Autonomous Vehicle Navigation Using
Stereoscopic Imaging

Senior Capstone Project Proposal

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Presentation Outline

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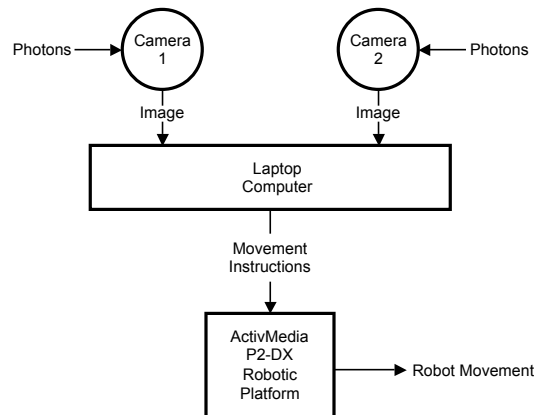- Schedule for Spring Semester
- Questions

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)
  - T-bird (Arik Brooks and Nick Patrick, 2004)
  - BirdTrak (Brian Crombie and Matt Zivney, 2003)

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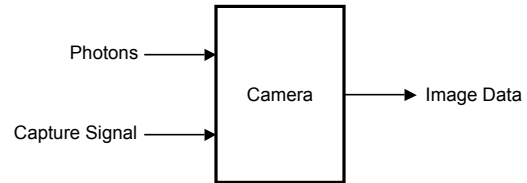
System Block Diagram

Photons → Camera 1

Camera 2 ← Photons

Image

Image

Laptop Computer

Movement Instructions

ActivMedia P2-DX Robotic Platform → Robot Movement
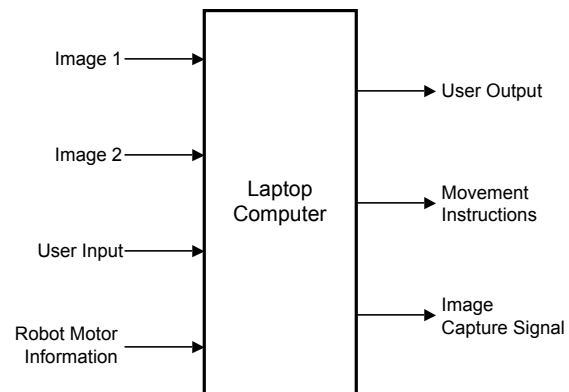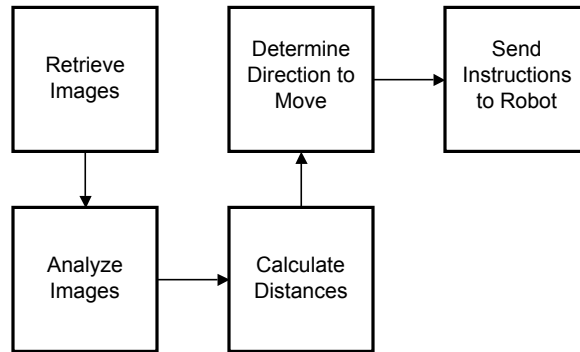
Subsystems

- 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│      │Determine │      │  Send    │
│ Images  │      │Direction │ ───> │Instructions│
│         │      │to Move   │      │ to Robot │
└────┬────┘      └────▲─────┘      └──────────┘
     │                │
     ▼                │
┌─────────┐      ┌────┴─────┐
│ Analyze │ ───> │Calculate │
│ Images  │      │Distances │
│         │      │          │
└─────────┘      └──────────┘
```

Robotic Platform

```
┌──────────────────────────────────────────┐
│   ActivMedia Robotics Pioneer 2           │
│   Mobile Robotic Platform                 │
│                                           │
│                  ┌──────────────┐         │
Movement ──────────>│Microprocessor│         │
Instructions       └──────┬───────┘         │
│                    ┌─────┴─────┐           │
│                    ▼           ▼           │
│              ┌──────┐    ┌──────┐          │
│              │ Left │    │Right │          │
│              │Wheel │    │Wheel │──> Motor Speed
│              │Motor │    │Motor │    Information
│              └──────┘    └──────┘          │
│                                  ──> Robot Movement
└──────────────────────────────────────────┘
```
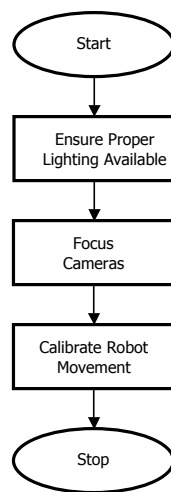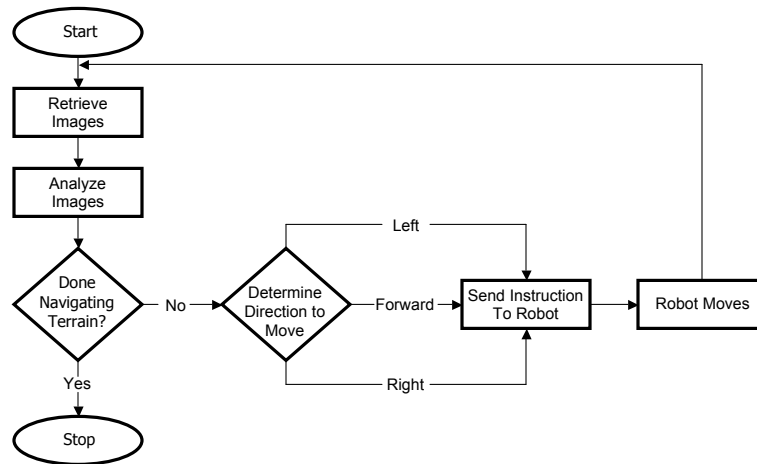
Modes of Operation

- Calibration Mode
  - Used to calibrate cameras and robot movement

- Navigation Mode
  - Main mode of operation where terrain navigation takes place

Calibration Mode

```
        ( Start )
            |
            v
  +-------------------+
  |  Ensure Proper    |
  | Lighting Available|
  +-------------------+
            |
            v
  +-------------------+
  |      Focus        |
  |     Cameras       |
  +-------------------+
            |
            v
  +-------------------+
  | Calibrate Robot   |
  |    Movement       |
  +-------------------+
            |
            v
        ( Stop )
```

Navigation Mode

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

Week of	Task	Assigned To
10/8	Get Specs of Robot Platform Review Relevant Prior Senior Projects Research Cameras	Nick Both Adam
10/15	Research Image Processing/Acquisiton Toolboxes Continue Researching Cameras	Nick Adam
10/22	Test Available Cameras with Matlab Continue Researching Cameras	Both Both
10/29	Continue Researching Cameras	Both
11/5	Setup Gateway Laptop Continue Researching Cameras	Adam Nick
11/12	Continue Researching Cameras Project Deliverable Documents	Both Nick
11/19	Thanksgiving Break!	Both
11/26	Performed Color Testing on Buddy Cams Project Deliverable Documents	Adam Nick

Spring Schedule

Week of	Task	Assigned To
1/21	Adjust Pinhole Equations for Horizontal Cameras Begin Development of 3D Map Software	Nick Adam
1/28	Begin Distance Calculation Software Continue 3D Map Software	Nick Adam
2/4	Continue Distance Calculation Software Continue 3D Map Software	Nick Adam
2/11	Continue Distance Calculation Software Continue 3D Map Software	Nick Adam
2/18	Begin Edge Detection Algorithms Begin Interfacing Robot Platform with PC/Matlab	Nick Adam
2/25	Continue Edge Detection Algorithms Continue Interfacing Robot Platform	Nick Adam
3/4	Continue Edge Detection Algorithms Continue Interfacing Robot Platform	Nick Adam

Spring Schedule

Week of	Task	Assigned To
3/11	Continue Edge Detection Algorithms Continue Interfacing Robot Platform	Nick Adam
3/18	Spring Break!	Both
3/25	Begin Direction Decision Algorithms Begin Implementing Max Time	Nick Adam
4/8	Continue Direction Decision Algorithms Continue Implementing Max Time	Nick Adam
4/15	Continue Direction Decision Algorithms "Close the Loop" with Motor Speed Feedback	Nick Adam
4/22	Continue Direction Decision Algorithms "Close the Loop" with Motor Speed Feedback	Nick Adam
4/29	Continue Direction Decision Algorithms "Close the Loop" with Motor Speed Feedback	Nick Adam

Questions

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