THE INTEGRATION OF CLOSE RANGE PHOTOGRAMMETRY AND DATABASE MANAGEMENT FOR TRAFFIC ACCIDENT MAPPING

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To my dearest husband, Saiful Adilin Ab Aziz

my lovely mama, Jamaliah Desa

my late dad, Hamzah Md. Jidin

my siblings, Faris Syahin,

Muhammad Qayyum and

Nur Batrisyia

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ABSTRACT

Various approaches in acquiring data of road accident are being implemented worldwide. For police and forensic in Malaysia, they face challenges in obtaining accurate measurements because they are still implementing the conventional method which is impractical to map the road accident scene, consequently explain the lack of a comprehensive accident recording and analysis system. This research presents the implementation of close range photogrammetry of accident scene for data collection by using three types of sensors to study the effectiveness of each sensor which are SONY DSCHX5V for compact camera, NIKON D300S for Single Lens Reflex (SLR) camera and MI DVJ350 for video recorder. Each accident simulation conducted at Universiti Teknologi Malaysia (UTM) was recorded and imported into two different processing softwares which are Photomodeler and iWitness that is employed together with CrashZone, to perform non-contact measurement on physical evidences and subsequently generate 3D model of the crash scene. The outcomes of this research are the measurement of evidences and 3D model of road accident from three types of sensors. Data is stored, organized and retrieved in accident data management system by using Microsoft Visual Studio together with SQL Server Management Studio. The result shows that among these three sensors, NIKON D300S is the best sensor that fit the requirement of law enforcement in acquiring accident data because it has achieved the highest accuracy for physical evidences measurement. From iWitness software the RMS obtained was 0.0344m while Photomodeler was 0.0348m. In conclusion, this research gives benefits and contribution to the Malaysia's traffic management system due to the application of close range photogrammetry (CRP). The final result can be as evidence in court litigation because in most jurisdictions, accidents involving fatalities must be surveyed and mapped.

ABSTRAK

Pelbagai pendekatan di dalam pengumpulan data kemalangan jalan raya sedang diimplimentasikan di seluruh dunia. Bagi pihak polis dan forensik di Malaysia, mereka menghadapi cabaran dalam mendapatkan pengukuran yang tepat kerana mereka masih mengimplimentasi kaedah konvensional yang mana tidak praktikal untuk memetakan kemalangan jalan raya, seterusnya menunjukkan kelemahan sistem merekod dan analisis yang komprehensif. Kajian ini mempersembahkan pengimplimentasian fotogrametri jarak dekat terhadap situasi kemalangan untuk pengumpulan data dengan menggunakan tiga jenis sensor untuk mengkaji keberkesanan setiap sensor iaitu; SONY DSCHX5V mewakili kamera kompak, NIKON D300S mewakili kamera lensa reflex tunggal dan MI DVJ350 mewakili perakam video. Setiap simulasi kemalangan dijalankan di Universiti Teknologi Malaysia (UTM) telah direkod dan diimport ke dalam dua perisian pemprosesan berbeza iaitu Photomodeler dan iWitness yang digunakan bersama dengan CrashZone, untuk melakukan pengukuran tanpa sentuh terhadap bukti-bukti fizikal dan seterusnya menghasilkan model 3D suasana kemalangan tersebut. Hasil kajian ini adalah pengukuran bukti-bukti dan model 3D kemalangan jalan raya daripada tiga jenis sensor. Data telah disimpan, diselenggara dan dicapai di dalam sistem pengurusan data kemalangan dengan menggunakan Microsoft Visual Studio bersama dengan SQL Server Management Studio. Keputusan menunjukkan di antara ketiga-tiga sensor ini, NIKON D300S adalah sensor terbaik yang sesuai dengan keperluan pihak penguasa dalam mendapatkan data-data kemalangan kerana ia telah mencapai ketepatan paling tinggi bagi pengukuran bukti-bukti fizikal. Dari perisian iWitness, RMS yang diperolehi adalah 0.0344m manakala Photomodeler adalah 0.0348m. Secara kesimpulannya, kajian ini memberi kelebihan dan sumbangan kepada sistem pengurusan trafik Malaysia disebabkan aplikasi fotogrametri jarak dekat (CRP). Keputusan akhir boleh dijadikan sebagai bukti di perbicaraan mahkamah kerana dalam kebanyakan bidang kuasa, kemalangan yang melibatkan kematian mesti diukur dan dipetakan.

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LIST OF ABBREVIATIONS

CAD	-	Computer Aided Design
CRP	-	Close Range Photogrammetry
DXF	-	Drawing Exchange Format
RMP	-	Royal Malaysia Police
RMS	-	Root Mean Square
SLR	-	Single Lens Reflex
TLS	-	Terrestrial Laser Scanning
2D	-	2 Dimension
3D	-	3 Dimension
DBMS		Database Management System

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

As time goes by, traffic accident has been a concern of the world community since the number of accidents occurs has increased drastically. According to Sahar and Jehan (2010), this phenomenon is increasingly being recognized as a growing public issue. There are many factors that cause road collision including the behaviour of driver, weather conditions, environment of the street, conditions of vehicles and so forth. Malaysia as a developing country is experiencing growing numbers of vehicles every year which is also contributing to the numbers of accidents (Road Safety Department Malaysia, 2010).

Various methods have been introduced to collect the measurement of road accident data ranged from conventional method to the sophisticated technology. The data collection techniques includes by using a tape measure, close range photogrammetry (CRP), laser scanner, and etc (Randles et al, 2010). Based on Haidir (2012), Malaysian police still make use of tape measure to obtain accident data measurement. Another method that can be implemented for this initiative is by using digital cameras.

These sensors comprises of cameras that can be utilized for capturing images and videos. Recorded images are the source of accident data collection to do measurement on evidences, reconstruct and map the crash scene afterwards. Crash data can be obtained by using close range photogrammetry (CRP) method. Coyle (2008) stated that CRP can be implemented in motor vehicle accident reconstruction while Richard and Stephen (2000) declared that videogrammetry can be used by forensic engineers to assist them in the same field.

There are numerous effects of a road accident to the individual involved, their family, and towards the country (Qirjako et al., 2008). Hence, many efforts have been made by different organizations in improving safety each year. The utilization of computers makes this effort more comprehensive and productive. One of the approaches is by using Geographic Information System (GIS) technology which has been a vital tool for visualization of accident data and analysis of hotspots on the road. Mino and Asada (2003) explained that they have demonstrated the spatial information technology such as GIS which can assist their case study.

The key of this study is to investigate five simulation cases of traffic accidents by using 3 types of camera which are SONY DSCHX5V for compact camera, NIKON D300S for Single Lens Reflex (SLR) camera and MI DVJ350 for video recorder. The accident scene is recorded and imported into two different processing softwares which are iWitness that is employed with CrashZone and Photomodeler to perform non-contact measurement on physical evidences. The generation of 3D model of crash scene is made afterwards. The outcomes from these three types of sensors are the measurement of evidences and 3D model of road accident that are analyzed in data analysis section.

Accident data that has been processed are the input for the database to be further analysed. These data are served as visualization purpose in the traffic accident database system. The data management system is developed using Visual Studio to

determine accident location, to identify the details of particular accidents and also to determine how accident countermeasures can be implemented.

1.2 Problem Statement

One of the major concerns for police investigators and forensic scientists in Malaysia is the challenges in documenting traffic accident scenes to obtain accurate measurements. The approach for collecting the measurement of evidences is conventional method which is using a tape measure (Yew, 2009). It is almost impractical to map the scene due to many issues such as traffic jam, the environment of the road, unstable flooring, and line of sight issues consequently this is often inaccurate for 3D data.

In spite of this matter, other techniques that can be implemented for most cases are close range photogrammetry. Currently, law enforcement in Malaysia depends on images captured on site of the accident scene which is only for visualization purpose (Haidir, 2012). The utilization of camera for them is just for pointed out the evidence which is difficult when it comes to retrieve the data.

Nowadays, different types of camera are available in the market with different technology and specification. Thus, the need to find the suitability of camera must be discovered to be the best sensor that can fit the requirement of law enforcement in acquiring accident data. This camera is expected to give the best image resolution and achieve the highest accuracy for physical evidence measurement.

The representation of different type of cameras; SONY DSCHX5V for compact camera, NIKON D300S for SLR camera and MI DVJ350 for video recorder, producing a variety of data accuracies in terms of image processing. Hence, analysis is done to evaluate the effectiveness of using three types of camera based on different data accuracy.

In the aspect of data processing, the usage of two different softwares which are iWitness and PhotoModeler yield different quality of evidences measurement and the reconstruction of accident scene. To check the reliability of accident simulation, 5 different cases were carried out by using the same three types of camera together with the two kinds of CRP data processing softwares. In brief, various types of camera and processing softwares are used in this research to produce different type of data. The result is different according to accident cases, sensor's accuracy, measurement of evidences, and crash scene mapping.

In addition, accident recording and analysis system must be developed to support crash data that are obtained by using proposed sensors. Therefore, an appropriate database is necessary to help the police investigators and forensic scientists to assist and manage the road collision data.

1.3 Objectives of Study

The objectives are specified as follows:

i) To reconstruct 3D model of simulation of five accident scenes by using PhotoModeler and iWitness software according to different types of camera.

ii) To develop traffic accident database system.

1.4 Scope of Study

Four scopes of research are listed as below:

i) Area of study is conducted in Universiti Teknologi Malaysia (UTM) as shown in **Figure 1.1**. It is located at Johor Bahru, the southern city in Iskandar Malaysia with 1177 hectares of land. The simulations of road accidents are located at 5 different places (yellow pinpoint) which are identified as 'hotspots' in UTM area.

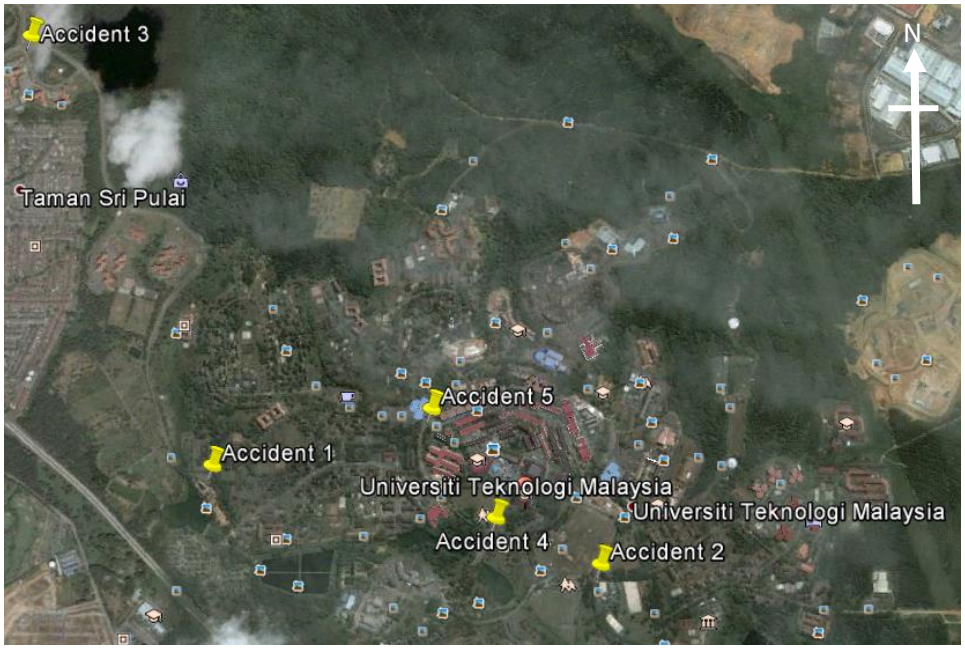

Figure 1.1: Research Area

Scale 1:25000

ii) 5 data of road accidents is obtained from 5 accident simulations. Crash scenes are captured by using 3 types of sensors which are SONY DSCHX5V (10.2 Megapixels), NIKON D300S (12 Megapixels) and MI DVJ350 (20.1 Megapixels) as illustrated in **Figure 1.2**. SONY DSCHX5V is used to capture images of road accidents to represent compact camera. NIKON D300S is characterized as SLR camera also

is utilized to take picture of accident scene. As for video recorder, MI DVJ350 is employed to capture video of road accident simulation. These cameras are calibrated before collecting the data. Several cars are used along with other tools such as scale bar, broken glasses as for the impact of accident, 6 traffic cones to control the crash area, and black aerosol spray for creating the scratch tyre. Several images are taken in different angles to cover the whole area of the crash scene.

i) ii)

iii)

Figure 1.2: i) Compact Camera, SONY DSC HX5V (10.4 x 5.8 x 2.8cm) ii) SLR Camera, NIKON D300S (14.7 x 11.4 x 7.4cm) iii) Video Recorder, MI DVJ350 (6.7 x 6.9 x 12.9cm)

iii) The data are processed by using 2 softwares:

a) iWitness and CrashZone: iWitness is used to process the data in terms of measurement. In addition, iWitness also used to perform the camera calibration. CrashZone support iWitness in order to display the 3D view of the collision scene.

b) Photomodeler: A photogrammetric-based processing software that measures and model real world objects and scenes through the use of images. This software brings the powerful capabilities of photogrammetry in a simple, user friendly Windows environment (Eos, 2010).

iv) The database of road accident data is stored in SQL Server Management Studio while the system is developed in Microsoft Visual Studio 2010.

1.5 Significance of Study

Various actions and treatments have been taken to reduce the rate of traffic accident in the whole world. According to U.S Department of Interior (2003), "an accident investigation is the methodical collection of evidence (facts), and the analysis and interpretation of the evidence. The fundamental purpose is to identify the cause, why the accident happened, and to recommend corrective actions to prevent or minimize the chance of a reoccurrence." Thus, accident data is significant for government and road agencies as it is served as evidence in jurisdictions and as countermeasure for road safety.

CRP is an alternative way to conventional method to obtain measurement of traffic accident data. This technique is more practical to be implemented because of

the reducing on scene time, which leads to shorter periods of traffic disruption. Furthermore, the procedure is easy to adopt for assisting police officers in managing the road accident case.

This research is expected to give benefits and contribution to the Malaysia's traffic management system due to the application of CRP. The final result can be as evidence in court litigation because in most jurisdictions, accidents involving fatalities must be surveyed and mapped. In brief, this research contributes to current practice of data collection with reducing the time and provides higher accuracy of positional crash data.

Variety of study and advice as well as mass media reports regarding the cause of the accident give useful messages to other road users. Despite, this tragedy on the roads continues to be a burden to the society. Thus, this study is essential for traffic accident management by utilization of database system. Since the rate of road deaths increases, a database system is extremely significant tool for traffic safety.

This tool has been employed more commonly by many traffic agencies for accident analysis due to the variety of function such as storing, sharing and managing a great quantity of data. Thus the need to attempt to avoid road accidents by whatever means that are effective will become increasingly important.

1.6 Thesis Chapters Layout

This thesis consists of five chapters, **Table 1.1** described the summary of each chapter.

Table 1.1: Thesis Chapters Layout

Chapters	Summary
1	Describe the introduction of the research background, problem statement, objective of study, scope of study, significance of study and chapters layout.
2	Describes the methods used in traffic accident data collection. Also describes related works on road accident database that has been established worldwide.
3	Describes the method implemented in the data collection of traffic accident and the development of traffic accident database.
4	Describes the results and analysis.
5	Describes the conclusion and recommendation for further research.

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