Development of Video Image Acquisition for Traffic Surveillance using Open Source Software

By

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بسم الله الرحمن الرحيم

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LIST OF SYMBOLS, ABBREVIATIONS OR NUMENCLATURE

Term	Description
2D	*2 Dimension*
3D	*3 Dimension*
API	*Application Programming Interface*
BG	*BackGround*
BGR	*Blue Green Red*
CCTV	*Closed-Circuit Television*
CPU	*Central Processor Unit*
CT	*Computer Tomography*
CV	*Computer Vision*
DFSG	*The Debian Free Software Guidelines*
f/sec	*frame per second*
FHS	*Filesystem Hierarchy Standard*
FPGA	*Field Programmable Gate Array*
FTP	*File Transfer Protocol*
gcc	*Gnu C Compiler*
GHz	*Giga Hertz*
GIF	*Graphic Interchange Format*
GIMP	*GNU Image Manipulation Program*
GUI	*Graphical User Intrface*
HCI	*Human Computer Interface*
I/O	*Input / Output*
IMCASM2	*Intelligent Multi-Camera Surveillance and Monitoring 2*

IP	*Internet Protocol*
IPP	*Integrated Performance Primitives*
iSEE	*Internet Sensor Exploration Environment*
ISO	*International Organization for Standardization*
ITS	*Intelligent Transport Systems*
IVMA	*Intelligent Visual Monitoring Algorithms*
JPG	*Joint Photographic Group*
kB	*Kilo Byte*
KDE	*K Desktop Environment*
LAMP	*Linux, Apache, MySQL, PHP, Perl, and Python.*
LAN	*Local Aria Network*
LSB	*Linux Standard Base*
MIME	*Multipurpose Internet Mail Extensions*
MLL	*Machine Learning Library*
MOG	*Mixture of Gaussians*
MRI	*Magnetic Resonance Imaging*
ms	*Millisecond*
OpenCV	*Open Computer Vision*
OS	*Operating System*
OSI	*Open System Interconnection*
OSS	*Open Source Software*
PC	*Personal Computer*
PDA	*Personal Digital Assistant*
PeMS	*Performance Measurement System*
PMMU	*Paged Memory Management Unit*

PNG	*Portable Network Graphics*
RAM	*Random Access Memory*
RGB	*Red Green Blue*
ROI	*Region Of Interest*
ROM	*Read Only Memory*
SCSI	*Small Computer System Interface*
SQL	*Sequential Language*
STEMS	*Smart Traffic Evacuation Management System*
T.R.A.C.E	*Total Recognition by Adaptive Classification Experiments*
TCP	*Transmission Controlling Protocol*
TIF	*Tagged Image File*
TV	*Television*
UDP	*User Datagram Protocol*
USB	*Universal Serial Bus*
VGA	*Video Graphic Array*

Mereka bentuk perolehan imej video untuk pemantauan Trafik menggunakan perisian sumber terbuka

ABSTRAK

Penyelidikan ini mempersembahankan inovatif dalam sistem memantau dihasilkan dengan mengaplikasi kaedah baru memprogram yang digunakan untuk Sistem Pengawasan Trafik/Jalanraya. Kini, perkembangan sistem pengawasan trafik di jalanraya adalah satu keperluan terutamanya di jalanraya dan lebuhraya kawasan bandar yang semakin sesak. Kesesakan ini menyumbang kepada peningkatan berlakunya kemalangan jalanraya. Sistem pengawasan trafik melakukan pengenalan imej dan proses menjejak objek. Kamera dipasang untuk mengawas jalanraya yang khas (lebuhraya, persimpangan...sb) dan berhubung dengan *server* utama. *Server* utama menyatukan sasaran imej dari kamera selepas memproses imej melalui beberapa langkah, kemudiannya berhubung dengan komputer yang lain dengan menghantar imej tersebut ke komputer itu. Prototaip pelaksanaan pengawasan trafik adalah berdasarkan program OpenCV dibawah GNU-Linux sokongan program *socket.* Objektif-objektif sistem pengawasan trafik adalah menjejaki pergerakan kenderaan, menjumlah bilangan kenderaan dan mengesan pergerakan kenderaan yang menyalahi undang- undang di tempat-tempat tertentu. Perkara tersebut dilakukan dengan menganalisa setiap *frame* yang di tangkap dan memproses *frame* tersebut mengunakan fungsi OpenCV. kegunaan sumber seperti fungsi OpenCV dalam GNU-Linux dari sumber terbuka adalah untuk menyediakan kaedah mudah bagi menggunakan rangka versi komputer mahupun dapat menjalankan kod visi dalam masa nyata. Pengawasan trafik berfungsi dalam proses masa-nyata untuk 5-33 fps perjalanan rakaman pada hari yang hujan mahupun hari yang terang. Sistem pengawasan trafik menerima rakaman sama ada dari tangkapan kamera ataupun dari fail. Sistem tersebut menjejak pergerakan kenderaan dengan pemprosesan imej dan pengenalan *algorithms* seperti penukaran ke *Gray scale* dan campuran kaedah Gaussian; tanda setiap kenderaan yang bergerak dengan petak segi empat sama dan mengira jumlahnya. Sistem ini mengandungi; bahagian menangkap, bahagian menjejak, bahagian mengenalpasti pegerakan yang menyalahi undang-undang di titik-titik tertentu dan mengalurkan pameran tersebut kepada komputer yang berhubung. Selain itu, sistem ini mengecilkan proses *frame* dalam keadaan resolusi tinggi tangkapan *frame* tersebut. Sistem ini berjaya di uji dengan tiga pemproses kelajuan yang berlainan, 1.2 GHz CPU, 2.0 GHz CPU dan 2.6 GHz CPU. Hasilnya di ukur dalam unit mili-sesaat dan hampir tepat. Sistem ini berfungsi di persekitaran luar yang rumit dengan ayunan dahan pokok dan hujan. Selain itu, sistem ini mengemaskini setiap *frame* dalam mana-mana modul latar belakang dari pandangan atas jalan bagi mendapatan imej penting semua objek. Semua keputusan akhir boleh direkodkan dengan menyimpan kumpulan gambar-gambar terpilih dalam mana-mana format imej. Kelajuan pemproses CPU bersama saiz proses *frame* mewakili salah satu faktor utama analisis prestasi pengawasan trafik. Pembandingan kelajuan memproses langkah-langkah memproses keputusan dalam resolusi berlainan untuk saiz *frame* dilakukan dan keputusan yang terpenting diperolehi dengan mengurangkan pengiraan masa untuk memproses apabila saiz *frame* yang ditangkap dikecilkan. Eksperimen ini di laksanakan dengan mengunakan 9 pandangan dengan 700 *frame* perspektif berlainan bagi setiap pandangan. Situasi pergerakan kenderaan dalam hujan dan panas di ambil di sekitar negeri Perlis. Ujikaji ini berjaya mengesan pergerakan semua jenis kenderaan.

Development of Video Image Acquisition for Traffic Surveillance using Open Source

ABSTRACT

The Research works to presents an innovative approach in monitoring system by applying new programming methods which can be used for Traffic/Road Surveillance Systems. Nowadays, the development of traffic surveillance on the road is compulsory as highways and roads are getting crowded especially in the cities. These crowded situations would increase the number of accidents on the roads. The Traffic Surveillance System performs image recognition and object tracking processing. A camera is used to monitor specific roads (highways, motorways, junctions…etc) and communicate with the main server. The main server integrates the target image from the camera after processing it in several steps then communicates with another computer by sending the image to it. A prototype implementation of traffic surveillance is based on OpenCV programming under GNU-Linux supported by socket programming. The objectives of traffic surveillance system are tracking moving vehicles, counting them and detecting the abnormal movement in specific places. This is done by analyzing the frames captured and processing them using OpenCV functions. The use of open source resources such as OpenCV functions in GNU- Linux provides an easy method to use the computer vision framework besides it can run vision code in real time. The traffic surveillance works in real-time process for (5-33 fps) of video stream in a rainy day and a sunny day. Traffic surveillance system accepts video images either from the camera captures or from the files. It tracks the moving vehicles using image processing and recognition algorithms such as converting to Gray scale and Mixture of Gaussian method; it marks each moving vehicle with a rectangle box and counts them. The system consists of: capturing part, tracking part, detecting abnormal movement from specific points and streaming the view to the other connecting computer. Besides it could minimize the frame processing in the case of the frame capture with high resolution. The system has successfully been tested in three different processor speeds which are 1.2 GHz CPU, 2.0 GHz CPU and 2.6 GHz CPU. The results are quite accurate and are measured in mille second. The system works in outdoor environment which is complex with wavering tree branches and flow of rain. Besides it updates frame by frame in any module of background views especially from the upper view of the road in order to get a significant images of all the objects. The results could be recorded by saving the requested group of photos in any image format. The CPU processing speed with the frame size process represents one of the key factors of the performance analysis of traffic surveillance. Processing speed comparison of the processing steps results in different resolutions for frame size made. And, a significant result is found by reducing the calculation time of processing when the frames size captured are reduced. The experiment was done by using 9 different views each with 700 frames consist of different views of moving vehicles in sunny or rainy situations on the roads of Perlis state. These experiments successfully detected the movements of all types of vehicles.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Recent developments in electronic imaging technology mostly are improvement of image processing, incremental of its storage capacity and also transmission enhancement of color images and video details. Digital images by its nature from beginning are tremendously promising a lot of ambitious DreamWorks and possibly be implemented in parallel with rapid hardware revolution progress along the time.

Image Processing represents the heart of any image technology. Applications of image processing are primarily in the areas of recognition, transmission and storage of information. Image transmission applications are in television broadcasting, remote sensing via satellite, military communication via aircraft, radar and sonar teleconferencing, computer communications, facsimile transmission, etc. Image storage is required for educational and business documents, such as storage of medical image from the Computer Tomography (CT) (Farrokhi, F., 1997), Magnetic Resonance Imaging (MRI) (Delaney, 1995) and digital radiology, motion pictures, satellite images, weathers maps and geological surveys. The image recognition applications are important and found in medicine, surveillance systems, personal digital assistant (PDA), and road monitoring systems. Application of image recognitions is also possible in the processing of algorithms where the number of operations required to implement an algorithm are reduced by working with the recognized data.

The field of image processing is a wide subject. It detects objects, removes noise from images and, does contrast analyses to the objects. All these things are possible by using special techniques and methods on images to be processed. The results could be used for other scientific applications or for other benefits.

These special techniques and methods in processing images may use various codes in coding programming of the applications. Different coding techniques are used for different applications. These codes could be programmed by using C/C++ programming language, MATLAB, Visual Basic, Visual C/C++, Borland C, OpenCV as library of C and Python as recent popular programming languages. The programs can be installed in several kinds of operating systems such as Microsoft Windows operating systems (Windows95/ NT/ 2000/ XP/ Melenium / Vista / 7) beside that it could be installed in Linux Operating systems such as: (RedHat/Debian/Mandriva/Fedora/Ubuntu/Kubuntu,). These programs could be used for real time execution of the application and to operate devices such as smart digital cameras and any mobiles system..

The use of Edge Detection algorithm is the most common direct approach for detecting and discontinuities that could highlight object-boundary information in a digital image. Edge detection must be efficient and reliable since it is crucial in determining how successful subsequent processing stages will be. In order to fulfill the reliability requirement of edge detection, a great diversity of operators has been devised with various differences in their mathematical and algorithmic properties (Tania Stathaki, 2008).

Several approaches to edge detection focus their analysis on the identification of the best differential operator necessary to localize sharp changes of the image intensity. These approaches recognize the necessity of a preliminary filtering step, as a smoothing

stage. The most widely used smoothing filter is the Gaussian one which plays an important role in detecting edges. Canny's approach (J.F. Canny, 1986) is a standard technique in edge detection. This scheme, in substance, identifies edges in the image as the local maxima of the convolution of the image with an 'optimal' operator. The operator's optimality is subject to three performance criteria as defined by Canny and is very close approximation to the first derivative of the Gaussian function. After this process, candidate edge pixels are identified as the pixels that survive an additional thinning process known as non-maximal suppression (J.Canny , 1985). Then the candidate edges are thresholded to keep only the significant ones. Canny suggests hysteresis threshold to eliminate streaking of edge contours (R. Deriche ,1987;Tania Stathaki 2008).

1.2 Overview of video surveillance system

Image processing is used for intelligent Transport systems in the roads, which recently have been widely developed. There has been much research and implementation using various image sensors to get information for traffic and vehicle control. The image seen from a camera is located on the road can be used for vehicle detection, such as velocity of a car or car group measurement and parking of vehicles. But the image seen from a camera located in the vehicle can be used for preceding car detection such as measurement of distance to the preceding car, detection of lane and obstacle. Shinji Ozawa 1999 did a study for image processing for vehicles on the road using some sensing techniques in vehicle and traffic control, Ozawa applies some procedures to a sensor in Intelligent Transport Systems (ITS) whereby he could apply the image processing technique to find: (Kiyoharu Aizawa, 2004; Shinji Ozawa, 1999).

- To a moving car.
- To locate traffic congestion due to accident .
- To count cars in parking lot by tracking.
- To measure travel time.

1.3 Problem Statement

Many of road events are not accidents at all. They are events arising from conflicts contrived by the rules and design of the road and users, A report published by the World Health Organization in 2004 estimated that some 1.2 million people were killed and 50 million injured on the roads around the world each year (World Health Organization, 2010) and was the leading cause of death among children 10 – 19 years of age. The report also noted that the problem was most severe in developing countries and that simple prevention measures could reduce to half the number of deaths. (*BBC News* 2008). There are many reasons causing accidents to happen such as the velocity of the cars, crossing the traffic lights and turnings abnormally. The development of the traffic surveillance systems works to reduce some of these accidents. Therefore the use of cameras with video system technology will help to prevent accident from happening. The Intelligent traffic surveillance system, in this thesis, works to detect the abnormal turning of the vehicles in specific areas, and also counts the number of moving vehicles to reduce the traffic jam, besides that the view could be streamed to the base station or recorded as images and sends the important one to the base station.

1.4 Objectives

The development of road surveillance systems with multifunctional techniques has received increasing attention. The use of the web camera is one solution to solve the traffic problems. This work discuss about the camera-video-surveillance capabilities of tracking across different and varied road environments including detection of moving vehicles. This effort has done by developing image processing and recognition Using OpenCV to:

- Developed a prototype video imaging techniques using open source system.
- Design road surveillance systems for all weather condition.
- Detecting abnormal movement of vehicles from specific points on the road.
- Allow the capture images of abnormal movement to be recorded.
- Comparison the capability of saving images in different formats.

1.5 Thesis layout

This thesis includes five chapters which deals with scientific purposes needed to develop the recognition method. Beside Chapter 1, Chapter 2 deals with Literature review of Image Processing and recognition in traffic surveillance. Chapter 3 presents the methodology of algorithms and the software techniques used in traffic surveillance system and the processing steps of the image processing.

Chapter 4 discusses results and performance analysis of the tracking and movement recognition method developed in chapter four and tested it with different processor speeds. Beside it contains the performance evaluation from preparing

comparisons between the results of experimental that has been done, using different processor speeds and a comparison of saving the images in different formats. Finally Chapter 5 concludes the thesis by demonstrating the success present ideas and its requirements of road traffic surveillance application. And also some suggestion has been discussed as a future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction:

The development of a traffic surveillance system is a main problem to the most of researchers and people around the world. The use of image processing techniques is useful for the intelligent detection of traffic and transport systems which recently have been widely developed. There has been much implementations and research using image sensors to get information and data for traffic control and vehicle control. Cameras could be used for vehicle tracking, measurement of the speed of the car and detection of perked car, etc. (Shinji Ozawa, 1999)

2.2 Fundamental of Image Processing and Its Applications

The interest in images and how to process them started a long time ago, most researchers and scientists were concerned about how to get a high quality of the photograph. Most of the previous work is in distributing the level of brightness and using lighting photograph technique to make images in gray scale better than what it was previously. The first computer was powerful enough to carryout meaningful image processing tasks which appeared in the early 1960s.The Birth of what is called digital image processing today can be traced to the availability of machines and the onset of the space program during that period. It took the combination of those developments to bring into focus the potential of digital image processing concept which work on using computer techniques for improving images from the space orbit programs at the same