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DESIGN AND CALIBRATION OF A SPECIALIZED POLYDIOPTRIC CAMERA RIG

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DESIGN AND CALIBRATION OF A SPECIALIZED
POLYDIOPTRIC CAMERA RIG

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of Master of
Engineering (Mechatronic and Automatic Control)

UNIVERSITI TEKNOLOGI MALSYSIA

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I declare that this project report entitled "*Design and Calibration of a Specialized Polydioptric Camera Rig*", is a result of my own research except as cited in the references. This project report has not been submitted in candidature of any other programme.

Signature	:	………………………………………………..
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Date	:	July 24, 2016

This work has been dedicated to my family, supervisor and friends for their support both financially and spiritually.

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ABSTRACT

The development of advanced computational machines does not necessarily provide solutions to all the scientific problems in the research. It has been observed in the nature that all creatures have evolved highly exclusive sensory organs depending on their habitat and the form of availability of the resources they utilize for their survival. In this project, a novel omnidirectional camera rig is proposed that is exclusively designed to operate for highly specified operations and tasks in the field of mobile robots. Navigation problems on uneven terrains and detection of the moving objects while the robot is itself in motion are the core problems that omnidirectional systems tackle. The proposed omnidirectional system is a compact and a rigid vision system with dioptric cameras that provide a 360° field-of-view in horizontal and vertical, with no blind spot in their site plus a high resolution stereo camera is mounted to monitor anterior field-of-view for precise results with depth information of the scene. Structure from motion algorithm is adapted and implemented to prove the validity of the design of the proposed camera rig and a toolbox is developed to calibrate similar systems.

ABSTRAK

Pembangunan mesin pengkomputeran canggih tidak semestinya memberikan penyelesaian kepada setiap permasalahan saintifik dalam bidang penyelidikan. Melalui pemerhatian secara semula jadi, organ-organ deria semua makhluk telah dicipta dengan sangat eksklusif bergantung kepada habitat dan sumber-sumber yang digunakan untuk kelangsungan hidup mereka. Dalam projek ini, pelantar kamera semua arah yang dicadangkan direka hanya untuk beroperasi dalam operasi dan tugasan yang sangat terperinci dalam bidang robot mudah-alih. Masalah utama yang dapat ditangani adalah pelayaran di bentuk muka bumi yang tidak rata dan mengesan objek yang bergerak ketika robot sedang bergerak. Sistem omnidirectional yang dicadangkan adalah sistem penglihatan yang kecil dan padat dengan kamera dioptrik yang menyediakan pemandangan 360 ° dalam keadaan mendatar dan menegak, tanpa titik buta semasa penggambaran serta dilengkapi juga dengan kamera stereo resolusi tinggi yang padat dipasang untuk memantau pemandangan untuk hasil yang lebih tepat beserta maklumat yang terperinci di tempat penggambaran. Struktur dari pergerakan algoritma disesuaikan dan dilaksanakan untuk membuktikan kesahihan reka bentuk pelantar kamera yang dicadangkan dan kotak penyimpanan dibangunkan untuk pengujian sistem yang sama.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The rapid development in computing systems and their availability to the consumer market, soon made researchers realize that computational inability may not necessarily be the only handicap in all scientific problems. If observed in nature, all creatures have evolved very unique and highly specified anatomical and physiological traits that depends in the habitat they live and the availability of the resources their survival is dependent on. The artificial vision systems with larger field-of-view are always appreciated in computer vision research. These are specialized systems that offer a possibility to acquire more information with less equipment/image-data used. Omnidirectional or panoramic cameras have become an affordable and popular photographic tool that allows to capture 360° panoramic images [1].

Some of the applications of the omnidirectional cameras are, but not limited to, robot localization and mapping [2-5], robot navigation [6-9], object tracking [10-12], visual servoing [13-16], structure-from-motion [17-20], and virtual-reality/visual-telepresence [21-23].

Figure 1.1 Proposed Omnivision Camera Rig

Omnidirectional cameras are also used in geo-localization [24] and lately a similar feature for google maps, that utilize omni-vision i.e. a 360° panoramic images, is embedded into the street maps. The use of visual-sensors/omnidirectional-cameras for the aforementioned applications, offers several advantages over other optical (laser) or ultrasonic sensors. Such systems provide improved results as compared to those obtained by the use of conventional perspective cameras as they require minimal physical motion of the robot/sensor to recover information about the environment [25].

1.2 Proposed Camera Rig

An omnivision camera rig has been developed using two fisheye cameras with 185° field-of-view each, which are fixed opposite to each other facing laterally, so as to cover 360° in horizontal and vertical. A depth camera, namely "ZED Camera", is also mounted in front of the rig that covers the anterior view providing high-resolution RGB + depth image.

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