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THESIS

Your Name, First Lieutenant, USAF

AFIT-ENG-MS-20-90210

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT-ENG-MS-20-90210

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THESIS

Presented to the Faculty

Department of Electrical and Computer Engineering

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

in Partial Fulfillment of the Requirements for the

Degree of Master of Science in Electrical Engineering

Your Name, B.S.E.E.

First Lieutenant, USAF

March 26, 2020

AFIT-ENG-MS-20-90210

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THESIS

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First Lieutenant, USAF

Committee Membership:

Your Advisor, Ph.D
Chair

First Committee Member, Ph.D
Member

Second Committee Member, Ph.D
Member

AFIT-ENG-MS-20-90210

Abstract

Cool, awesome abstract that tells people why they should read your awesome thesis.

Table of Contents

List of Figures

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I. Introduction

Overview the chapter here

1.1 First Section Title Here

Modern navigation solutions used in practical applications substantially rely on the use of the Global Positioning System (GPS), as when fully operational, no other technology can currently achieve a similar performance. Blah...

1.1.1 Classical Cameras and Feature Detection

1.2 Research Objectives

The primary goal of this research is to ...

1.3 Document Overview

This document is organized as follows. Chapter II provides an overview of relevant background information. Chapter III details the process of training a Convolutional Neural Network (CNN) that produces feature points and descriptors, and the method of evaluating this network. Chapter IV presents the results of evaluating variations of the feature detector/descriptor network, as well as the results of the Event Visual-inertial Odometry (EVIO) pipeline. Finally, Chapter V discusses the conclusions drawn from the results.

1.4 First Section Title Here

Text description here, can reference other Chapters or Sections, like Chapter I or ??.

1.4.1 Subsection Title Here

Take about an equation with text without space, like

$$\frac{1}{z}\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = K \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} \tag{1}$$

where λ can be referenced. Don't put lines before or after equations, unless the equation is the end of a paragraph's discussion.

You can also include an algorithm, like Algorithm 1.

Reference equations a little differently like (1). Or reference a table like Table 1.

Algorithm 1 Algorithm Title Here

function FOO(a, b, c)
  $\mathbf{R}_W^{C_0}, \mathbf{p}_{C_0}^W \leftarrow$ GETPOSE($e_0.t$) ▷ Target pose
  for $k \leftarrow 1, N$ **do** ▷ Loop over events
    $\begin{bmatrix} x_H \\ y_H \end{bmatrix} \leftarrow$ UNDISTPOS(e_x, e_y) ▷ Pixel location to position
  end for
  return *image* ▷ Output
end function

Table 1: Table Title Here

Description	**Variable**	**Value**
Focal lengths	f_x	198.444
	f_y	198.826
Image Center	c_x	104.829
	c_y	92.838
Radial Distortion	k_1	-0.394
	k_2	0.156
	k_3	0
Tangential Distortion	p_1	-0.125×10^{-3}
	p_2	-1.629×10^{-3}

II. Background and Literature Review

Overview the chapter here

2.1 Visual Odometry

Add descriptions, figures, cool text and more to this chapter! For example:

And cite cool literature, like this [1].

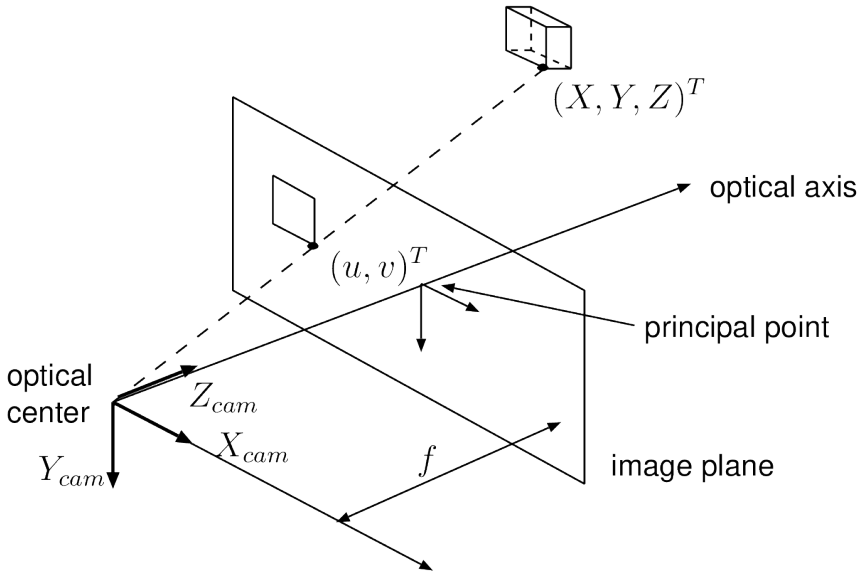

Figure 1: Longer, more descriptive caption for under the figure. This caption should stand alone (with the image of course). For example: Perspective Projection Pinhole Camera Model: 3-D objects in space are projected through an optical center onto a 2-D image plane.

III. Methodology

Preamble

The methodology described in this chapter is inspired by a combination of research to build an Event Visual-inertial Odometry (EVIO) pipeline....

3.1 Programming Platform

The Python programming language [**?**] was used with multiple specialized libraries throughout this work mainly for its compatibility with the TensorFlow ...

3.1.1 Some Cool Equations

First, prior to propagating the covariance as described in **??**, $\mathbf{\Phi}_k$ is modified according to Equation (2) - Equation (4), where $\mathbf{\Phi}_{11}$, $\mathbf{\Phi}_{31}$ and $\mathbf{\Phi}_{51}$ correspond to the first, third and fifth 3×3 blocks in the first three columns of $\mathbf{\Phi}_k$.

$$\mathbf{\Phi}_{11} = \mathbf{R}_{I,k|k-1}^{I,k+1|k} = \mathbf{R}_{G}^{I,k+1|k}\mathbf{R}_{I,k|k-1}^{G} \tag{2}$$

$$\mathbf{\Phi}_{31}\mathbf{R}_{G,k|k-1}^{I}\mathbf{g}^{G} = ([\hat{\mathbf{v}}_{I,k|k-1}^{G}\times] - [\hat{\mathbf{v}}_{I,k+1|k}^{G}\times])\mathbf{g}^{G} \tag{3}$$

$$\mathbf{\Phi}_{51}\mathbf{R}_{G,k|k-1}^{I}\mathbf{g}^{G} = (\delta t[\hat{\mathbf{v}}_{I,k|k-1}^{G}\times] - [\hat{\mathbf{p}}_{I,k+1|k}^{G}\times])\mathbf{g}^{G} \tag{4}$$

IV. Results and Analysis

Preamble

Fill this with your cool results

4.1 Awesome Stuff I got to Work

V. Conclusions

In this thesis we did cool stuff....

5.1 Future Work

Stuff you would have been able to accomplish if you had been able to clone yourself.

- Saved all stranded kittens everywhere
- World Peace
- 5 incredible, completely true bullets for my TR.

Add some heavy derivations, extra data and/or plots here.

Bibliography

1. Davide Scaramuzza and Friedrich Fraundorfer. Visual odometry part I: The first 30 years and fundamentals. *Robotics and Automation Magazine*, pages 80—-92, Dec 2011.

Acronyms

CNN Convolutional Neural Network. 1

EVIO Event Visual-inertial Odometry. 1, 5

GPS Global Positioning System. 1

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Summarized version of your awesome abstract.

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artificial neural network (ANN), convolutional neural network (CNN), deep learning, dynamic vision sensor (DVS), event-based cameras, event-based visual-inertial odometry (EVIO), Extended Kalman Filter (EKF), machine learning, multi-state constraint Kalman filter (MSCKF), neuromorphic engineering, visual odometry (VO)

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