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# Infrared Stereo-Vision Target Tracking Robot

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# Infrared Stereo-Vision Target Tracking Robot

ECE 404 | **Team members:** Alex Elliott, Jeff Miller, Juan Perez | **Faculty adviser:** Dr. Yuichi Motai

## Abstract

Long wave infrared (LWIR) computer stereo-vision was implemented using thermal imaging sensors mounted to a mobile robot platform in order to perform target tracking. Distance estimation was obtained from a stereo-correspondence algorithm to facilitate implementation.

## Background

- Depth information from a set of 2-dimensional images of the same scene can be extracted by way of triangulation.
- The human brain utilizes this concept in order to perceive depth.
- Computers can replicate this by solving the stereo-correspondence problem.
- Although computer stereo-vision has been actively researched for more than a decade, there are very few applications using LWIR.

## Hardware

- Intel NUC
- Pioneer 3 Mobile Robot
- Raytheon Thermal Imaging Sensors

## Software

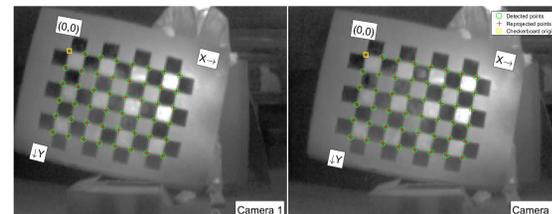- Matlab
- OpenCV Library
- ARIA Library
- Visual Studio

## Stereo-Calibration

- Calibrating the set of cameras produces the Fundamental Matrix, **F**.
- For a point in 3D space **X**, image points **x** and **x'** satisfy the following equation
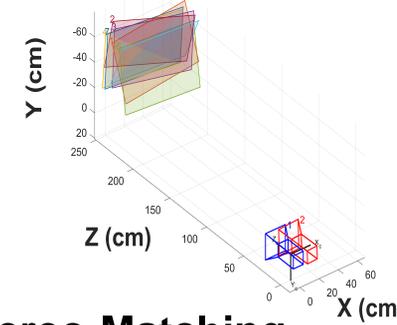
$$x'^{T}Fx = 0$$

- A checkered board pattern was used to perform the calibration.

- The complexity of the problem is reduced for cameras in the same image plane.
- Orientations of checkerboard and results of calibration are depicted in the figure.
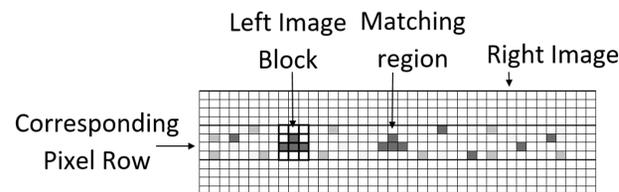
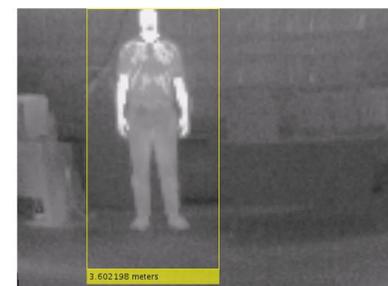**Extrinsic Parameters Visualization**

## Stereo-Matching

- The Sum of Absolute Differences (SAD) formula was used to match feature points between the two images.
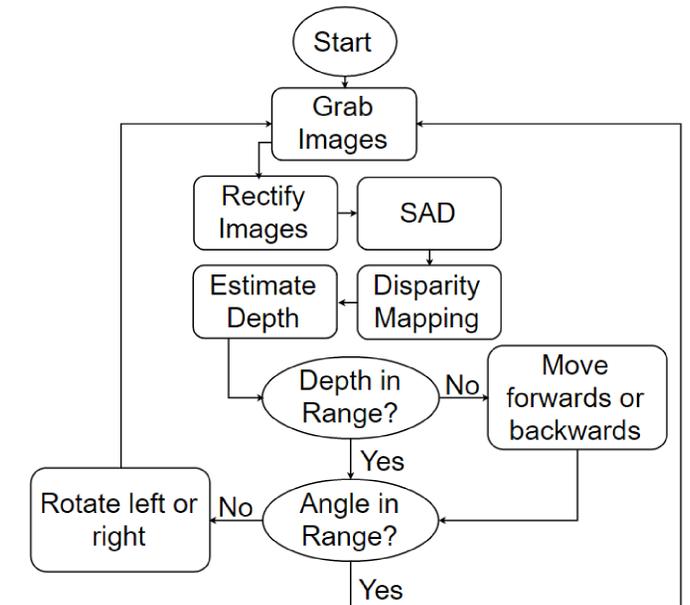
$$SAD = \sum_{i=0}^{i}\sqrt{(a_i - b_i)^2}$$

- The disparity between identical points is inversely proportional to depth

Left Image Matching
Block region Right Image

Corresponding
Pixel Row

- A box is drawn around detected targets and includes depth information.

## Tracking Algorithm

Start → Grab Images → Rectify Images → SAD → Disparity Mapping → Estimate Depth → Depth in Range? → No → Move forwards or backwards → Yes → Angle in Range? → No → Rotate left or right → Yes

## Results

- Reference block of size 5 returned average error of 9.1%
- Reference block of size 25 returned average error of 12.2%

**Stereo Depth Estimation vs True Distance**

Block size 5
Block size 25

Stereo Depth (m)
True Distance (m)