Image Processing Based Autonomous Bradley Rover

Bradley University
ECE Department
December 7th, 2004

Team Members:
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Pete Lange
Rob Scherbinske

Advisors:
Dr. Huggins
Dr. Malinowski
Dr. Schertz
Project Summary

- Autonomous Vehicle Navigation
  - Object Avoidance
  - Heading Control
  - Vehicle Locator
- Web-Based Control
- Wireless Communication Link
Project Outline

- Previous Work
- Project Description
- Preliminary Lab Work
- Equipment and Parts List
- Development Schedule
- Questions
Project Outline

- **Previous Work**
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Previous Senior Project Work

- BirdTrak Project – Brian Crombie and Matt Zivney (2003)
  - Basic Stereoscopic Imaging Techniques
  - Datasheets for Gaucho and Linear Actuator
  - NMEA Message Parsing Method
Standards

  - Transmitter Power: 1 mW – 1000 mW
  - Input level: -76 dBm (min) to -10 dBm (max)
- National Marine Electronics Association (NMEA) GPS Messaging Standard
### Applicable Patents

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>6,661,449</td>
<td>Object recognizing apparatus for vehicle and the method thereof</td>
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<tr>
<td>5,812,269</td>
<td>Triangulation-based 3-D imaging and processing method</td>
</tr>
<tr>
<td>6,751,535</td>
<td>Travel controlling apparatus of unmanned vehicle</td>
</tr>
<tr>
<td>6,151,539</td>
<td>Autonomous vehicle arrangement and method for controlling an autonomous vehicle</td>
</tr>
<tr>
<td>6,775,614</td>
<td>Vehicle navigation system using live images</td>
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</table>
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Project Description

- Functional Description
- Block Diagram
- Datasheet
Project Description

- **Functional Description**
  - System I/O
  - Modes of Operation
- Block Diagram
-Datasheet
System I/O

PHOTONS
Modes of Operation

- **Wait** – Startup mode with systems active but no data processing
- **Relocate** – Systems active including data acquisition and processing. Motors active.
- **SOS** – Catch-all for any errors or in the event of unavoidable obstacles. Same as wait mode except cannot recover without operator intervention
Project Description

- Functional Description
- **Block Diagram**
- Datasheet
Block Diagram
Detailed Subsystem Block Diagram
Project Description

- Functional Description
- Block Diagram
- Datasheet
Datasheet

- Maximum Speed – TBD
- Turning Radius – TBD
- Motor HP - TBD
- Sensors
  - Stereoscopic Cameras
  - GPS Receiver
  - Digital Compass
- Battery Life – TBD
- RF Link Range – TBD
- Field of View – TBD
- Object Resolution (Maximum Distance) – TBD
- Image Processing Latency - TBD
- Client System Requirements - TBD
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Preliminary Lab Work

- **Stereoscopic Imaging Progress**
- GPS Receiver Progress
- 802.11x Progress
Stereoscopic Imaging Progress

- Matlab Image Acquisition Toolbox
- USB Cameras
- Camera Calibration Toolbox for Matlab
- Pinhole Camera Equations
Stereoscopic Imaging Progress

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Stereoscopic Imaging Progress

- Matlab Image Acquisition Toolbox
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- Pinhole Camera Equations
Pinhole Camera Equations and Coordinate System

\[ X = \frac{X_L \ast d}{X_L - X_R} \]
\[ Y = \frac{Y_L \ast d}{X_L - X_R} \]
\[ Z = \frac{f \ast d}{X_L - X_R} \]

Equations from Bird Tracking Project 2003
Preliminary Lab Work

- Stereoscopic Imaging Progress
- GPS Receiver Progress
- 802.11x Progress
GPS Receiver Progress

- Ashtech G8 GPS Receiver chosen
- Jobst/Baker quad landmarks mapped
- Java chosen for serial port communication and GPS data parsing
- NMEA messages for initialization and position request tested via Hyperterminal
- Java serial port initialization code investigated
Preliminary Lab Work

- Stereoscopic Imaging Progress
- GPS Receiver Progress
- 802.11x Progress
802.11x Progress

- 802.11 standards researched
- Power and signal levels researched
- RF antenna design researched
- Friis Transmission Formula:

\[ P_r = P_t g_t g_r \left( \frac{\lambda}{4\pi r} \right)^2 \]
Project Outline

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Equipment and Parts List

- Bradley Rover (Gaucho)
  - MEM00015 DC Motors
  - Electrak 1 Linear Actuator with feedback potentiometer
- 2 USB 2.0 Webcams – Undetermined Model
- Onboard Laptop – Gateway 450Eb series
- Standard Lab PC in grad-lab for Java Server
- Ashtech G8 GPS Receiver – Part #110085
- Vector 2X Digital Compass Module – Part #126703
- 12V Car Battery
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## Development Schedule

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<thead>
<tr>
<th>Week</th>
<th>Pete</th>
<th>Rob</th>
<th>Steve</th>
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<tr>
<td>1</td>
<td>RF Antenna &amp; Power Electronics Designs</td>
<td>Camera System Assembly and Testing</td>
<td>GPS Software</td>
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<td>2</td>
<td>RF Antenna &amp; Power Electronics Designs</td>
<td>Camera System Testing and Beginning Calibration</td>
<td>GPS Software</td>
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<td>3</td>
<td>RF Antenna &amp; Power Electronics Designs</td>
<td>Camera System Calibration (Matlab Code)</td>
<td>Digital Compass Control</td>
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<td>Power Electronics Design &amp; Construction</td>
<td>Correlating Images Work (Matlab Code) &amp; Object Avoidance Algorithm</td>
<td>Global Navigation</td>
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<tr>
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<tr>
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<td>Avoidance System Testing</td>
<td>Java Web Interface</td>
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