MOVING SHIP DETECTION FOR UNMANNED AERIAL VEHICLE USING ATOM PROCESSOR FOR CAMERA VISION

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Dedicated to my beloved parents, supervisor and friends.

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ABSTRACT

Ship detection has become an important approach for security and surveillance system in a maritime environment. By upgrading the ability of the detection module by using Unmanned Aerial Vehicle (UAV) will increase the coverage or limitation in operation module especially for navy purposes. UAV has plays an important role in mobile aerial surveillance for military as well as civilian application. UAV is used to get an overview from bird's eye view of locating and tracking an interested object in most operations. Unfortunately, in previous application the video processing and UAV control usually being done under ground control station which using wireless communication network to communicate among each other. It is not really practical by relying on video streaming via radio link as execution platform cause it may produced a delayed or blurred video images which will degrade detection performance. Maritime environment which consist robust environment and dynamic scenes gives a huge challenges for automatic object detection. This thesis presents the development of real-time moving ship detection in embedded platform using Inforce computing board which consist Intel Atom processor. Major part of this work is to validate the algorithm applied to be able to detect a moving ship and remove a camera motion that affect the detection part. The algorithm is tested offline using pre-captured videos from top view as similar from video captured from UAV. Experimental result shows that the algorithm applied are able to detect a moving ship but the performance are dependent on number of corners and skipping rate of frames used in the system. Thus, the algorithm used in the system is suitable for real-time ship moving detection system in UAV application.

ABSTRAK

Mengesan kapal telah menjadi salah satu kaedah yang sangat penting dalam sistem kawalan dan pengawasan di kawasan maritim. Penambahbaikan keupayaan mengesan dapat dilakukan dengan menggunakan kenderaan udara tanpa manusia (UAV) bagi meningkatkan tahap keupayaan dalam modul operasi terutamanya bagi tentera laut. Dalam kebanyakan operasi, UAV digunakan untuk mencari dan menjejaki objek penting dari pandangan udara. Bagaimanapun, sistem terdahulu menggunakan sistem kawalan dan pemprosesan maklumat dari stesen kawalan. Kaedah ini menggunakan rangkaian komunikasi tanpa wayar sebagai kaedah komunikasi antara stesen kawalan dan UAV. Dengan kebergantungan terhadap kaedah ini akan merencatkan proses pengesanan kerana kualiti imej video yang dihasilkan akan tergendala atau tidak jelas bergantung terhadap kestabilan rangkian yang digunakan. Persekitaran maritim yang mengandungi kawasan yang tidak seimbang serta pemandangan yang agak dinamik memberi kesukaran terhadap pengesanan objek secara automatik. Tesis ini membentangkan pembangunan sistem pengesanan kapal bergerak pada masa sebenar yang menggunakan kaedah tertanam dari ‘Inforce computing board’ yang mengandungi ‘Intel Atom processor’. Bahagian yang paling utama dalam kajian ini adalah untuk mengesahkan algoritma yang digunakan mampu mengesan kapal yang bergerak serta membuang kesan gerak dari kamera yang mempengaruhi proses pengesanan. Algoritma ini diuji dengan menggunakan video pra-tangkap daripada pandangan atas seperti video yang ditangkap dari UAV. Hasil kajian menunjukkan algoritma yang digunakan mampu mengesan kapal yang bergerak di kawasan maritime namun prestasinya bergantung kepada bilangan bucu yang digunakan serta bilangan rangka yang dilangkau untuk setiap proses. Algoritma yang digunakan terbukti sesuai digunakan bagi sistem mengesan kapal yang bergerak pada masa sebenar untuk applikasi UAV.

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LIST OF ABBREVIATIONS

UAV	-	Unmanned Aerial Vehicle
RANSAC	-	Random Sample Consensus
CCL	-	Connected Component Labelling
FAST	-	Features from Accelerated Segment Test
NCC	-	Normalized Cross Correlation
I/O	-	Input Output
SR	-	Skipping Rates
NC	-	Number of Corners
GHz	-	Giga Hertz
RAM	-	Random Access Memory
MACH	-	Maximum Average Correlation Height
SAD	-	Sum of Absolute Difference
SSD	-	Sum of Square Difference
ROI	-	Region Of Interest
SVM	-	Support Vector Machine

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CHAPTER 1

INTRODUCTION

Nowadays, digital video cameras have widely being used and become part of our life. In current society where technology has already being developed rapidly, we cannot walk or drive around without being captured by security or surveillance device. Video surveillance system is one of the most important applications in security which has an ability and tendency to monitor important places such as crowd surveillance in public areas and traffic monitoring from being invaded or avoid any unwanted events to occur. Previously, this monitoring process has been done by installing a fixed camera in the selected location to transmit real-time video to a central control room which being processed and monitored by human. However, due to certain limitation this surveillance system has been upgraded by using moving camera which is installed on a remote aircraft, called Unmanned Aerial Vehicle (UAV). Through this enhancement, the performance of the system has increased. Dangerous operation can be executed without risking any human lives anymore even it able to give high resolution view due to its smaller size and able to fly at low altitude [1]. Due to its advantages, the use of camera systems for security and surveillance purposes has risen and gaining importance for maritime environment as well, especially for navy operation. Radar systems are widely being deployed aboard military and even in commercial ship and traditionally are the main sensor system for object detection. Unfortunately radar system has few weaknesses such as minimum detectable range, a lack of sensitivity to small, non-metallic targets and poor classification power [2]. Other than navy, this camera system also being applied in aquaculture industry which used to detect and tracks intruders that

surpassed or crossed their area to overcome fish stolen crisis that become a nightmare to a fishermen [3]. Automated object detection is a crucial part within these applications and has become an important research area in computer vision to ensure the minimization of using human control and having a faster response. Figure 1.1 shows how ship detected looks like.

Figure 1.1 Ship detected visual from camera

1.1 Problem Statement

UAVs have been developed and used in many areas such as security and surveillance purposes. However, there are still many limitations in this technology. The biggest issue in this system is most of the video processing is usually done in the ground control station while the live video will be streaming through wireless communication. There are 2 critical issues in this method. First, the video quality will greatly depend on the strength and stability of the wireless communication network which might caused a blurred and delayed images under poor communication environment. Thus, it is not practical in relying on video streaming via radio link, as well as sending UAV guiding instructions from ground control station [4]. Second, by assigning human operator or crew to process and scan images manually and it must be done continuously to ensure that possible target will not out of sight. This result will cause a fatigue condition

towards the operator due to limitation in human being which in turn wills increases the probability of errors [2].

Within a maritime environment, there are number of factors that might complicate the process of automatic ship detection. These factors include [2]:

- Camera motion:
  Once the camera installed on the UAV, the motion of the camera cannot be avoided and therefore a detection algorithm must be able to deal with these movements and vibrations.
- Highly dynamic background:
  Since this system is dealing with maritime environment, the background is highly dynamic and far from stationary due to waves, ship wakes and illumination changes. It is also quite challenging due to lack of background information than can be collected to be used as references for motion compensation as being done in landed area as shown in figure 1.2.
- Meteorological circumstances:
  Meteorological circumstances can be varied which will make an automated detection more complicated. Rain, snowfall, fog, glare caused by the sun and variations in the sea-state are examples of such circumstances.

Due to these factors, automated ship detection in maritime environment is a bit complicated compared to conventional detection methods that are applicable in ground area.

Figure 1.2 Object detected in ground area

1.2 Objectives of Project

This research targeted to design moving ship detection for UAV using atom processor. The goal of this project was taken based to the following objectives:

i. To select a proper algorithm which are suitable for moving ship detection.
ii. To develop a moving ship detection system using Intel atom processor.

1.3 Project Scope and Limitations

This work is focused on developing a moving ship detection system using embedded platform to be mounted on a UAV, where Intel atom has been selected as a targeted platform. However, this work does not involve any UAV usage directly, the system just being tested offline using pre-captured video. Video sample in this project

will cover certain static background information such as near the shore as a reference point.

1.4 Thesis Layout

Chapter 1 presents background of study, problem statement, project objectives, project scope and limitation. Last part of this chapter will present the overall report layout.

Chapter 2 reviews the literatures and previous works related to object detection and ship detection.

Chapter 3 focuses in project design methodology which covers overview of the project and the experimental setup.

Chapter 4 presents the results and analysis of the works done throughout this research.

Chapter 5 summarizes the conclusions from this research. The last part of this chapter discussed recommendation for future works and project contribution.

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