بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة / سامية زكى يوسف

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات: لا يوجد

Ain Shams University
Faculty of Engineering
Public Works Department

Indoor Navigation Using Smart Devices Sensors

A Thesis submitted in partial fulfillment of the requirements of the degree of Doctor of Philosophy in Civil Engineering (Public Works Department)

by

Eng. Mohamed Ramadan Kassem Mohamed

Master of Science in Civil Engineering (Public Works)
Faculty of Engineering, Ain Shams University, 2014

Supervised By

Prof. Dr. Mohamed Elhosseiny Abdel Khalk El-Tokhey,

Professor of Surveying and Geodesy
Faculty of Engineering, Ain Shams University, Cairo, Egypt

Prof. Dr. Ayman Fouad Mohamed Ragab,

Professor of Photogrammetric Surveying
Faculty of Engineering, Ain Shams University, Cairo, Egypt

Prof. Dr. Tamer Fathy Fath-Allah Ahmed,

Professor of Surveying and Geodesy
Faculty of Engineering, Ain Shams University, Cairo, Egypt

Dr. Ahmed Emad Hafez Ragheb

Associate Professor of Surveying and Geodesy
Faculty of Engineering, Ain Shams University, Cairo, Egypt

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Examiners' Committee

Name and Affiliation	Signature
Prof. Dr. Mohamed Elhosseiny Abdel Khalk El-Tokhey Professor of Surveying and Geodesy Faculty of Engineering, Ain Shams University	.....
Prof. Dr. Naser El-Sheimy Professor of Geomatics Schulich School of Engineering, University of Calgary	.....
Prof. Dr. Ibrahim Fathy Mohamed Shaker Professor of Surveying and Geodesy Faculty of Engineering, Ain Shams University	.....

Date: 07 May 2022

Dedication

This work took years from my life. I wish to dedicate it to those who suffered to educate, prepare and help me to be as I am,

To My Lovely Mother and The Soul of My Father

Also, I wish to dedicate my thesis

To My Dear Sisters

for their encouragement and help to complete this work.

Finally, I wish to dedicate my thesis

To Everyone Who At Least Listened to Me When I Needed Something

Statement

This thesis is submitted as partial fulfillment of Doctor of Philosophy in Civil Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Eng. Mohamed Ramadan Kassem Mohamed

Signature:....Mohamed Ramadan....

Date: 07 May 2022

Researcher Data

Name: Mohamed Ramadan Kassem

Date of birth: 17 / 12 / 1981

Place of birth: Egypt

Last academic degree: M.Sc. Degree

Field of specialization: Civil Engineering

University issued the degree: Ain Shams University

Date of issued degree: 2014

Current job: Teacher Assistant

Abstract

In indoor navigation, cameras may be used as an aiding algorithm for inertial navigation. Also, fast and accurate image matching is an important task used in various applications in computer vision and visual odometry.

Recently many techniques for detection, description, and matching are available. A comparison was made between different algorithms offered by the OpenCV library to show which algorithm was the best and most robust against image distortions. The results showed that the ORB detector, the ORB descriptor, and either the BruteForce-Hamming or the BruteForce-HammingLUT matchers were favored to be used in indoor environments.

Moreover, the performances of some platform navigation solutions in indoor environments were assessed. The experimental results show that the stereo visual odometry technique is the most accurate method, but it should be aided with wall constraints to enhance navigation positional accuracies. This technique was used to form a features database. This features database contains several well-described keypoints whose 3-d world coordinates were known.

The main part of this thesis focuses on developing a simple and accurate navigation algorithm suitable for pedestrian people using smartphone sensors. The suggested pedestrian navigation

solution was a dead reckoning solution based on the motion sensors aided by monocular visual odometry.

This suggested solution needs some preparation before starting the navigation. The testing area should be photographed using two cameras in order to apply the stereo visual odometry principle and form a features database for this area. Also, the plan of this testing area should be surveyed to be used when applying the wall constraints.

During the navigation, the position of the user will be determined based on the motion sensor measurements. When the solution drifted with time, the user should stop and capture an image using his camera. The corrected location of the user could be determined by comparing the captured image with the features database. Also, this correct location helps the user to estimate his corrected stride length. In addition, the wall constraints should be applied to enhance the navigation results. The accuracy of this suggested solution was about 1.7 meters with a closing error of about 0.3%.

Keywords:

Computer Vision, Feature detector, Feature descriptor, Image matching, Accelerometer, Gyroscope, Magnetometer, Pedestrian Indoor navigation, Kalman Filter, Wall Constraints.

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One of the prettiest moments of my graduate studies was when I completed this thesis. It was a wonderful feeling of finishing another important period of my life. A period that was full of happiness and sadness, relaxation and anger, satisfaction and frustration. A period from which I gained so much knowledge; not only scientific knowledge, but that kind of knowledge that is so hard to learn from science; it is the knowledge of how to go on in life and how to share it with those you love, friends, colleagues, and people in general.

Having the opportunity to write what I feel, it is time I wrote my acknowledgments. First, I want to thank **God** for all the things He has blessed and is still blessing me with, without which I would not be able to pursue knowledge, or even life.

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