# Firefighter Indoor Navigation using Distributed SLAM (FINDS)

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## Background

In December of 1999, a fire broke out in a cold storage warehouse in Worcester, MA. A combination of poor building construction and faulty floor plans led to two firefighters becoming lost, and subsequently running out of air. Additional teams were sent in to rescue the two firefighters. By the end, six firefighters lost their lives. The need was established to supply the Incident Commander with the current location of each firefighter in order to both communicate directions to firefighters and direct rescue teams to the location of a downed firefighter.

### Simultaneous Localization and Mapping (SLAM)

SLAM is a method of localization that utilizes a series of images to build a map of an unknown environment. SLAM functions by identifying and tracking features (corners) from frame to frame. The open source EKFMonoSLAM[1]

Mobile Unit

Base Station

## Design

Mobile Unit (device worn by the firefighter)

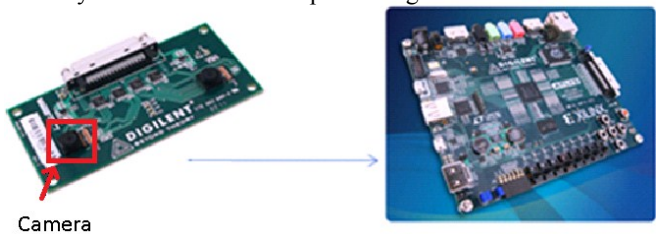
- Captures video
- Processes images to detect corners, and sends data to Base Station

Base Station (laptop used by incident commander)

- Receives data (corner coordinates), and inputs them to SLAM algorithm
- Calculates and displays location of Firefighter

## Implementation

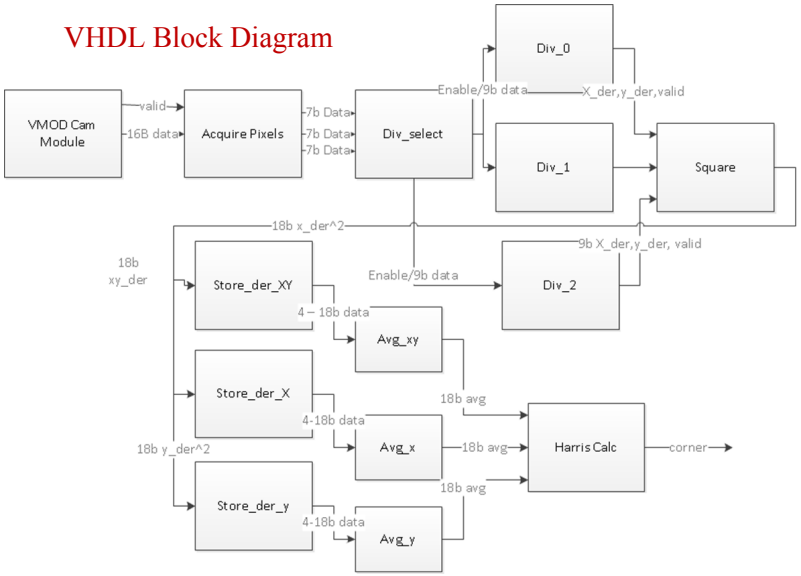
The Mobile Unit consist of VModCAM for video capture and Atlys FPGA for real-time processing.



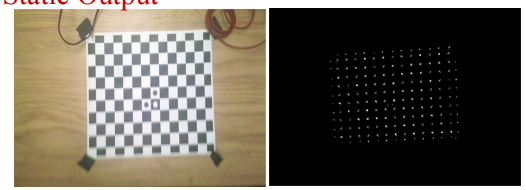

Corner Detection utilized Harris Corner Detection[2] Algorithm, which was implemented in VHDL.

$$H(x,y)=detC\_str-\alpha(traceC\_str)^2$$

### VHDL Block Diagram

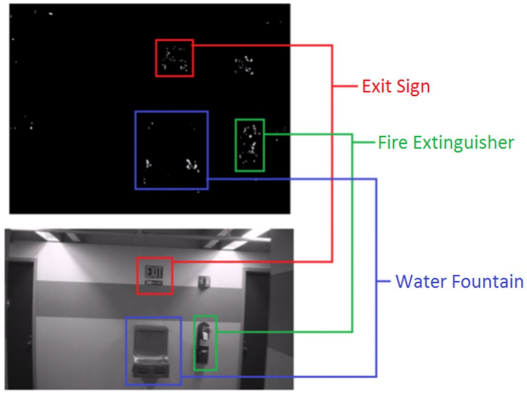



### Static Output



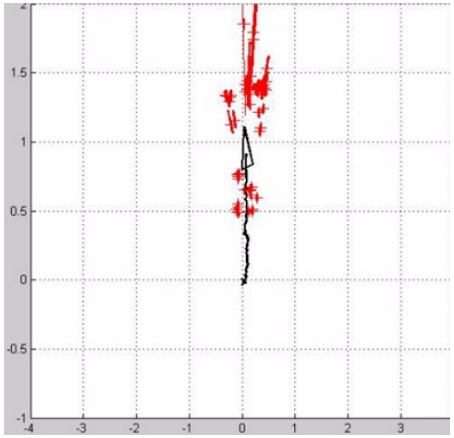
## Results

### Corner Detection Verification




The system was tested by walking down the corridor and observing the path at the base station

### Complete System Verification




[1] Javier Civera, Oscar G. Grasa, Andrew J. Davison, J. M. M. Montiel, 1-Point RANSAC for EKF Filtering: Application to Real-Time Structure from Motion and Visual dometry, to appear in Journal of Field Robotics, October 2010.
[2] Csetverikov, Dmitrij. *"Basic Algorithms for Digital Image Analysis: acourse"* Institute of Informatics Budapest, Hungary. http://ssip2003.info.uvt.ro/lectures/chetverikov/corner_detection.pdf (accessed October 5, 2011)

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