OBJECT TRACKING FROM UNMANNED AERIAL VEHICLE USING KANADE-LUCAS-TOMASI TRACKER AND SPEEDED UP ROBUST FEATURES

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This thesis is dedicated to my parents.

For their endless love, support, encouragement.

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ABSTRACT

Object detection and tracking are important and challenging tasks in many computer vision applications such as surveillance, vehicle navigation, and autonomous robot navigation. Video surveillance in a dynamic environment, especially for humans and vehicles, is one of the current challenging research topics in computer vision. In this thesis a tracking and location method for Unmanned Aerial VehicleVision System called UAV tracker is proposed. In this method, the target is extracted from the Region of Interested (ROI) automatically by Speeded Up Robust Features (SURF); then the Kanade–Lucas–Tomasi tracker is used to get the target's position in the sequence images. The proposed framework learns about target appearance by updating the object module in each frame, which can further improve the robustness of tracker as well as feature extraction and matching process. Extensive experimental results are provided by comparing proposed algorithm with (15) related approaches on (15) challenging sequences, which demonstrate the robust tracking achieved by proposed tracker. Experimental results show that the proposed method deals with translation, rotation, partial occlusion, deformation, pose, scale changes, similar appearance and illumination change successfully.

ABSTRAK

Pengesanan penjejakan objek merupakan salah satu perkara penting dan mencabar dalam bidang penglihatan komputer terutamanya untuk aplikasi seperti pemantauan, navigasi kenderaan dan navigasi robot berautonomi. Pemantauan video dalam persekitaran dinamik terutamanya untuk manusia dan kenderaan merupakan salah satu topik hangat dalam bidang penglihatan komputer. Thesis ini mencadangkan kaedah penjejakan dan lokasi untuk sistem penglihatan kenderaan udara tanpa pemandu (UAV) yang juga dikenali sebagai penjejak UAV. Dalam kaedah yang dicadang, sasaran akan diekstrak dari kawasan berkepentingan (ROI) secara automatik menggunakan Cirian Teguh Yang Dipercepatkan (SURF) dan kemudian dengan penjejak Kanade-Lucas-Tomasi digunakan untuk menentukan lokasi sasaran dalam urutan imej. Rangka kerja yang dicadangkan belajar penampilan sasaran dengan mengemaskini modul objek dalam setiap kerangka yang dapat meningkatkan keteguhan penjejak dan juga pengekstrakan cirian dan proses pemadanan. Keputusan experimental yang menyeluruh terhadap 15 urutan yang mencabar berserta 15 kaedah sedia ada diberikan. Keputusan experimental menunjukkan bahawa kaedah yang dicadangkan dapat menangani penterjemahan, putaran, penutupan separa, perubahan pada bentuk, posisi, skala, penampilan yang serupa dan pencahayaan dengan berjaya.

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LIST OF ABBREVIATIONS

AUC	-	Area under curve
BRISK	-	Binary Robust Invariant Scalable Keypoints
BSBT	-	Beyond Semi-Supervised Tracking
CPF	-	Convolution particle filtering
DoG	-	Difference of Gaussians
DFT	-	Distribution Field Tracking
EKF	-	Extended Kalman filter
EMD	-	Earth Mover's Distance
FRAG	-	Fragments
KF	-	Kalman filter
KMS	-	Kernel Mean-shift
KLT	-	Kanade-Lucas-Tomasi
LoG	-	Laplacian of Gaussians
LOT	-	Locally Orderless Tracking
MHT	-	Multiple Hypothesis Trackers
MS	-	Mean-Shift Tracker
MIL	-	Multiple Instance Learning
RANSAC	-	Random Sample Consensus
ROI	-	Region of interest
SIFT	-	Scale-Invariant Feature Transform
SURF	-	Speeded Up Robust Features

SAD	-	Sum of absolute differences
SHT	-	Single Hypothesis Trackers
SSD	-	Sum of squared differences
SemiT	-	Semi-supervised Tracker
UAV	-	Unmanned Aerial Vehicle
TLD	-	Tracking Learning Detection

LIST OF SYMBOLS

σ	-	Scale parameter
G	-	Gaussian kernel
I	-	Input image
L	-	Smoothed image
D	-	Stands for DoG
H	-	Hessian matrix
D_{xx}	-	Partial derivative in x-axis
D_{xy}	-	Partial derivative in y-axis
v	-	Descriptor vector
W	-	Window size
x_t	-	Object state
w	-	Pixel location
b^T	-	Template transpose
I_t	-	Template
I_k	-	Original image
$\hat{q}$	-	Model histogram
$\hat{p}$	-	Candidate histogram
N_b	-	Number of pixels
$\hat{q}_u$	-	Target model
$\hat{p}_u$	-	Likelihood value
ρ	-	Bhattacharyya coefficient

$\cap$	-	Intersection
$\cup$	-	Union
S	-	Intersection area
t_0	-	Overlapping threshold

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CHAPTER 1

INTRODUCTION

1. 1 Introduction

Video surveillance is an active research topic in computer vision that focuses on to detection, recognition and tracking objects over a sequence of images and it also makes an attempt to understand and describe object behaviour by replacing the aging old traditional method of monitoring cameras by human operators. Object detection and tracking are important and challenging tasks in many computer vision applications such as surveillance, vehicle navigation and autonomous robot navigation. Object detection involves locating objects in the frame of a video sequence. Every tracking method requires an object detection mechanism either in every frame or when the object first appears in the video. Object tracking is the process of locating an object or multiple objects over time using a camera. The high availability of computers, high quality video and Unmanned Aerial Vehicles (UAV) to perform challenging surveillance, monitoring tasks, has generated a great deal of interest in object tracking algorithms.

In order to achieve the goal of autonomous UAV operation, algorithms for automatic target detection and tracking are deployed on aerial platforms. Nevertheless, processing of UAV imagery is challenging due to several factors such as rapid camera motion and low-resolution images captured from high altitude vehicles making it difficult to discriminate similar targets. Additional challenges stem from the fact that targets may undergo significant appearance changes and they can also go in and out of camera field of view. Since the technology has matured and the general hardware is sufficient, so it is necessary to start conducting research in the area and develop a video tracking solution that can be applicable to surveillance missions carried out by an UAV.

1. 2 Problem Statement

This project aims to propose an object-tracking algorithm, which can detect and track moving or stationary object in video streams, which is captured from a moving or stationary camera. This algorithm will address some of the tracking challenges such as; pose change, partial occlusion, appearance and viewpoint changes, background clutter, scale changes and Illumination changes.

1. 3 Objectives

(i) Given a bounding box defining the object of interest in a single frame, the goal is to automatically determine the object's bounding box in every frame that follows.

(ii) To design object detection and tracking which overcome the following challenges :

- Illumination changes.
- Similar targets.
- Clutter background.
- Scale change.
- Out-of- plane rotation.

1. 4 Project Scope

The aim of this project is to propose a tracking algorithm which can track single moving or stationary object in video streams, which are captured from moving or stationary camera.

1. 5 Thesis Outline

The structure of this thesis is as follows. In chapter 2 reviewed previous works related to object tracking. Chapter 3 describes the methodology of the proposed object tracking method. Chapter 4 goes to explain object tracking method and, implementing the algorithms with necessary parameters. In Chapter 5 the experimental results and performance of the proposed algorithm is provided. In 6, the work is concluded and direction for future work is proposed.

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