Autonomous Vehicle Navigation Using Stereoscopic Imaging

Senior Capstone Project Proposal

Department of Electrical and Computer Engineering
Bradley University

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Advisors: Dr. Huggins, Dr. Stewart

December 5th, 2006

Presentation Outline

• Project Overview
• Review of Previous Work
• System Block Diagram
• Subsystems Overview
• Modes of Operation
• Equipment
• Work Performed to Date
• Schedule for Spring Semester
• Questions
Project Overview

• The objective of our project is to develop a vehicle that can navigate autonomously through a terrain of obstacles.
• Utilizes Stereoscopic Imaging
• Two Modes of Operation
  – Calibration Mode
  – Navigation Mode

Previous Work

• Stereoscopic Imaging
  – Bradley Rover (Steve Goggins, Rob Scherbinski, and Pete Lange, 2005)
  – BirdTrak (Brian Crombie and Matt Zivney, 2003)

• ActivMedia P2-DX Robotic Platform
  – MapBot (Stephanie Luft, 2006)
  – GuideBot (Dan Leach and John Hathaway, 2005)
System Block Diagram

Subsystems

• Cameras
• Laptop and Software
• Robotic Platform
Cameras

- Photons
- Capture Signal
- Camera
- Image Data

Laptop

- Image 1
- Image 2
- User Input
- Robot Motor Information
- Laptop Computer
- User Output
- Movement Instructions
- Image Capture Signal
Software

Retrieve Images → Determine Direction to Move → Send Instructions to Robot

Analyze Images → Calculate Distances

Robotic Platform

ActivMedia Robotics Pioneer 2
Mobile Robotic Platform

Microprocessor

Left Wheel Motor → Right Wheel Motor

Movement Instructions → Motor Speed Information → Robot Movement
Modes of Operation

• Calibration Mode
  – Used to calibrate cameras and robot movement

• Navigation Mode
  – Main mode of operation where terrain navigation takes place

Calibration Mode

1. Start
2. Ensure Proper Lighting Available
3. Focus Cameras
4. Calibrate Robot Movement
5. Stop
Navigation Mode

Start

Retrieve Images

Analyze Images

Done Navigating Terrain?

Yes

Stop

No

Determine Direction to Move

Send Instruction To Robot

Robot Moves

Forward

Left

Right

Equipment

• Hardware
  – 2 Logitech Buddy Cams
  – Gateway Laptop
  – ActivMedia P2-DX Robotic Platform

• Software
  – Mathworks Matlab
  – Image Processing Toolbox
  – Image Acquisition Toolbox
# Work Performed to Date

<table>
<thead>
<tr>
<th>Week of</th>
<th>Task</th>
<th>Assigned To</th>
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</thead>
<tbody>
<tr>
<td>10/8</td>
<td>Get Specs of Robot Platform, Review Relevant Prior Senior Projects, Research Cameras</td>
<td>Nick, Both, Adam</td>
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<tr>
<td>10/15</td>
<td>Research Image Processing/Acquisition Toolboxes, Continue Researching Cameras</td>
<td>Nick, Adam</td>
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<tr>
<td>10/22</td>
<td>Test Available Cameras with Matlab, Continue Researching Cameras</td>
<td>Both, Both</td>
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<tr>
<td>10/29</td>
<td>Continue Researching Cameras</td>
<td>Both</td>
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<tr>
<td>11/5</td>
<td>Setup Gateway Laptop, Continue Researching Cameras</td>
<td>Adam, Nick</td>
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<td>11/12</td>
<td>Continue Researching Cameras, Project Deliverable Documents</td>
<td>Both, Nick</td>
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<td>11/19</td>
<td>Thanksgiving Break!</td>
<td>Both</td>
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<tr>
<td>11/26</td>
<td>Performed Color Testing on Buddy Cams, Project Deliverable Documents</td>
<td>Adam, Nick</td>
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# Spring Schedule

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<tr>
<th>Week of</th>
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</thead>
<tbody>
<tr>
<td>1/21</td>
<td>Adjust Pinhole Equations for Horizontal Cameras, Begin Development of 3D Map Software</td>
<td>Nick, Adam</td>
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<td>1/28</td>
<td>Begin Distance Calculation Software, Continue 3D Map Software</td>
<td>Nick, Adam</td>
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<tr>
<td>2/4</td>
<td>Continue Distance Calculation Software, Continue 3D Map Software</td>
<td>Nick, Adam</td>
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<td>2/11</td>
<td>Continue Distance Calculation Software, Continue 3D Map Software</td>
<td>Nick, Adam</td>
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<tr>
<td>2/18</td>
<td>Begin Edge Detection Algorithms, Begin Interfacing Robot Platform with PC/Matlab</td>
<td>Nick, Adam</td>
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<tr>
<td>2/25</td>
<td>Continue Edge Detection Algorithms, Continue Interfacing Robot Platform</td>
<td>Nick, Adam</td>
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<td>Continue Edge Detection Algorithms</td>
<td>Nick</td>
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<tr>
<td></td>
<td>Continue Interfacing Robot Platform</td>
<td>Adam</td>
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<tr>
<td>3/16</td>
<td>Spring Break!</td>
<td>Both</td>
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<tr>
<td>3/25</td>
<td>Begin Direction Decision Algorithms</td>
<td>Nick</td>
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<tr>
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<td>Begin Implementing Max Time</td>
<td>Adam</td>
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<td>4/8</td>
<td>Continue Direction Decision Algorithms</td>
<td>Nick</td>
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Questions

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