WWW.MWFTR.COM

HOWARD UNIVERSITY ECE DEPARTMENT
SENIOR DESIGN

CHRYSLER
INSPIRATION COMES STANDARD

AUTONOMOUS MAP FOLLOWER

Sponsored by Chrysler

CHRYSLER

INSPIRATION COMES STANDARD

Overview

- Introduction
- Problem Formulation
- Design Requirements
- Design Selection
- Final Solution
- Prototype Product
- Implementation
- Prototype Specifications
- Vehicle Subroutines
- Autonomous Vehicle Algorithm
- GPS System
- Evaluation and Results
- Suggested Future Work
- Review

CHRYSLER

INSPIRATION COMES STANDARD

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

CHRYSLER

INSPIRATION COMES STANDARD

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

CHRYSLER

INSPIRATION COMES STANDARD

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

CHRYSLER

INSPIRATION COMES STANDARD

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**

CHRYSLER

INSPIRATION COMES STANDARD

Final Solution

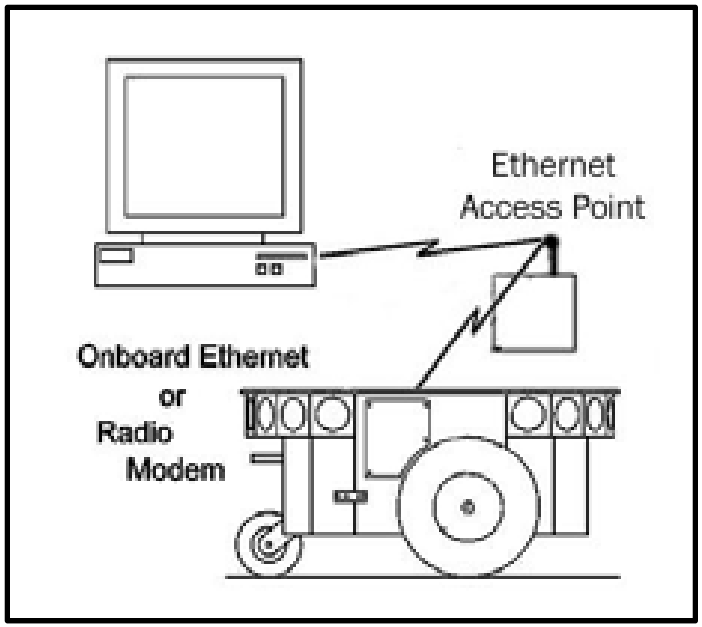
- Contains computer, and one microcontroller.
- Microcontroller in charge of receiving, interpreting GPS signal.
- Microcontroller will also be in charge of the motors and will move the vehicle.
- The computer will be the core part of the system that will interpret, plan, translate given instructions.

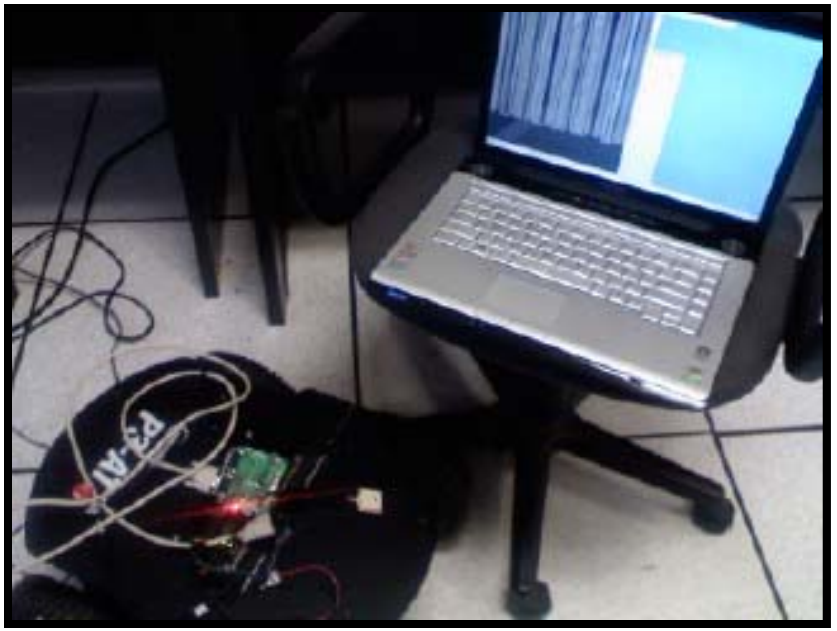
CHRYSLER

INSPIRATION COMES STANDARD

Prototype Product

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



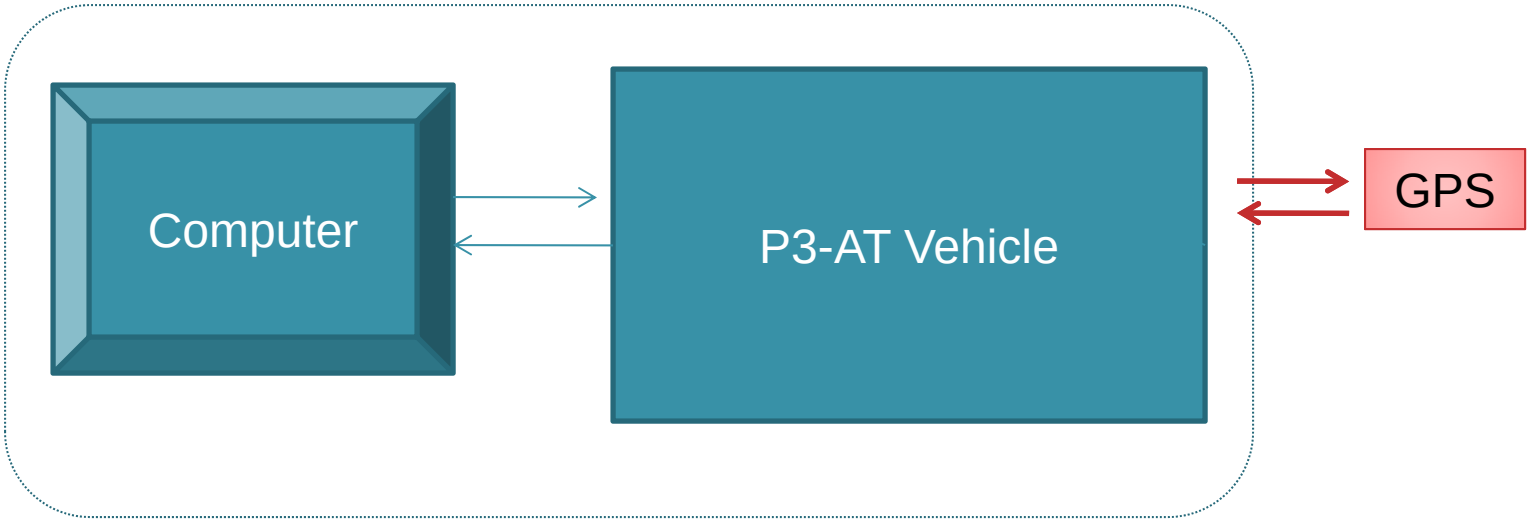


CHRYSLER

INSPIRATION COMES STANDARD

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



Prototype Specifications

CHRYSLER
INSPIRATION COMES STANDARD

P3-AT Vehicle

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

GPS

- Operating temperature between -30 ~ +80 C
- 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

CHRYSLER

INSPIRATION COMES STANDARD

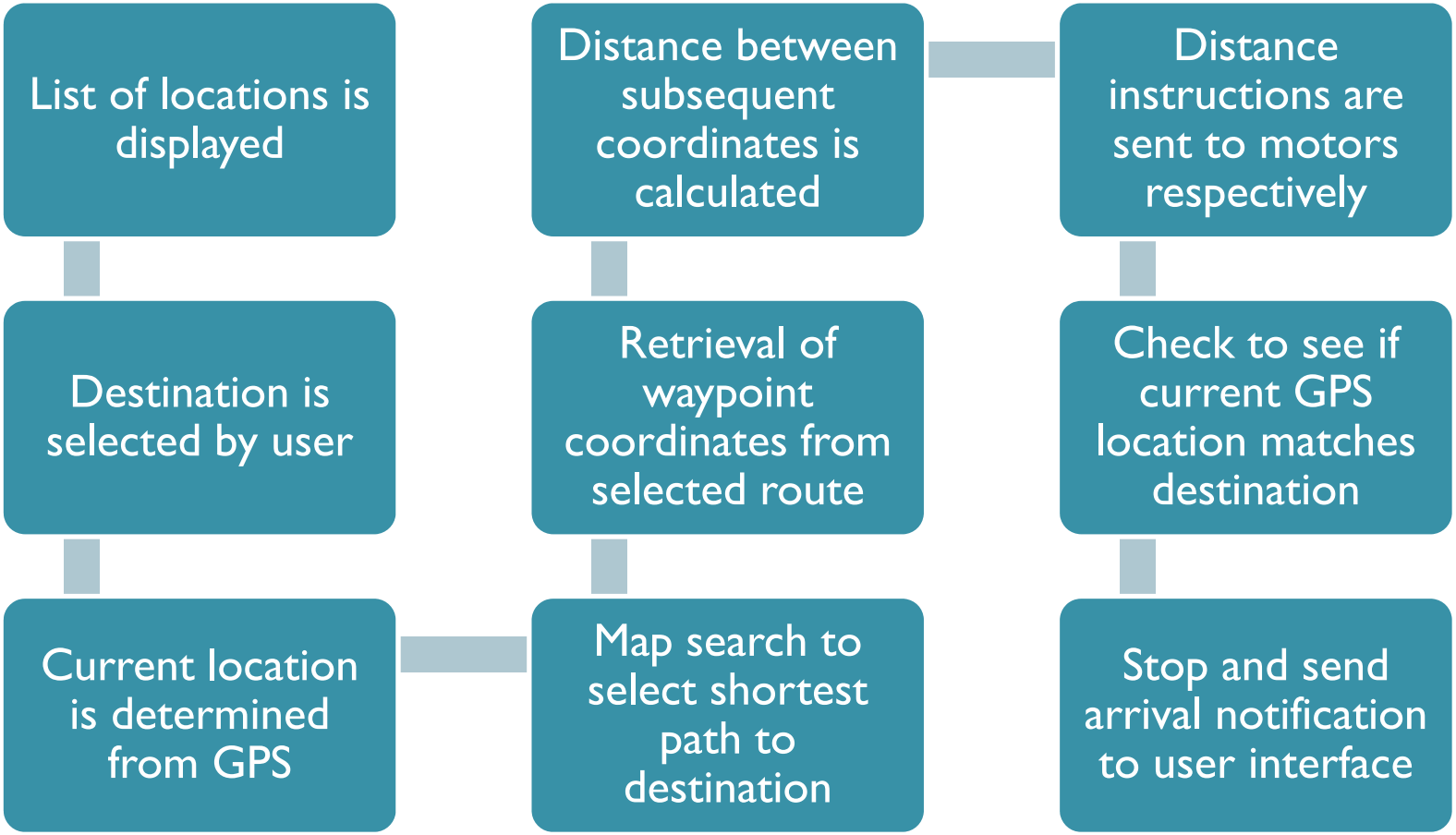
Vehicle Subroutines

- 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

CHRYSLER

INSPIRATION COMES STANDARD

Autonomous Vehicle Algorithm

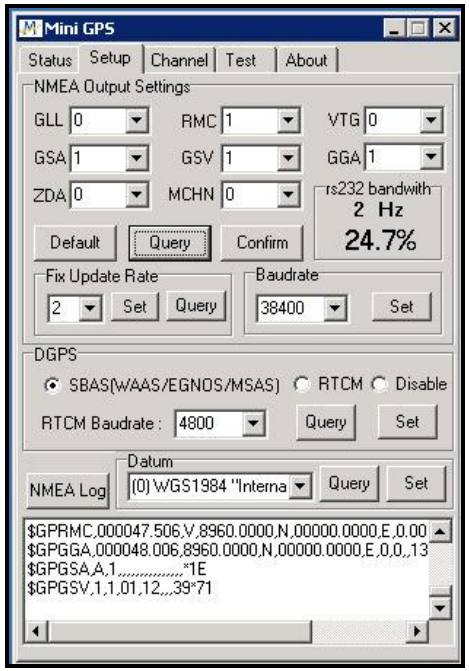


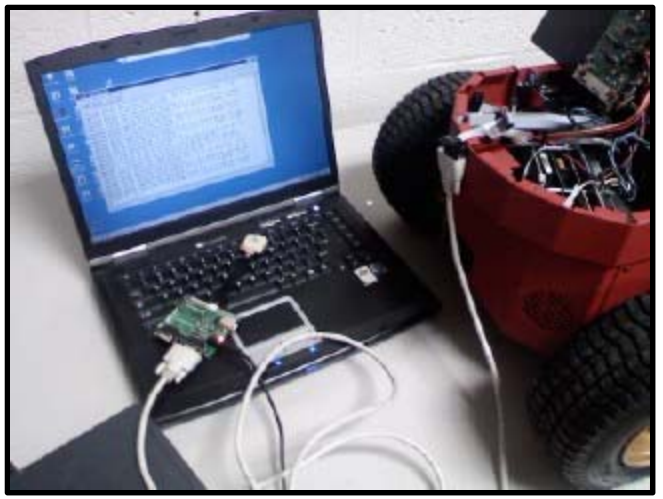
CHRYSLER

INSPIRATION COMES STANDARD

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)

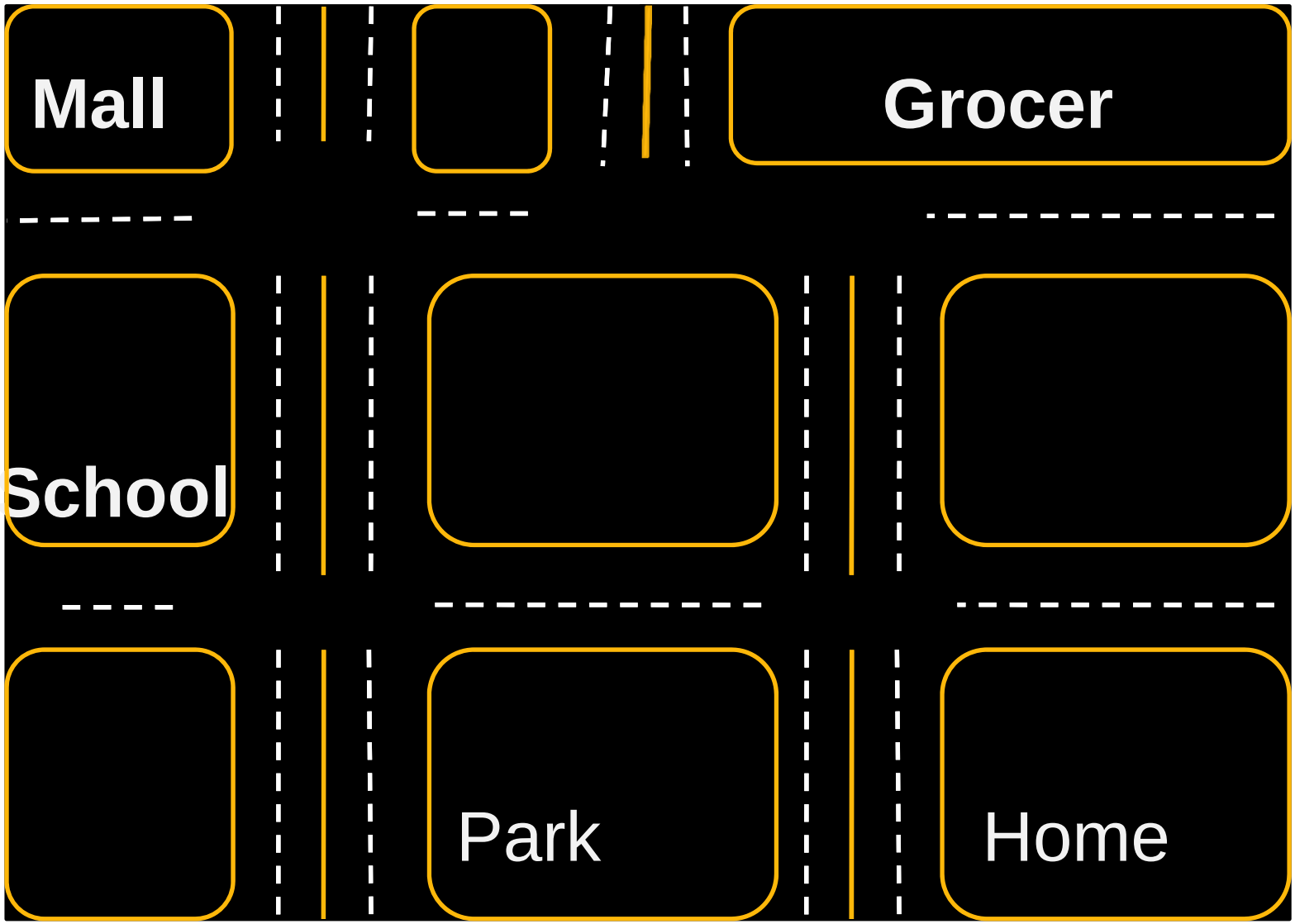




CHRYSLER

INSPIRATION COMES STANDARD

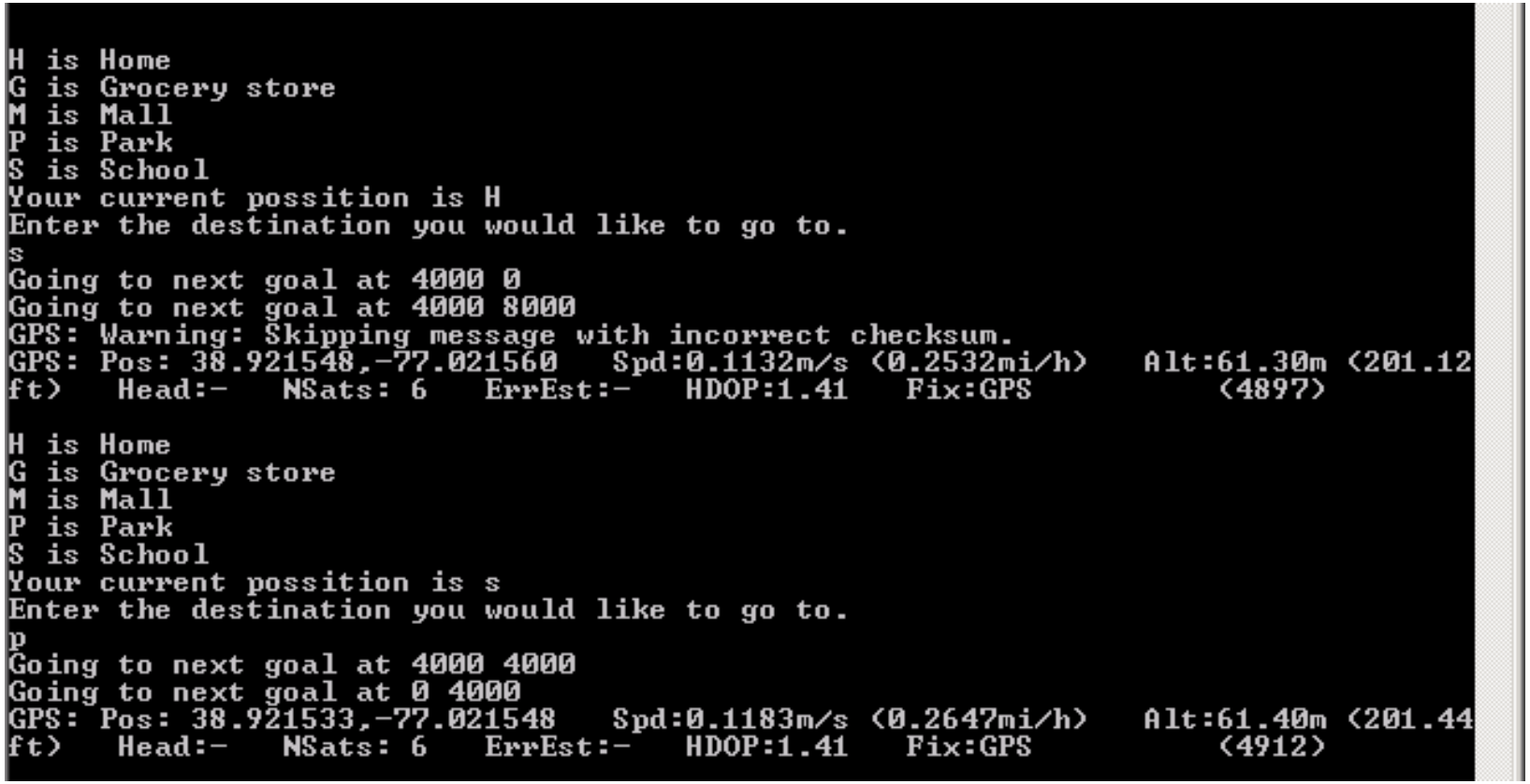
Virtual Map 1



CHRYSLER

INSPIRATION COMES STANDARD

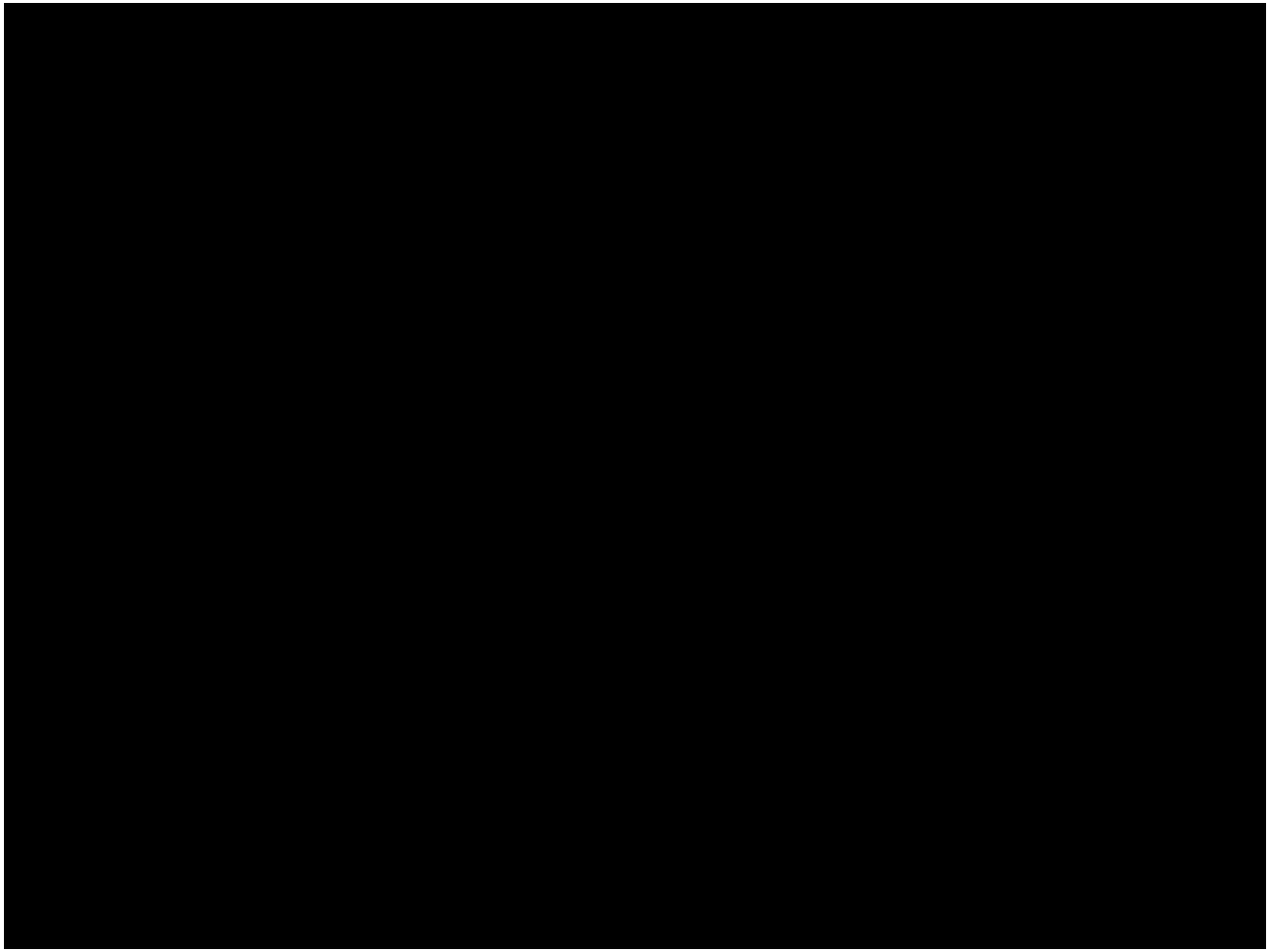
User Interface 1



CHRYSLER

INSPIRATION COMES STANDARD

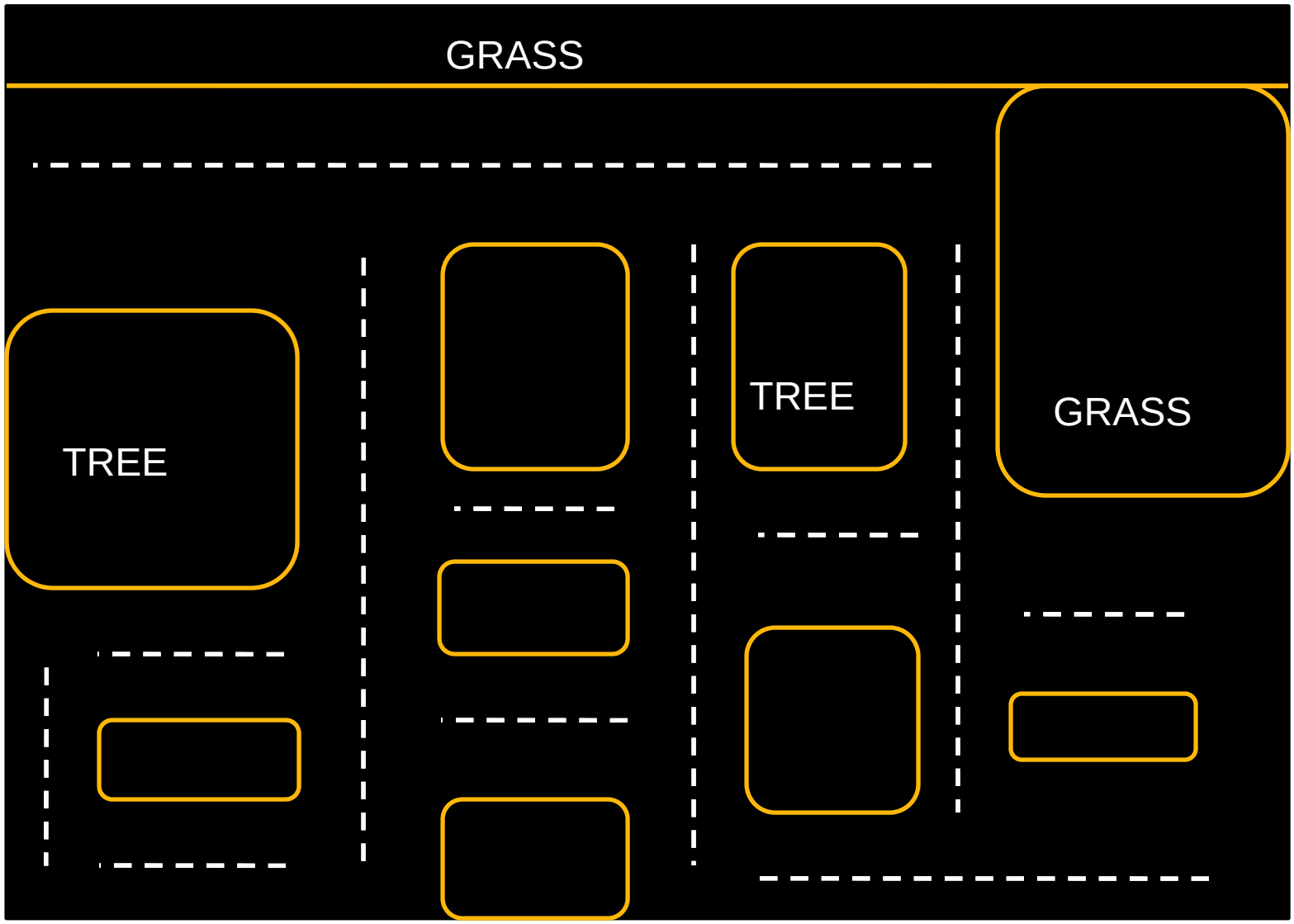
Demo Run



CHRYSLER

INSPIRATION COMES STANDARD

Virtual Map 2



CHRYSLER

INSPIRATION COMES STANDARD

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

CHRYSLER

INSPIRATION COMES STANDARD

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

CHRYSLER

INSPIRATION COMES STANDARD

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

CHRYSLER

INSPIRATION COMES STANDARD

Review

- Introduction
- Problem Formulation
- Design Requirements
- Design Selection
- Final Solution
- Prototype Product
- Implementation
- Prototype Specifications
- Vehicle Subroutines
- Autonomous Vehicle Algorithm
- GPS System
- Evaluation and Results
- Suggested Future Work
- Questions?