Customer Requirements	Customer Weights	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17
CR1	9	X	X	X	X	X			X	X	X	X	X	X	X	X	X	
CR2	9	X			X		X			X				X				
CR3	9		X	X	X	X	X			X		X	X	X			X	
CR4	9		X	X		X				X			X	X				
CR5	9				X	X			X		X	X	X				X	
CR6	6		X	X				X			X	X					X	
CR7	9				X						X	X					X	
CR8	3							X	X									
CR9	3			X	X	X												
CR10	1			X	X	X												
CR11	9																	X
CR12	9				X												X	
CR13	9	X																

Preliminary Schedule

Task Name	Duration	Start	Finish
Problem Definition Presentation	3 days	Tue 9/8/15	Thu 9/10/15
Peer Reviews	3 days	Tue 9/8/15	Thu 9/10/15
Research/Brainstorm	15 days	Fri 9/11/15	Thu 10/1/15
Other collegiate autonomous vehicles	15 days	Fri 9/11/15	Thu 10/1/15
LiDAR output data processing algoritms	15 days	Fri 9/11/15	Thu 10/1/15
Object detection with LiDAR	15 days	Fri 9/11/15	Thu 10/1/15
Map data to computer	15 days	Fri 9/11/15	Thu 10/1/15
Obstacle avoidance strategy algorithms	15 days?	Fri 9/11/15	Thu 10/1/15
Robot Operating System	15 days?	Fri 9/11/15	Thu 10/1/15
Stereo camera distance detection	15 days?	Fri 9/11/15	Thu 10/1/15
Route planning algorithms	15 days	Fri 9/11/15	Thu 10/1/15
Systems Design Phase	**15 days**	**Fri 9/11/15**	**Thu 10/1/15**
Functional Decomposition	5 days	Fri 9/11/15	Thu 9/17/15
Functional Analysis	5 days	Fri 9/11/15	Thu 9/17/15
Concept Generation & Mophological Table	5 days	Fri 9/11/15	Thu 9/17/15
Brainstorm, research, and identify different alternative solutions	6 days	Tue 9/15/15	Tue 9/22/15



Potential Risks

- Phase II not completing requirements
- Control system physically failing
  - Steering
  - Brake
  - Throttle
- Sensor Malfunction
  - LiDAR
  - Ultrasonics
  - Visual cameras
  - GPS
- Physical Vehicle Malfunction
  - Damage to cart
  - Flat tire
  - Brakes locked out
- Algorithm Failure
  - Path planning
  - Obstacle avoidance

Potential Risks Continued

- Weather Issues
  - Daylight
  - Snow/Ice
  - Rain
  - Heat
- Computer Failure
  - Bandwidth issues
  - Processing too slow
  - Software bugs
- Malicious Actions
  - Passenger
  - Bystander

Questions