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INSPIRATION COMES STANDARD

AUTONOMOUS MAP FOLLOWER

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Sponsored by Chrysler

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Overview

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- Design Requirements
- Design Selection
- Final Solution
- Prototype Product
- Implementation
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- Autonomous Vehicle Algorithm
- GPS System
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- Review

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Introduction

- To design a system that allows a vehicle to drive autonomously from one destination to another
- By replacing the human driver with a system that can autonomously drive the vehicle, it is likely that driving can be made safer for both commuters and pedestrians.
- Aim was to deliver a scaled version of the prototype mirroring full functionality of the design

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Problem Formulation

- Calculate and drive a route in a controlled environment
- Stop within 3 meters of destination
- Alert the user upon arrival at destination
- Allow the user to abort on-going destination navigation
- Change desired destination during on-going navigation
- Automatically calculate and return to departure location
- Turn off remotely

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Design Requirements

- Calculate destination route within 30 seconds
- Automate vehicle to travel at 10mph for the duration of the journey
- Arrive within 3m of intended destination
- Abort on-going navigation if need be within 30 seconds
- Send arrival notification within 10 seconds of arriving at destination
- Adhere to relevant IEEE standards and regulations

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Design Selection

	DECISION MATRIX						
		Solution 1 GPS Guided System		Solution 2 Triangulation System		Solution 3 Electric Compass System	
Selection Criteria	**Weight**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**
Ease of Use	35	7	2.04	6	1.75	4	1.17
Accuracy	35	8	2.33	6	1.75	5	1.46
Safety	30	8	2.00	6	1.50	6	1.50
Price	20	8	1.33	7	1.17	7	1.17
Total Score			**7.7**		**6.2**		**5.3**
Rank			**1**		**2**		**3**

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Final Solution

- Contains computer, and one microcontroller.
- Microcontroller in charge of receiving, interpreting GPS signal.
- Microcontroller will also be in charge of the motors and will move the vehicle.
- The computer will be the core part of the system that will interpret, plan, translate given instructions.

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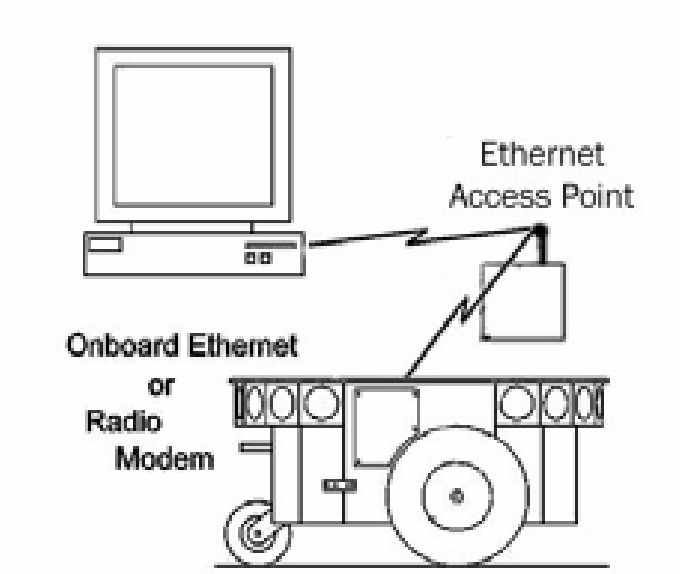
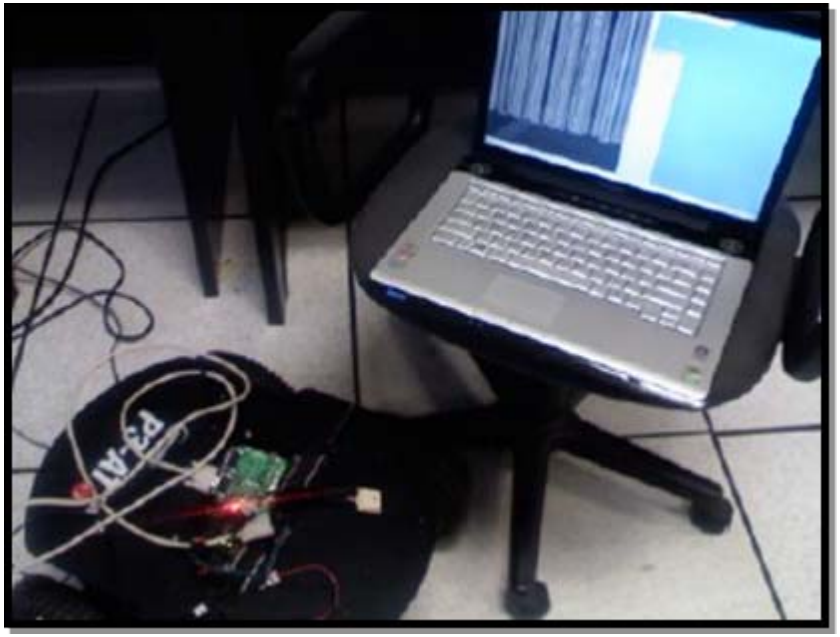
Prototype Product

- Design Solution uses GPS to help vehicle navigate autonomously
- Prototype design selected will utilize the P3-AT robot as a vehicle





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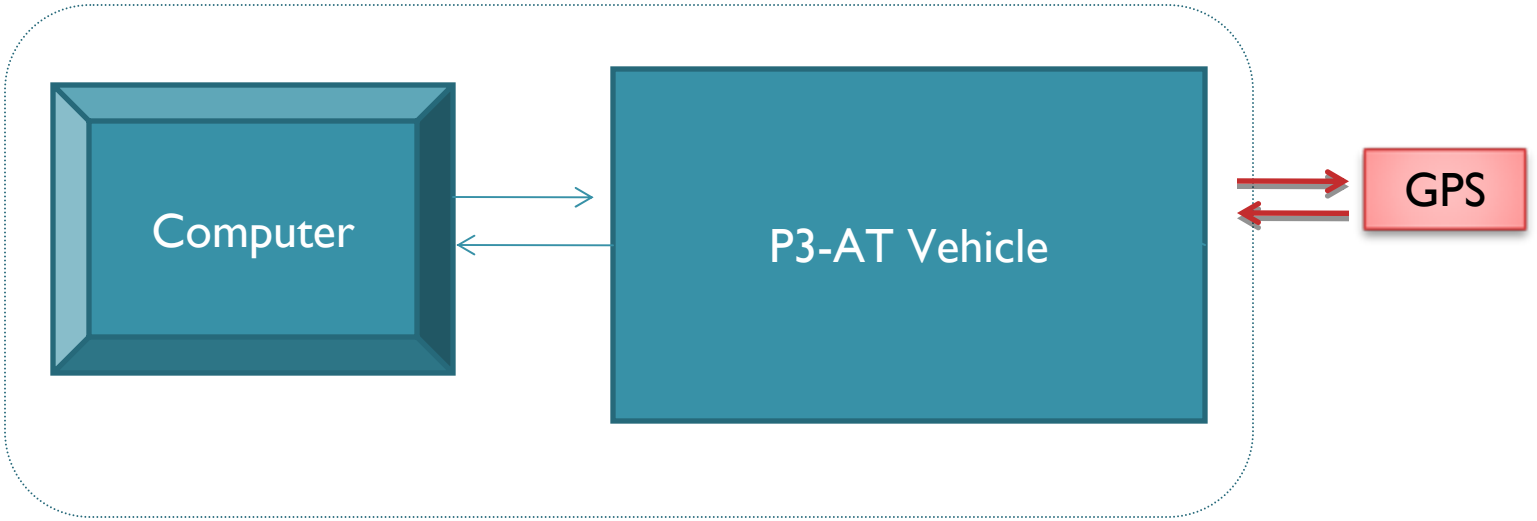
Implementation

- Use ARIA API , an object-oriented, robot control applications-programming interface
- Program microprocessor to receive and translate the GPS signal for the vehicle
- Code subroutines to allow vehicle navigate autonomously



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Prototype Specifications

P3-AT Vehicle

- Translational velocity can be varied to a maximum of 0.7mph

GPS

- Operating temperature between -30 ~ +80 ℃
- Start-up time ranging from 1 second to 41 seconds
- Baud rate of 38400 bps (default) 4800/9600/38400/57600/115200 bps are adjustable
- Position accuracy of 3.3 m CEP (circular error probability)
- Compliant with ITU 992.1, 992.5 and IEEE 802.11 standards for IT telecommunications

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Vehicle Subroutines

- Top Level Code – Links all of the functions for a successful trip from start to finish
- Route Selection – Algorithm that selects the best route
- Distance Calculation – Calculates the distance from the start to end
- Navigation Route - Keeps track of the vehicle progress (via Waypoints)
- Notification Arrival – Alerts the user of arrival at final destination
- GPS - Retrieves location information from GPS unit

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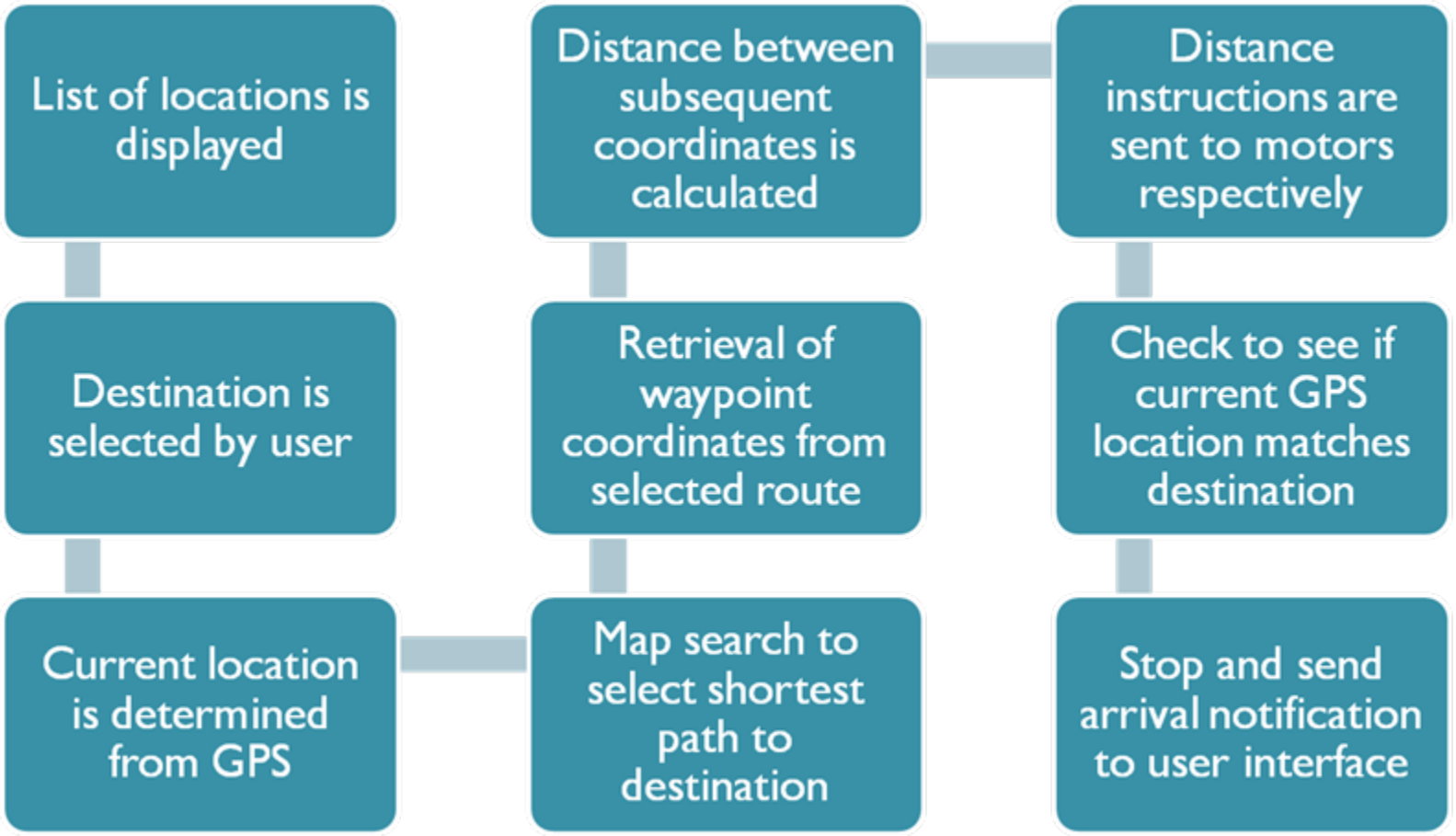
Autonomous Vehicle Algorithm



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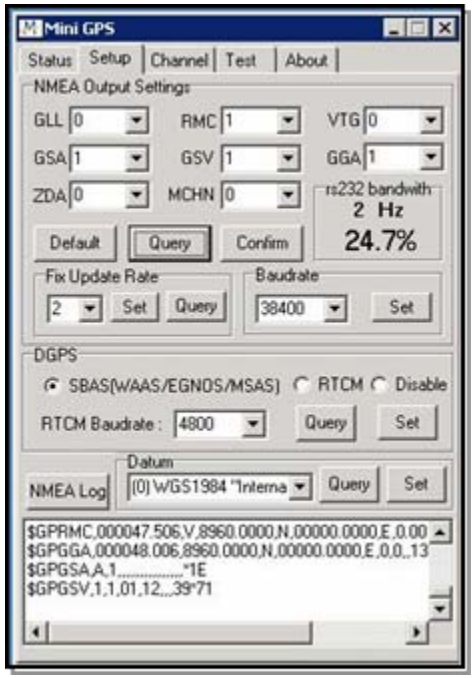
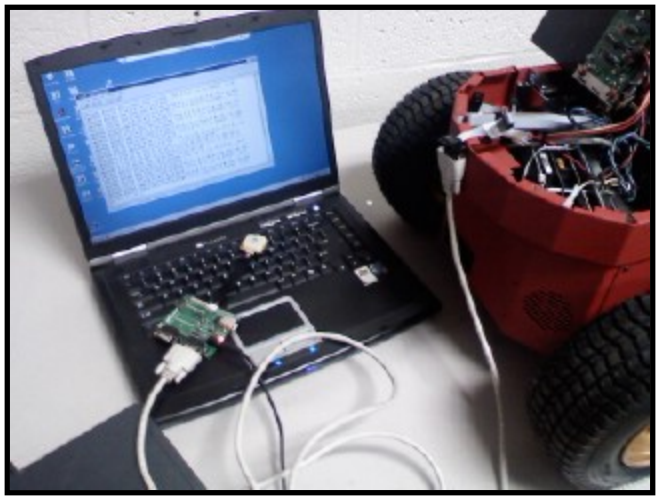
GPS SYSTEM

- Decoded NMEA GPS protocols to extract required GPS information strings relevant to project (GGA, RMC, GSA, GSV)
- Configured GPS and P3-AT link to eliminate delays (2Hz was satisfactory update rate)
- Implemented DGPS to reduce CEP error of GPS from 3.3m to 2.5m (WAAS satellite)





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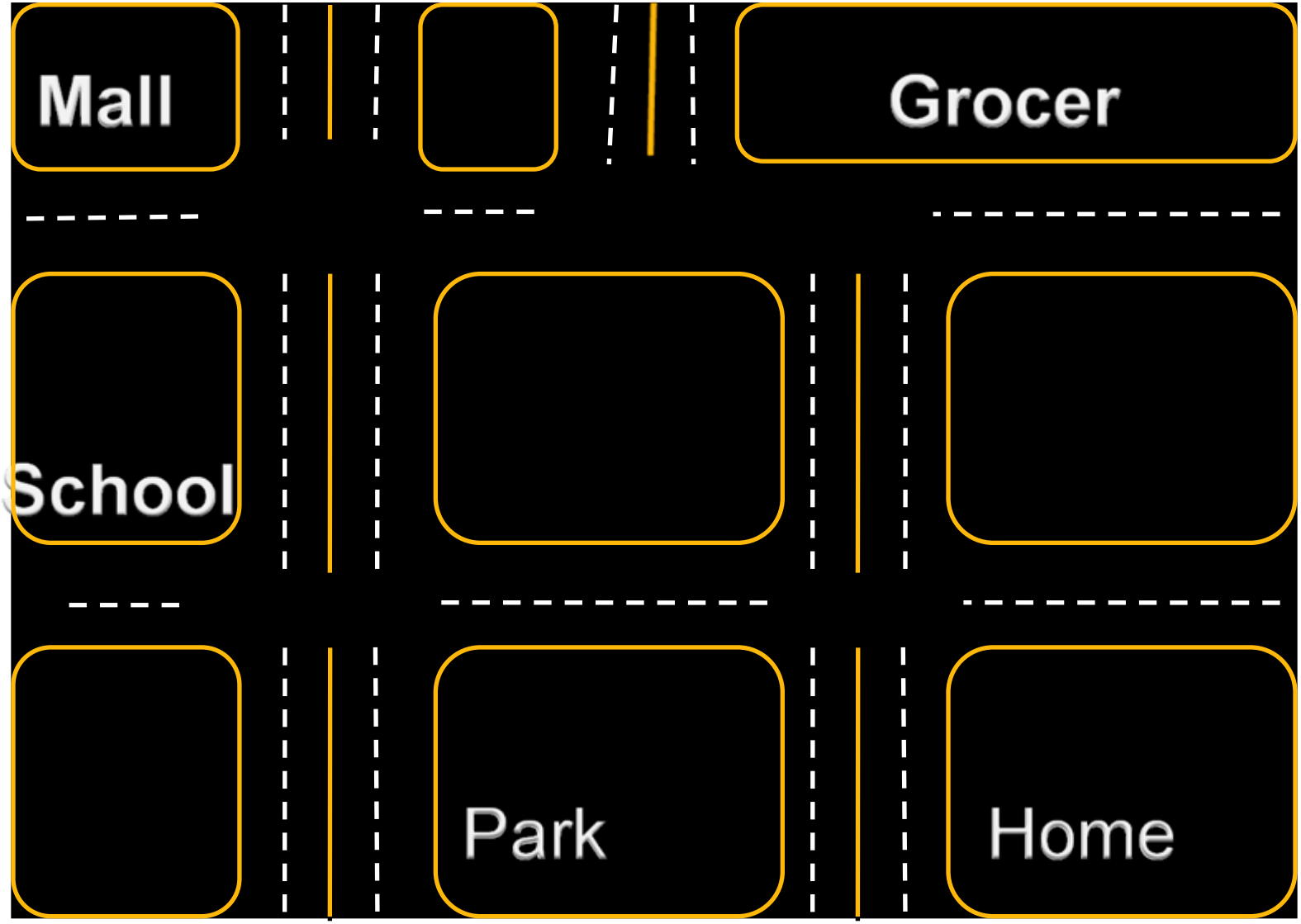
Virtual Map I



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User Interface 1

```
H is Home
G is Grocery store
M is Mall
P is Park
S is School
Your current possition is H
Enter the destination you would like to go to.
s
Going to next goal at 4000 0
Going to next goal at 4000 8000
GPS: Warning: Skipping message with incorrect checksum.
GPS: Pos: 38.921548,-77.021560   Spd:0.1132m/s (0.2532mi/h)   Alt:61.30m (201.12
ft)   Head:-   NSats: 6   ErrEst:-   HDOP:1.41   Fix:GPS          (4897)

H is Home
G is Grocery store
M is Mall
P is Park
S is School
Your current possition is s
Enter the destination you would like to go to.
p
Going to next goal at 4000 4000
Going to next goal at 0 4000
GPS: Pos: 38.921533,-77.021548   Spd:0.1183m/s (0.2647mi/h)   Alt:61.40m (201.44
ft)   Head:-   NSats: 6   ErrEst:-   HDOP:1.41   Fix:GPS          (4912)
```

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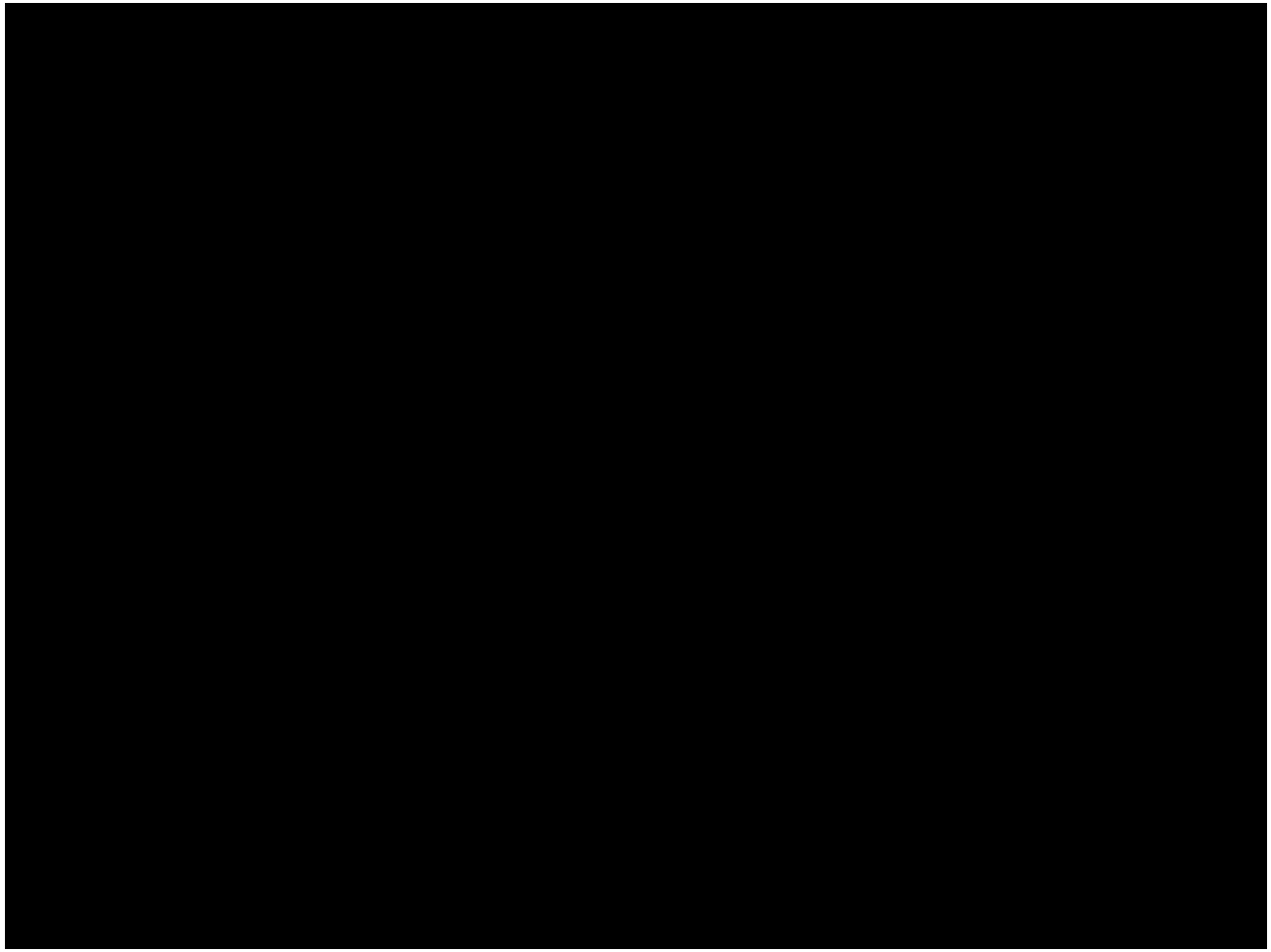
Demo Run



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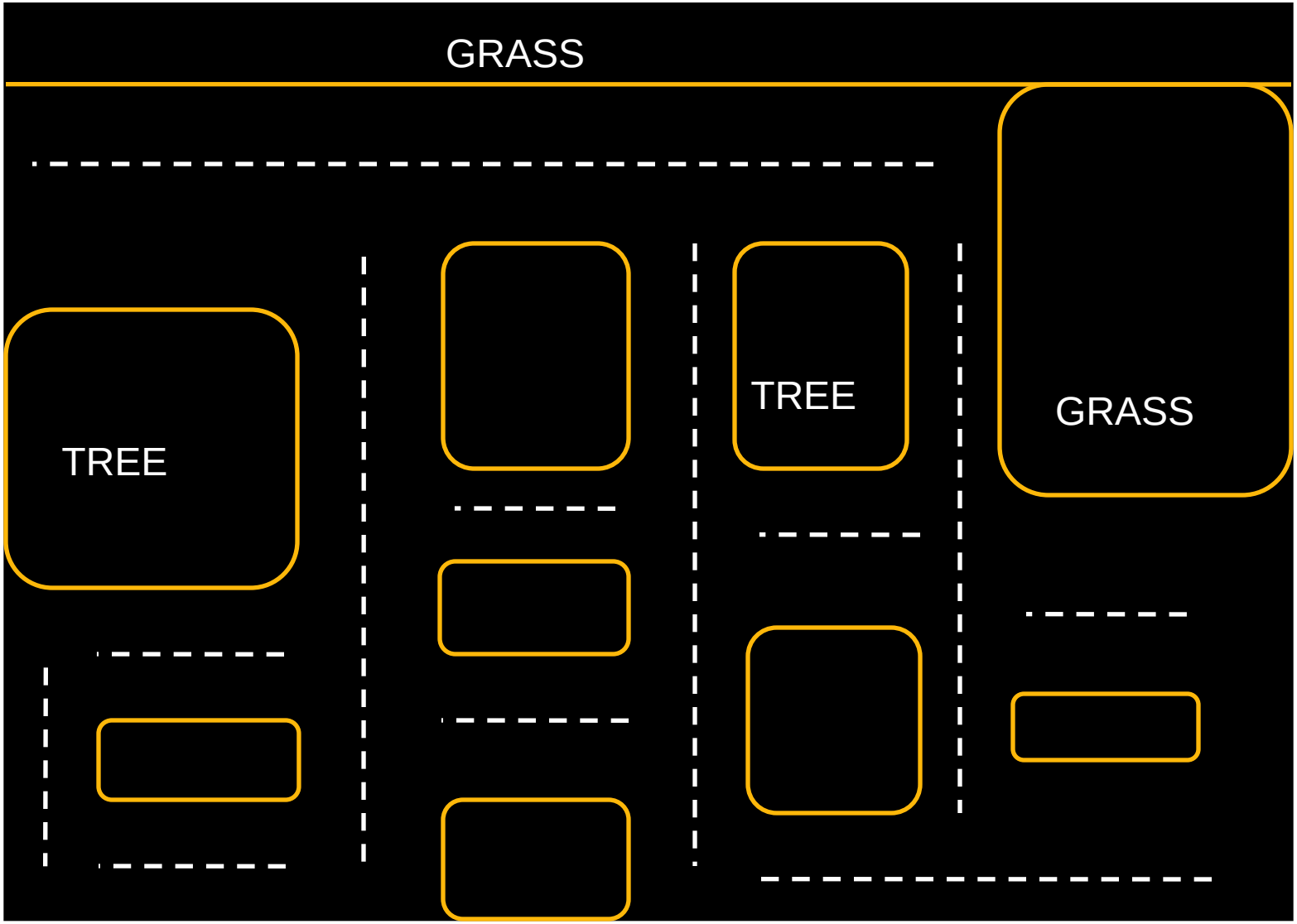
Virtual Map 2



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Evaluation Results

- System could calculate route under 30 seconds
- System could recalculate optimal route and navigate autonomously to destination
- User received notification of arrival within 10 seconds of arrival at destination
- Limited memory capacity of P3-AT processor resulting in smaller map area
- Vehicle was unable to maintain straight line course over a long distance due to lane drift
- GPS system was unreliable due to periodic loss of satellite signals

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Challenges

- Developing and implementing search algorithm to work with P3-AT vehicle
- GPS to P3-AT interface complications resulting in frequent communication loss
- Use of HCS12X board as an external processor for the GPS receiver
- Unavailability of maps of test area with latitude and longitude information

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Suggested Future Work

- Implementation of lane departure warning system to enable vehicle remain within lane
- Addition of obstacle detection system to enable vehicle operate outside controlled environment
- Addition of Assisted GPS system to ensure better location accuracy

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- Questions?