APPLICATION OF HUMAN DETECTION ALGORITHMS IN FIXED VIDEO SURVEILLANCE SYSTEM FOR RESERVED PLACES

By

OPATI KENNEDY OTANGA

A research dissertation submitted in partial fulfilment of the award of the Degree of Master of Science in Data Communication in the Faculty of Computing and Information Management

KCA UNIVERSITY

NOVEMBER, 2014

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Declaration

This dissertation is my original work and has not been presented for a degree in any other University.

Student Name: **Opati Kennedy Otanga** Reg. No. 12/02689

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Supervisor: This dissertation has been submitted with my approval as the university supervisor.

Professor Patrick Ogao

Signature________________________ Date_________________________

ABSTRACT

Insecurity in many parts of the world is a major challenge that has led to increased deployment of video surveillance in both private and public entities. As a result, the need to have automated video surveillance systems is receiving serious attention as demonstrated in intense ongoing research in Human Detection Algorithms by various research communities in the field of computer vision. In this dissertation we propose an automated fixed video surveillance system based on human detection algorithms with a focus on wildlife surveillance. Today, endangered species of wildlife, in particular the Rhinos and Elephants are faced with the threat of extinction due to poaching, which is motivated by the value of their horns and there is need to use video surveillance technology to supplement current methods of wildlife protection.

We used prototyping method to implement the system using Open CV library algorithms in MATLAB language by cascading upper body, full body and face detection algorithms to achieve the objectives set out in this research. The proposed system successfully detects human beings in different postures such as upright facing the camera and away from the camera, walking upright, bending, sitting and squatting. With average positive detection rate of 90% achieved in different test environments, it has been demonstrated that the system can be used to improve the efficiency of video surveillance of reserved places.

ACKNOWLEDGEMENTS

I wish to acknowledge the tremendous support, encouragement, suggestions and guidance given by my project supervisor Professor Patrick Ogao throughout the project period. I also wish to acknowledge the honest critique and ideas of all panellists and colleagues in class during project presentations that helped me to improve the project. To all I say thank you.

I also acknowledge the financial support I received from my employer the Kenya Wildlife Service that enabled me to start the Data Communication course at KCA University on time.

I am grateful to my wife and children for their understanding and patience during the period of this project.

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF ABBREVIATIONS

1. CCTV - Closed Circuit Television
2. USA - United States of America
3. UAS - Unmanned Aerial Systems
4. UAV - Unmanned Aerial Vehicle
5. IP - Internet Protocol
6. SMS - Short Message Service
7. ICT - Information Communication Technology
8. MPEG - Mobile Picture Expert Group
9. HOG - Histogram of Oriented Gradients
10. UML - Unified Modelling Language
11. SVM - Support Vector Machine
12. OpenCV - Open Computer Vision Library
13. PC - Personal Computer
14. RAM - Random Access Memory

CHAPTER I: INTRODUCTION

1.0 Background

1.1 State of poaching

This research was inspired by the need to respond to the global poaching problem particularly of the endangered wildlife species such as Rhinos and elephants. In Kenya for instance poaching has reached crisis level with only about a thousand Rhinos left in the country. Cases of Rhinos being killed in highly protected parks and animal sanctuaries have been reported in the past. It is clear therefore that if no concerted efforts are made to curb the trend, soon those species will be extinct. There have been various non- technological attempts to put measures in place to stop poaching but these have had insignificant impact on the global poaching crisis which continues to rise exponentially (Akash and How 2014). These measures include using informants to report activities of poaching crime syndicates, dehorning of Rhinos to remove the value and motivation behind poaching, and poisoning of horns. All these approaches however, have raised concerns over for instance the safety of the informants, poachers killing dehorned Rhinos for unclear reasons and ethical concerns over intent to kill wildlife products consumers through horn poisoning. As shall be demonstrated in chapter II, video surveillance technology is a key component in wildlife conservation at the moment and supplements other wildlife protection strategies. However, most existing video surveillance systems rely on a human observer with the limitation that it is impossible for a single observer to visualize simultaneously all observed objects behaviour from multiple cameras, hence intelligent, automatic video surveillance is more efficient and effective for security personnel (Lipton, Heartwell, Haering and Madden 2002).

1.2Application of Video surveillance

Video surveillance technology is a form of remote sensing technology, being the acquisition of data about an object without making contact with it. The technology has a long history and different approaches ranging from indoor, commonly known as CCTV to outdoor surveillance systems have been used. For outdoor surveillance we have Aerial video surveillance and fixed video outdoor surveillance systems in use today for different purposes in both private and public setups. Video surveillance is applied in security surveillance of private and public premises, industrial plants, Forest fire, ports, in road traffic systems and border surveillance for instance in the USA.

1.3 Video surveillance in wildlife

As shall be demonstrated in chapter II, video surveillance applications are increasingly becoming important in wildlife surveillance and ecological monitoring studies. However, few countries worldwide use video surveillance technology for anti-poaching activities. In Africa in particular only South Africa has made tremendous progress in embracing video surveillance technology for wildlife conservation. At the moment the country uses a combination of manned, Unmanned Aerial Vehicles (UAVs) and fixed IP video systems in protection of its wildlife. However, most video systems currently in use still rely on a human observer and are thus less efficient as it is impossible for one to visualize objects from multiple cameras simultaneously.

1.4Challenges in wildlife Surveillance

While most wildlife areas are expansive and pose difficulties in ensuring protection for all the animals, the ready market and value attached to some animal horns in Asia is a major challenge to wildlife protection efforts. Further, poachers have over time become more sophisticated in their activities and weapons that containing them is posing serious challenges to organizations mandated with conservation of the wildlife.

Other challenges include acquisition of video surveillance systems such as UAVs which require high initial acquisition cost that is out of reach for many countries. Kenya for instance, despite being a key player and home to significant wildlife resources in the world has no single UAV. Operation and maintenance costs of UAVs are also high and therefore deployment of such video surveillance systems in expansive areas of wildlife require high investment. However, with the growth of wireless telecommunication infrastructure in wildlife areas it is going to be possible to share this resource for video surveillance.

An article on the (Wildlife Protection Solution Organization of South Africa 2014) website identifies the use of ground forces as the most commonly used approach in wildlife protection worldwide. It is however noted that this method of wildlife surveillance is not cost effective and only achieves partial protection of the animals as indeed it is not possible for ground patrols teams to be everywhere in the expansive wildlife places to ensure security for all animals. A number of approaches using various video surveillance technologies have been tried in some part of the world as shall be demonstrated in the literature review chapter but all these approaches have limitations and no single approach can be a complete solution to the poaching crisis, a combination of approaches and particularly the use of automated video surveillance technology is necessary.

1.5 Aim and Objectives

The aim of this research was to implement human object detection algorithms and SMS technology in video surveillance system for detecting poachers in wildlife parks to help curb poaching of endangered wildlife species. This research will contribute to the knowledge base of wildlife conservation bodies mandated with protection of wildlife and agencies responsible for security of reserved places in general.

Specific objectives were:

1. To review the existing wild life video surveillance technologies to identify gaps and requirements for an improved video surveillance system
2. To design a human detection algorithm for automated fixed video surveillance system.
3. To implement the design using a computer based prototype.
4. To conduct simulation of the system using the computer prototype.

1.6 Significance of the research

In Kenya, tourism which is based mainly on wildlife attraction is a major foreign exchange earner and driving force in economic development of the country. In particular, the endangered species (e.g. Rhinos and Elephants) are key tourist attractions in Kenya. Their extinction would result into a decline in tourist numbers to the country and lead to loss of foreign income and unemployment due to job cuts in the tourism sector. This study therefore forms part of the efforts being made by various stakeholders to ensure the endangered animal species are protected through use of video surveillance technology to supplement traditional methods used in wildlife protection.

Further, the growth of telecommunication infrastructure in terms of spread and bandwidth in Kenya and worldwide is a resource that needs to be exploited to provide opportunity for deployment of terrestrial surveillance systems for wildlife protection using wireless technologies. This study therefore will be an eye opener to the potential benefits of increased presence of ICT infrastructure in wildlife places.

1.7 Organization of the dissertation

This dissertation starts with Chapter I: an introduction with a brief account on the state poaching and video surveillance technology. Chapter II reviews literature relevant to wildlife surveillance and the state of the art in the area of human detection algorithms that are necessary to provide intelligence and automation to video surveillance systems. Chapter III gives the methodology used in achieving the objectives of the research while Chapter IV discusses the solution analysis and design of the system. Chapter V has the implementation of the designed system followed by simulation results in Chapter VI and finally, future work and conclusions.

CHAPTER II: LITERATURE REVIEW

2.0 Introduction

In this literature review, journal publications, books, projects and case studies are reviewed to provide an insight and understanding into the existing video surveillance systems in wildlife conservation to identify gaps and demonstrate how these can be improved through the proposed system. A state of the art solution to the poaching problem using human detection algorithms is explored by considering innovations in the field of computer vision.

2.1 Video Surveillance for Wildlife Protection

Video surveillance technology is a form of remote sensing technology, being the acquisition of data about an object without making contact with it. The technology has a long history and has been used for varied purposes with different approaches ranging from Unmanned Aerial Vehicles (UAV), closed circuit television (CCTV) to long range fixed IP video surveillance systems. (Watts, Ambrosia, and Hinkley 2012) studied applications of different types of UAVs for surveillance purposes and highlights systems that have been used for surveillance over the years with applications in the military warfare. In the military, these systems are generally referred to as drones but other names such as Unmanned Aircraft Systems (UAS), unmanned aerial vehicles (UAVs) or remotely piloted aircraft (RPA) are used. Use of unmanned aircrafts has a long history dating back to 1849 when aerial bombardment of Venice took place using balloons and also in the American civil war.

The authors conclude by suggesting that possible applications of UAVs include Forest health monitoring, Forest inventory, Wildlife surveys and Avalanche patrols among others.

Despite the importance of unmanned aerial systems in surveillance, the following differences and disadvantages of both piloted aircraft and UAVs are noted and demonstrates their limitations in anti – poaching missions (Rango, Laliberte and Steele 2006)

1. That UAV is mostly stationed near the area of interest, while most piloted aircrafts are normally far away from the area under surveillance.
2. There is some delay in data processing after a piloted exercise. In many occasions such missions are not real-time and quick action is not possible in this circumstances.
3. Owing to the cost of an aircraft, most organization will own just a limited number and therefore, the availability of the piloted research aircraft is sometimes limited because of multiple demands on the aircraft.
4. Both capital and operational costs are much higher for piloted missions.

In view of budgets constraints, remote sensing or video surveillance systems need to be simple and as affordable as possible to allow for wider deployment.

In an article titled (Kruger Park protects wildlife 2009), Cam secure implemented Milestone X Protect® IP video software to manage Axis network cameras at Kruger Park gates and camps. Park management could access the surveillance centrally from the headquarters while local access is also available at the gates. The system enabled the park management to be able to closely monitor movement of vehicles in the park and track those suspected to have hit animals or carrying poachers. This system however is less efficient as it relies on a human observer with possibility of missing detection of a suspicious event in the area under surveillance.

In a research project conducted in Mozambique and Kruger National Park - South Africa, use of CCTV. systems capable of continuous recording of vehicle registrations, and face of driver as part of the access control strategies at gates to the National park to identify poachers is recommended (Montesh 2012). While this system is real time and provides useful information about activities in the park, it still relies on a human observer with added complexity of having to store images continuously, some with nothing of interest.

(Jayadevan and Sangeetha 2011) underscores how India's wildlife and Forest authority have devised a new way of dealing with endangered animal species by using radio sensors to track the movement of the animals and breeding habits. The technology also helped to improve the accuracy of animal census data which previously were unknown. What is significant in this study is that by using a camera trap reliable population estimation of the tigers was achieved. This underscores the importance of video surveillance that helped to improve the effectiveness of animal tracking.

(Macnulty, Plumb and Smith 2014) studied Validation of a new video and Telemetry system for remote monitoring of wildlife and observed that current techniques for remotely monitoring wildlife lack the capability to survey a wide area or transmit data in real time. For instance, remote cameras can transmit live video but the field of view is typically limited to record wildlife movements outside specific site. This study though meant for ecological monitoring and aimed at addressing this limitation through use of video and telemetry system has also a lot of relevance to ant-poaching. Wind and solar power were used to power the equipment of the system. A satellite internet uplink transmitted data in real time to a central place for control and monitoring.

2.2State –of – The – Artin Video surveillance systems

2.2.1 Analogue to Digital Migration

Video surveillance systems have been evolving from analogue and being replaced by digital systems, which offer many benefits. These benefits include greater flexibility in video content processing and transmission mechanisms such as IP based as compared to analogue systems which have some limitations. In video systems, it is possible and perhaps much easier to implement advanced techniques and features (Peng 2003). Today we have camera systems that are capable of motion detection and object tracking and even face detection.

Computer vision technology is revolutionizing video surveillance and CCTV applications for security of large outdoor facilities. People are less likely to commit crime if they are aware they will be caught on camera (Dr Lipton, Heart well, Dr Haering, and Madden 2002) in an article titled “Critical Asset Protection, Perimeter Monitoring and Threat Detection Using Automated Video Surveillance “. The knowledge of the presence of video surveillance in any setup is a deterrent measure that can keep people away from wildlife places and have significant impact on controlling poaching.

(Ostheimer, Lemay, Mayisela and Dagba 2006) designed an automated, real time Modular Distributed Video Surveillance System over IP for detection of objects in a wide range of applications. The system components were interconnected to allow multiple feeds of video streams. The system used distributed computing allowing use of standard computers and MPEG -4 compressions for reduced disk and network consumption, and real time delivery of video. The authors' note that compared to distributed systems, centralized systems deliver less performance due to increased hardware requirements.

(Akash, How, Poh, Lee, Rishi, Tan, Shiah and Awara 2014) implemented a system known as "Skyno project" in South Africa which uses a balloon with night vision camera and transmission hardware and software that detects poacher trucks in the park and sends an alert to the users. The system enables reliable detection of a larger sized moving object (vehicle) among smaller sized moving objects (animals or humans) and can detect poachers' vehicles. In this project the primary feature of Skyno is that it enables its users to identify threats before harm is caused to the animals.

The Skyno project above illustrates the latest approaches in wildlife surveillance using intelligent video processing algorithms where poachers' vehicles are automatically detected and alerts sent to users to facilitate necessary security measures. The challenges in anti-poaching operations include inability to have security rangers everywhere considering the expansive nature of most wildlife parks. In most cases arrest of poachers is impossible or done long after the animal has been killed due to lack of early warning systems.

2.2.2 Wireless Video surveillance systems

Wireless Video Surveillance represents a more recent development in video surveillance systems that address the challenges in the current physical network infrastructure for video transmission over wireless channel. The focus is on video compression and transmission over wireless networks to maximize on the received signal quality under constrained resources such as bandwidth limitations. Wireless video surveillance is popular in various visual communications and usage of video surveillance applications was predicted to double up from 2011 to 2016 (YUN, Song, Aggelos, Yanwei and Yi2013). Given the need to maintain environmental integrity in wildlife parks, wireless video transmission approach would be the most preferred option compared to wired systems.

In a video system that uses wireless sensor network there is possibility of extracting gathered information from a master node via 3G or 4G networks(Garcia-Sanchez 2010) While bandwidth issues can arise when streaming video, this assertion by Garcia-Sanchez illustrates one possible wireless way of interconnecting video cameras to transmit video to cover a larger area.

(Fairhurst, Nazir and Newey 2012) in a study titled “Wireless Internet Sensing Environment” (WISE) project underscores the importance of getting accurate and timely data for efficient management of natural resources. While acknowledging the importance of video surveillance for security purposes to ensure safety in crucial areas, they point out a short coming that such deployments are done only in places with power and internet provision. That approach of course fails to explore possibility of using solar power and wireless transmission such as 3G, WIMAX etc, which is increasingly becoming available in may remote areas of wildlife.

However, the study notes a setback of ordinary video surveillance as the potential to record tremendous data that may be of no relevance and use, requiring that a lot of work be done manually to sort the required materials for processing and storage.

Contrary to the authors assertions that deployments of this wireless video system is limited to places with internet and power, it is possible to run this system using solar power, which is increasingly becoming cheaper to deploy due to tax exemptions on solar equipment by many countries worldwide including Kenya.

Today we have intelligent IP based video surveillance systems with software that allows remote control of the camera and processing of high resolution images. Long range cameras are also available and being used for example in port surveillance (United Vision Solutions 2014). These modern and powerful systems will increasingly find application in wildlife surveillance due to the advantages they offer in remote surveillance. The long range cameras in particular will find wide usage in wildlife surveillance, which mostly involve coverage of vast distances of wilderness.

2.2.3 Application of human detection algorithms in video

Below we review application of human detection algorithms in video surveillance. In view of the ongoing research in automated video surveillance, these algorithms are going to form the foundation for future intelligent, automated video surveillance systems for reserved places such as wildlife parks where unauthorised human movement is prohibited.

With continuous growth of the video surveillance market spurred by the need to protect people and other resources, prices of the video equipment has come down and this has contributed to the wide spread deployment of video cameras. This has led to a scenario where a large number of cameras are monitored by a single user. However, it is impossible to visualize simultaneously the behaviour of all observed objectsin order to address a dangerous situation with urgency, hence automatic surveillance systems are crucial for security personnel (Duque, Santos and Cortez 2007). This automation can only be achieved through application of intelligent algorithms. Various techniques are used in human detection in intelligent video surveillance; the most common ones include face detection, upper body detection and whole body detection. Each of these is implemented in unique ways.

2.2.4 Face Detection

(Wong, Lam and Siu 2000) in a study titled – "An efficient algorithm for human face detection and facial feature extraction under different conditions", appreciates that detecting human faces and extracting the facial features in an unconstrained image is a challenging process due to various variables that include wearing of glasses, deferent skin coloring, and gender. This assertion is corroborated by (Manoranjan, Haque and Chakraborty 2013) in a review titled "Human detection in surveillance videos and its applications" Object detection methods fall into three categories commonly known as background subtraction, optical flow and spatio-temporal filter techniques. On the other hand object classification techniques also fall into three categorize namely shape-based, motion-based and texture-based methods; however it is acknowledged that it is a difficult task extracting an image from a video particularly in low resolution.

Face detection is necessary and has several applications in areas of video coding, crowd surveillance and intelligent human –computer interface. Some of the best algorithms are still too computationally expensive to be used in real time but this will change with improvements in hardware (Hjelmas and Low 2001)

(Viola, Shakhnarovich and Moghaddam 2002) in a paper titled “A Unified Learning Framework for Real Time Face Detection and Classification” developed an algorithm using demographic classification scheme specifically designed to work in real-time and real-world context. The key difference with previous work is that faces can be extracted from unconstrained video which can be of poor quality.

Traditional approaches to facial recognition treat video as a collection of images. However, there is a clear difference between photographic facial data and video acquired facial data (Gorodnichy 2005). The researcher developed another framework which does not divide video into images but treats it as a whole entity.

(Viola and Jones 2004) presented a face detection solution with three key contributions, these are: ability to compute features used by the detector very quickly, a simple efficient classifier based on the Adaboost Algorithm and a method of cascading classifiers to enable background regions of the image to be discarded while applying more computational effort on promising face like features. The system was implemented on a desktop with 15 frames per second and yielded good performance.

(Jensen 2008) in a Masters project titled “Implementing the Viola-Jones Face Detection Algorithm” worked on recreating the Viola - Jones algorithm to be able to detect all visible faces in any conceivable image using figures posted by Viola – Jones. Images from the internet and private collections were used in training, evaluation and testing of the algorithm to ensure a good representation of the unconstrained environment the detector was expected to work.

(Sandeep and Rajagopalan 2002) proposed a face detection algorithm for detecting human faces in colour images. They assert that detecting faces in still images is more difficult and poses challenges as compared to detecting faces in video since motion information can lead to probable areas where a face could be located. The algorithm was implemented in MATLAB and took 11 seconds to respond with a Pentium III, 128MB RAM. The algorithm was tested with natural images taken under uncontrolled conditions.

2.2.5 Upper body Detection

(Buehler, Everingham, Huttenlocher and Zisserman 2011) investigated upper body detection and Tracking in extended signing sequences. They approached the problem of segmenting the head and torso using multiple candidates shapes as templates and fitting these templates to the image using a simple two-part pictorial structure model. For a given template, orientation and scale, the appearance term at every position is computed by convolution of the pixel-wise likelihoods under the torso colour model with the template. The final appearance term for the torso is then defined for each pixel individually as the maximum over all orientations and scales. Appearance terms for the head are computed in a corresponding manner, using the head shape templates and skin colour model.

Candidate masks of the head and torso are fitted to the image using a pictorial structure model with two parts. The maximum segmentation is restricted to the head and torso shapes provided by the masks. In contrast, this method is based on a weighted nonlinear combination of the masks and hence achieves a more accurate segmentation. The position of the shoulders is obtained by projecting the position of the shoulders from the torso masks into the image. They proposed a model which can reliably find hands and arms in a sign language in a TV broadcast program with continuously changing background and challenging image conditions.

2.2.6 Whole body human detection

(Kim and Rajasooriya 2013) proposed A Moving Human-Object Detection for Video Access Monitoring algorithm. In this study a simple moving human detection method was proposed for video surveillance system or access monitoring system. The difference in frames is used to detect a moving human object. Results showed that the algorithm was fast and of excellent performance recording 95% detection rate qualifying to be used as an intelligent video monitoring tool. The researchers declared it an effective algorithm for moving object detection.

(Dalal and Triggs 2006) studied a technique known as Histograms of Oriented Gradients (HOG) for Human Detection and concluded that HOG out performs other methods used in human detection in video.

(Takayanagi andKatto2012) studied Human Body Detection using HOG with Additional Color Features. Given that HOG feature does not contain color information the researchers considered that inclusion of color information can be used in human detection. For instance, face skin colors are used in simple human face tracking algorithms. They used Adaboost machine learning to choose useful features from the HOG. Adaboost is composed of simple weak classifiers. They concluded that this method of HOG using additional colors performs even better than other techniques.

(Dalal, Triggs and Schmid 2010) in a study titled “Human Detection using Oriented Histograms of Flow and Appearance” developed a detector for standing and moving people in video with moving camera and background. These motion based descriptors were combined with HOG appearance descriptors. Test results showed that false detection rate reduced by a factor of 10 compared with the best appearance detector.

(Benezeth, Hemery, Laurent, Emile and Rosenberger 2014) studied Evaluation of Human Detection Algorithms in Image Sequences focusing on in- door environments and suggested an evaluation metric.

(Lu Xia, Chenand Aggarwal 2011) studied Human Detection Using Depth Information by Kinectusing a 2-D head contour model and a 3-D head surface model.

2.3Critique of Literature

Issues that have emerged from the literature review are discussed below**:**

I. Recording of no- information video content in continuous monitoring has been mentioned as being wasteful. To the contrary in anti- poaching surveillance this should be seen as a positive feature if necessary hardware is available since it is never known when poachers will strike. However, the proposed system seeks to remove the burden of monitoring from the user through automated alert system. Recording is only done upon detection of a person and limited to a few seconds to make efficient use of storage facilities. The objective behind recording being to retain an image of the intruder for future investigation. The user will only be required to respond on receiving an alert message (SMS).

II. In a number of cases some researchers have used standalone camera systems in their studies due to lack of internet point. This approach failed to explore possibility of using wireless IP data communication solution simply because there was no internet point nearby. With wireless IP, compressed data can be transmitted over a long distance through well designed radio links with adequate bandwidth.

III. Lack of mains power has been cited as a limitation to some remote implementations of video surveillance yet it is possible to use solar power in such situations. In Kenya for instance, the government has waived tax on solar equipment resulting into price reduction of solar equipment to enable wide deployment of solar power systems as part of the green energy strategy.

IV. Use of Unmanned Aerial systems (UAS) has been recommended as a solution to wildlife conservation by some authors. However, the scope of usage and wide spread adoption of this technology is in doubt. To date, despite the fact that this technology has been around for long very few organizations use it in wildlife protection. Issues of operation costs, maintenance and safe operation are still contentious and will continue to limit the use of this technology.

2.4Conclusions

Video surveillance remains a very crucial technology and a critical component in security applications. In view of increasing insecurity in many places and wide spread poaching, automated video surveillance systems will be very useful in ensuring effective surveillance of reserved places. Video surveillance is deterrent to potential criminals because most people would avoid intruding into an area if they are aware they are being captured by a camera system. Given the continuing spread of wireless IP based telecommunication infrastructure in Kenya's parks and other wildlife areas, intelligent fixed video surveillance systems is a potential solution that will find wide application in wildlife and security surveillance in the near future. The potential for the system proposed in this research is immense and ranges from cost savings due to capability of re-using existing infrastructure to networking capabilities. Furthermore, as more wireless IP points become available in protected areas, it will be possible to monitor large areas of wildlife with networked fixed surveillance cameras.

In general, from literature reviewed, characteristics of a good surveillance system include:

1. Simplicity of the solution to enable ease of adoption
2. Cost effectiveness to allow a large number of potential users to buy the system
3. Automation to remove the need for a human operator
4. Economy on video storage space

CHAPTER III: METHODOLOGY

3.0 Introduction

In this research, we implemented human detection algorithms to create a system that can detect the presence of poachers in a wildlife park. Upon detection of a person, the system is supposed to send SMS alert to the users. It was recognized that the area of human detection in video is currently a subject of intense research that seeks to have improved algorithms for intelligent video surveillance systems for varied applications and therefore any proposed systems in this area should be open to future improvements. Further, the time available for this project is limited and quick results are required to demonstrate proof of the concept.

In these circumstances, in order to achieve the objectives of this research, a Prototyping method was considered to be the most appropriate method of undertaking the research.

Below are the steps that were followed in fulfilment of the objectives of this research.

Step 1

3.1 Review of literature

Literature review was conducted to identify gaps in wildlife surveillance and to identify the state-of - the –art in the area of human detection algorithms applicable to automated video surveillance. Objectives to address the gaps were developed. The goal was to identify the most appropriate algorithm or combination of algorithms for implementation of the proposed system.

Step 2

3.2Establish Requirements

A conceptual view of the system was done using Unified Modeling Language (UML) graphical tools. These helped to visualize the communication and interaction between the various components of the system. The requirements were established to ensure the designed system meets expectations.

The logical component requires that the system shall comprise of two modules, the human detection module and the SMS module. The two modules were linked in order to communicate, as the activation of the SMS module relies on the output of the human detection module.

Step 3

3.3 Algorithm Design and Implementation

Design of the algorithms was derived based on the Unified Modelling Language (UML) graphical tools.UML was preferred as it can be used for modelling the whole system independent of platform language. It is also a recommended tool for object oriented design implementations.

Modeling provides a structure for problem solving that helps manage the complexity of systems before actually starting development work. Modeling any problem before its development minimizes chances that the development plan will go wrong, thus decreasing development costs and mistakes. Coding of the human detection algorithms was done through customizing the Open Computer vision Library code (Open CV Library) using MATLAB language. The SMS code that uses modem attention commands was incorporated and integration with the human detection module implemented through coding.

Step 4

3.4 Simulation

The prototype system was tested through computer simulation to check performance of the algorithms using different image samples and video. The purpose of this was to confirm whether the human detection algorithms and the SMS perform as intended. The tests were carried out in different environments to simulate uncontrolled environment the system is expected to work and the response documented.

Step 5

3.5Modifications and Final Prototype

Improvements were done as necessary to ensure the system meets the intended objectives before the final prototype was attained. The final prototype was tested using a webcam camera to simulate the expected system performance in real life environment.

CHAPTER IV: SOLUTION ANALYSIS & DESIGN

4.0 Introduction

The focus of this chapter is to present the approach that was used to design the algorithm for use in video surveillance camera system to enable detection of persons in a video stream. Incorporation of a text message module to allow sending of alerts to the users is also presented and represents a crucial component of the automated surveillance system to ensure timely action is taken before an animal is killed by poachers. Simulation of the surveillance system was done using a computer based prototype to confirm the performance of the algorithms. Various test samples and environments were tried to check the effectiveness of the algorithms to detect humans in uncontrolled environment.

4.1 System Design and Implementation Process

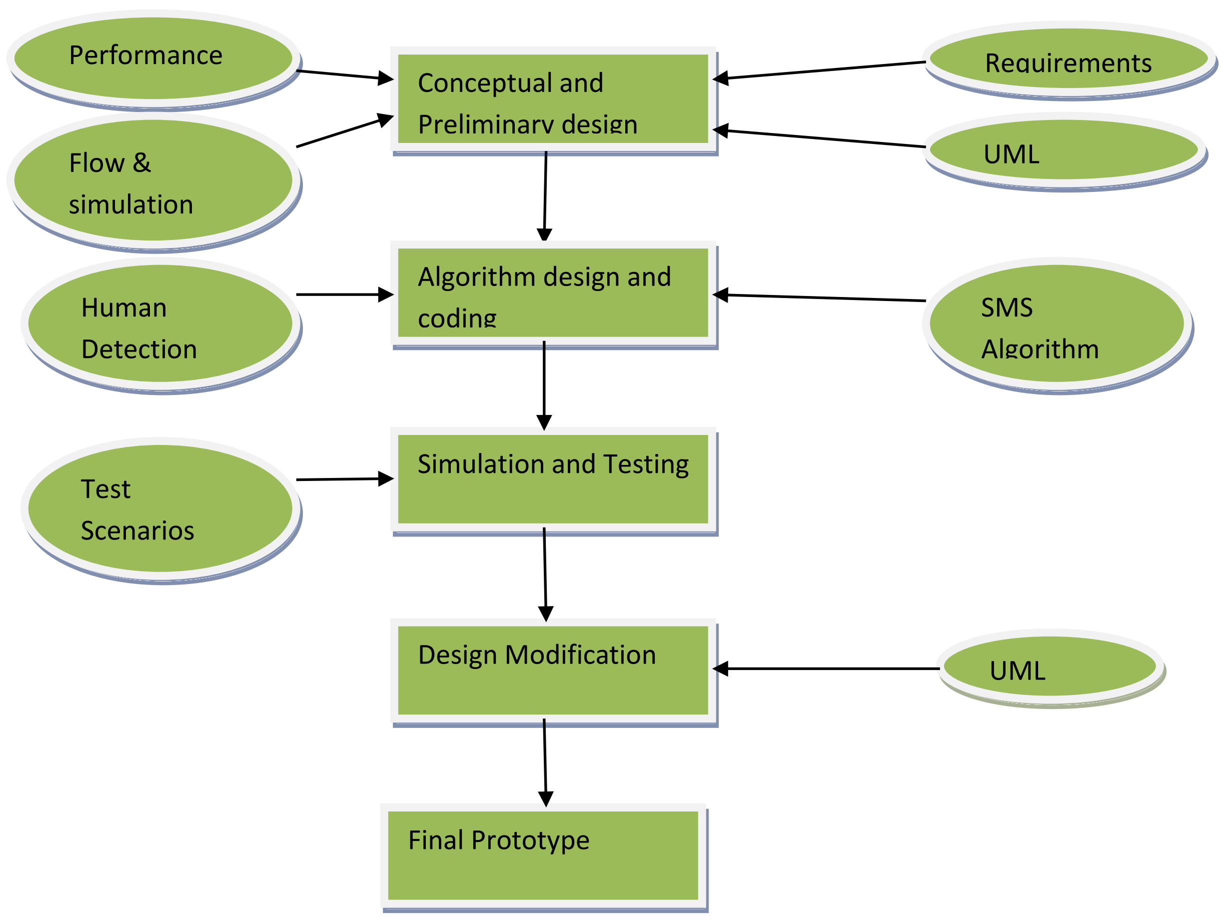


Fig1: Design and Implementation diagram

Figure1 above shows the flow chart that guided the overall system design and implementation process. The performance of the human detection algorithm and how it integrates with the SMS algorithm is an important consideration in the conceptual and preliminary design process. The prototype surveillance system was tested based on this integration. A number of modifications such as reorganizing the sequence of the separate algorithms used was done to improve performance of the system before the final prototype system was generated.

4.2Conceptual Model

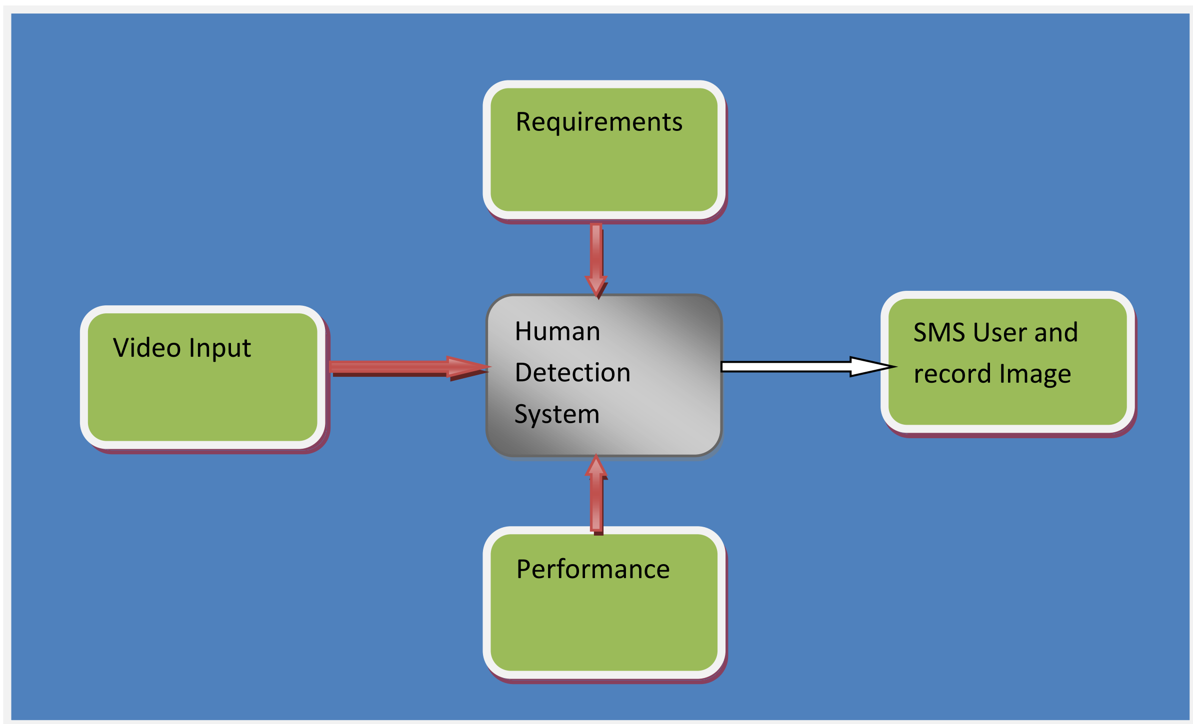


Fig2: Conceptual Diagram

From the above diagram, a video stream is fed into the human detection algorithms to determine whether there are any objects in the video stream. The objects are then classified to determine whether it is a human or not. If a person is detected the system returns a value which is used to trigger the SMS part to send alert to user and record the image of the detected person.

4.2.1 Requirements and Performance

It is required that the system shall be able to detect persons in various postures. These are: standing and walking upright, bending, sitting, squatting, facing camera and facing away from camera. This closely represents the expected postures of a person in real life situation. Based on research in the literature review a detection rate of 95 per cent is considered good and acceptable for practical application.

4.2.2 System operation

The requirement was to have automatic method for finding humans in a video stream. Once the human is detected, the system can do further processing and send SMS alerts to the users as an early warning that a person has been detected in the area under surveillance. Part of the SMS information conveys to the users the camera location where the human has been detected and the time detection occurred to facilitate efficient deployment of security personnel. The users will then initiate action to move to the area to apprehend the culprits.

4.2.3 Computational Flow and sequence

The human detection module contains the algorithms necessary for detecting objects, classify them to determine if it is human and trigger the SMS algorithm to send alerts if a human is detected. The operation of the system depends on the ability of the two modules to interface and communicate properly. The output of the human detection algorithm is used to automatically activate the SMS system.

In order to be able to establish whether the algorithm works as expected, the system was tested several times to determine the detection rate (positive and negative detections). The system can send alerts to more than two phone lines.

4.2.4 Algorithms

Various techniques have been used in design of human detection algorithms; the most common ones include face detection algorithm, Upper body detection and whole body detection algorithms. Each of these requires a different modeling approach. However, in our context, the main challenge was to try and model the natural characteristics of a poacher that manifests in the different natural postures the poacher can present such as walking, sitting, standing, and squatting among others. The desired algorithm should be able to detect any human in these postures. The algorithm should allow for recording of the detected image for a brief moment to enable retrieval of the image and identification of the poacher as appropriate later. Researchers in this field of computer vision have cited a number of challenges encountered in detection of a persons in different environments, these include occlusion, changes in lighting, which results in poor resolution of the video images and hence difficulties in detecting the human.

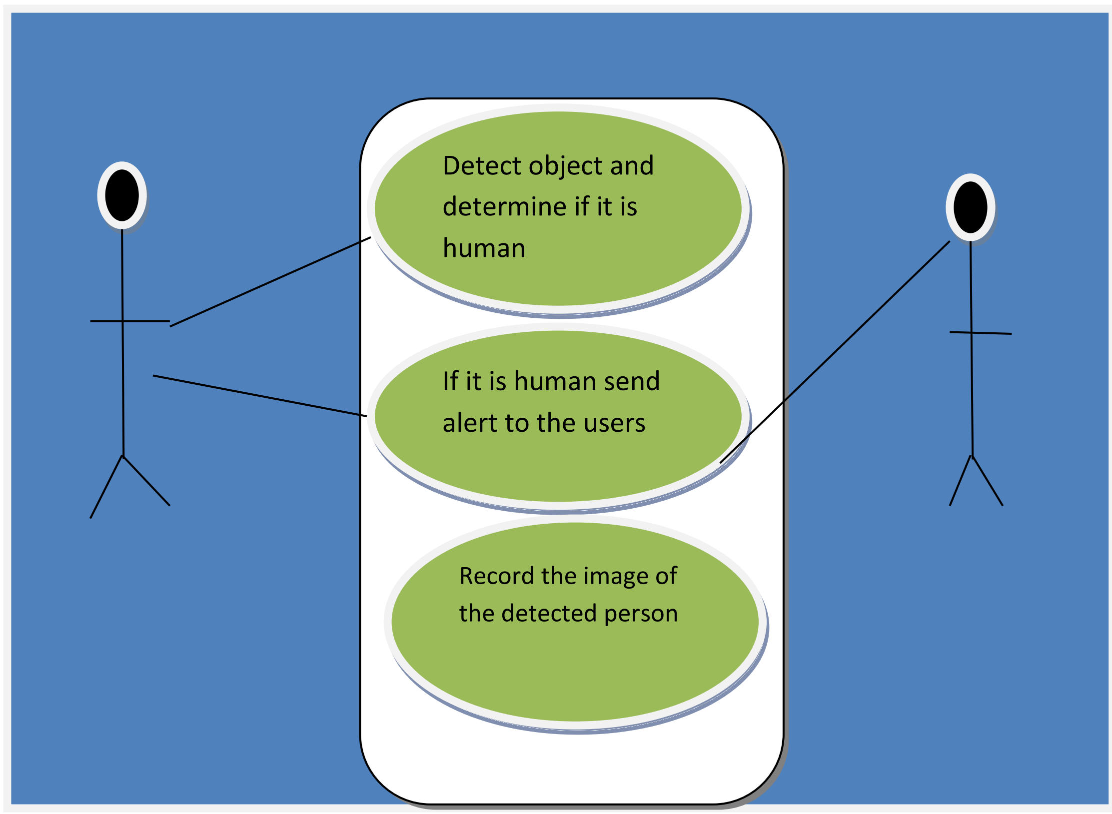
4.3System Modeling Using UML

Two UML modeling diagrams are used; these are:

I. Functional model –this shows functionality of the system and includes the use -case diagrams.
II. Dynamic model – this shows the internal behavior of the system and includes sequence and activity diagrams.

4.3.1 System Functional Model

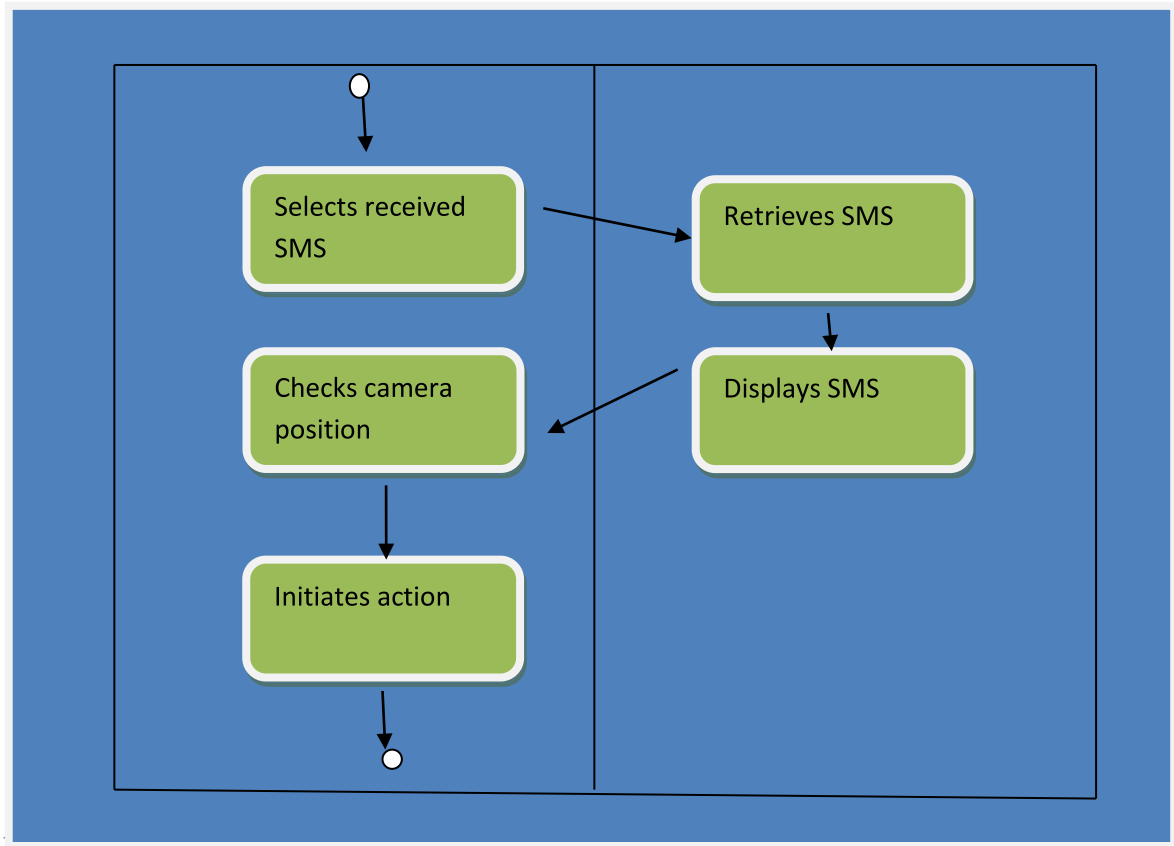
Poacher **User**



The use case diagram above shows a diagrammatic representation of how the proposed system shall function. The two main actors are the poacher and the users. Since movement is prohibited in reserved wildlife parks by law, any person detected by the video system in those areas is deemed to be a poacher and an alert is sent to the user. Upon detecting a person, the system shall record the image for a few seconds for future retrieval. For effective performance of the system and in order to avoid sending unnecessary alerts, security rangers will be required to deliberately avoid moving into areas that are under video surveillance.

4.3.2 Dynamic Model

User **Surveillance Tool**



Upon receiving an SMS, the user shall read it to determine the location of the camera where detection has occurred**.** The user shall be expected to take quick action to ensure the intruder is apprehended by deploying security teams promptly**.**

4.4 Human Detection Techniques

Human detection is a difficult task that is influenced by a wide range of possible appearances due to changing pose, clothing, lighting and background, but prior knowledge on these limitations can improve the detection performance (Manoranjan 2013). (Dalal, Triggs and Schmid 2010) made the same observation in their study of the Human detection using the oriented histograms of flow and appearance. The human detection process occurs in two steps: object detection and object classification as depicted in the diagram below.

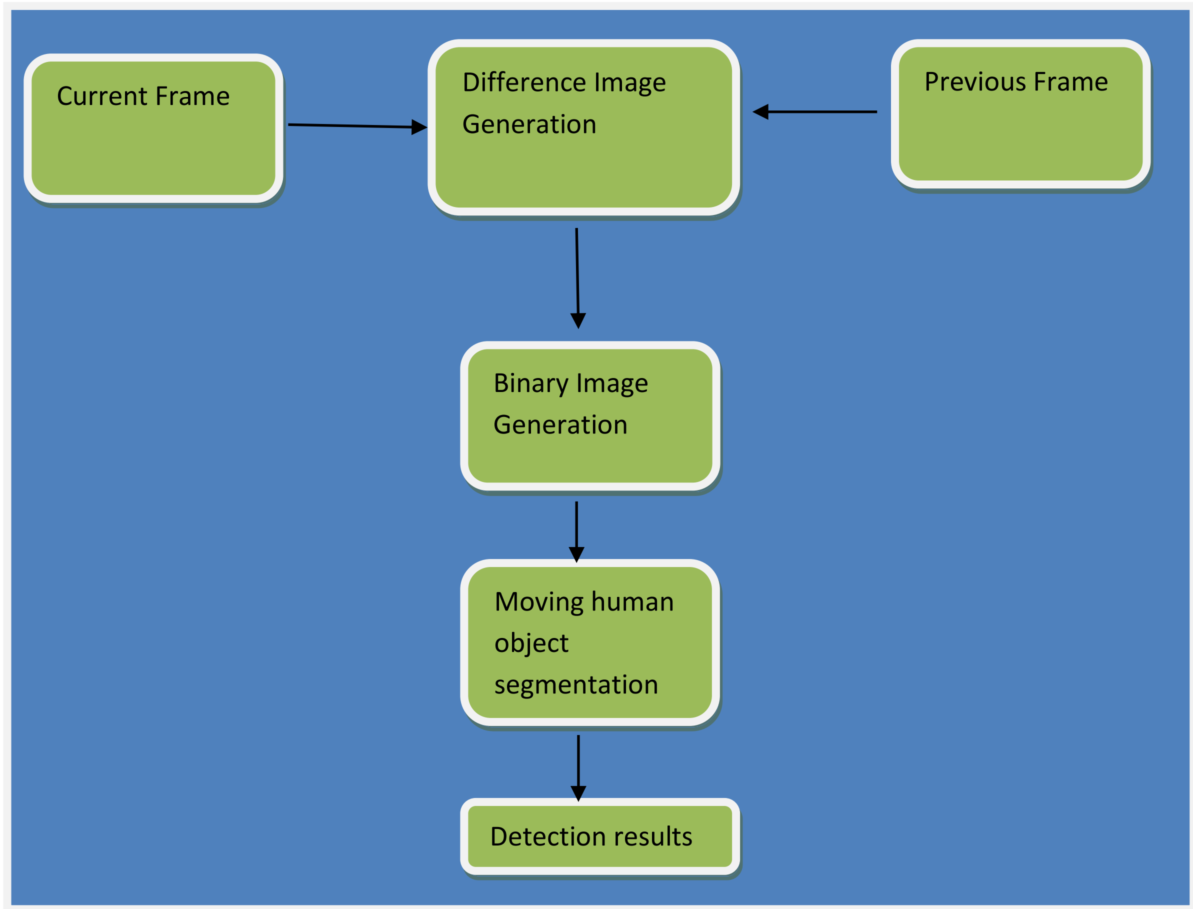


Fig 5: Human Object Detection Algorithm Diagram

Object detection can be performed in several ways which include background subtraction, optical flow and Spatio-temporal filtering.

4.4.1 Background subtraction

This is a popular method for object detection which uses the difference between the current frame and the background to detect moving objects. The most common ways of achieving background subtraction are adaptive Gaussian mixture, non-parametric background, temporal differencing, warping background and hierarchical background models (Rakibe and Patil 2013). The area of the image plane where there is a significant difference within these images indicates the pixel location of the moving objects. These objects, which are represented by groups of pixel, are then separated from the background image.

After the background image B(l,m) is obtained, the background image B(l,m) is subtracted from the current frame Fk (l,m*)*. If the pixel difference is greater than the set threshold *T*, then that determines that the pixels appear in the moving object, otherwise, as the background pixels. The moving object can be detected after threshold operation.

Expression is given as-:

$$D_k(l,m) = \begin{cases} 1 & \text{if } F_k(l,m) - B_k(l,m) \geq T \\ 0 & \text{Otherwise} \end{cases}$$

Any detection system using background subtraction ought to take into account the following important issues-

1. Noise from poor quality image source
2. Variations of the lighting conditions in the affected area
3. Shaking of tree branches and bushes.
4. Any other movements that can change parts of the background to be different from the original.

4.4.2 The optical flow-based object detection technique

This technique uses characteristics of flow vectors of moving objects over time to detect moving regions in an image sequence. This technique is vulnerable to image noise, colour, non-uniform lighting, have large computational requirements and are sensitive to motion discontinuities. To solve the problem of computation consuming (Tian and Hampapur 2005) combine these two techniques together. They firstly use the background subtraction to locate the motion area, and then perform the optical flow computation only on the motion area to filter out false foreground pixels.

4.4.3 Spatio-temporal filter methods (Frame subtraction method),

The motion is characterized via the entire three-dimensional (3D) spatio-temporal data volume spanned by the moving person in the image sequence. The advantages include low computational complexity and a simple implementation process but they are susceptible to noise and variations of the timings of movements.

4.5 Object Classification

The object classification methods could be divided into three categories: shape-based, motion-based and texture-based.

Shape-based approaches first describe the shape information of moving regions such as points, boxes and blobs. However, the articulation of the human body and the differences in observed viewpoints lead to a large number of possible appearances of the body, making it difficult to accurately distinguish a moving human from other moving objects using the shape-based approach.

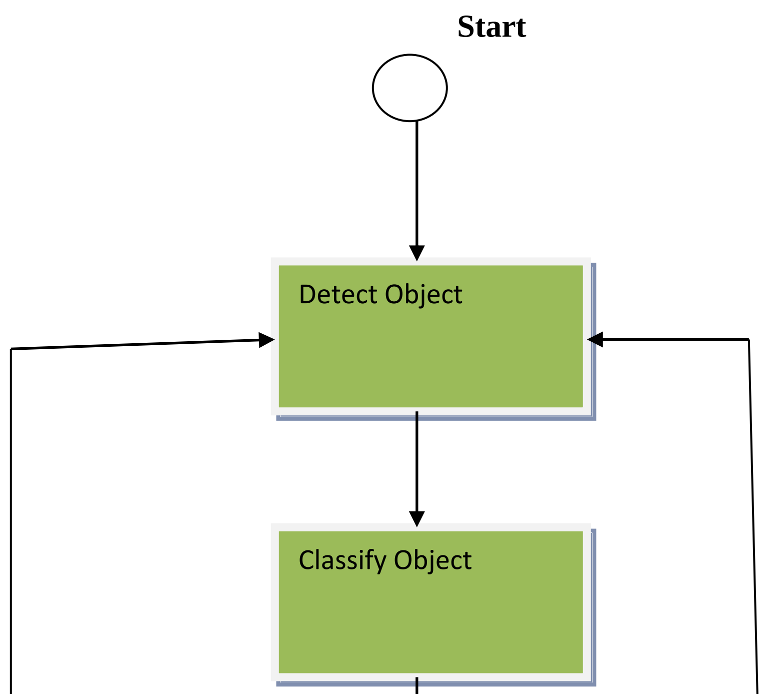
Motion based method is based on the idea that object motion characteristics and patterns are unique enough to distinguish between objects. Motion-based approaches directly make use of the periodic property of the captured images to recognize human beings from other moving objects.

Texture-based methods such as histograms of oriented gradient (HOG) use high dimensional features based on edges and use support vector machine (SVM) to detect human regions. HOG is an image descriptor based on the image gradient orientations. The descriptor is based on dominant edge orientations. The image is divided into cells and then histogram of edge orientations compiled. Cells are grouped into cells using Rectangular HOG or circular HOG. MATLAB has built in functions and allows quick image processing and testing (Yamada 2009)

4.6 Performance consideration

According to a study by (Dalal and Triggs 2008), Histogram of Oriented Gradients method out performs other techniques of human detection algorithms. This assertion is corroborated by another study by (Takayanagi and Katto 2012) titled “Body Detection using HOG with Additional Color Features”. Experimental results showed that the additional color features makes it more effective for increasing the detection rate than the case using only HOG features.

4.7 System Flow Chart



No

Yes

Fig 6: System Flow chart

From the flow chart above, after detection the object is classified as human or not human. If the output is a “true” meaning a human has been detected, an SMS is send to the user for appropriate action and the image is recorded for a brief moment (in our case we set 20 seconds, but this is variable). After 20 seconds the system resumes checking for any detection. If it is “false” the system continues to check the video input stream.

Algorithm

Initialize code

Create object detectors for upper body, full body and face detection

Access video device

Read Image

Check object flow to detect object

Check for upper body, if not

Check for full body, if not

Check for Face

If person detected, put a rectangle and comment ‘person”

Show detected image

Send SMS

Record image for a defined time (20seconds)

Stop recording and resume detection.

4.8 Design consideration

Our design is based on prominent implementations of human detection algorithms in MATLAB by key researchers Viola –Jones and Dalal and Triggs who have been widely cited by a large number of researchers. Viola Jones proposed a very fast face detector for frontal faces and upper body which are regarded as the standards in the Open CV library.

Dalal and Triggs proposed an efficient full body detector using Histogram of Oriented gradients (HOG). We have implemented our solution using Open CV algorithm implementations in MATLAB founded on the work of these researchers.

4.9 Pseudo Codes (With the use of MATLAB Computer vision toolbox)

A Pseudo Code for People Detection –`function name:` *`Detecting People`*

```
1) Create an object for upper body detection
2) Create an object for full body detection
3) Create an object for face detection
4) Create an object for video acquisition
5) Set the properties of the created objects
6) Read video from the camera
7) Initialize detection to FALSE
8) For each acquired frame, do
        Detect upper body
        If upper body is detected, go to 9
             Else detect full body
```

```
                If full body is detected, go to 9
                     Else detect face
                          If face is detected, go to 9
                               Else, read next frame
9) Set detection to TRUE
10)     Return detection as the output of the function
11)     Save  video
12) Go to 6
```

B Pseudo code for SMS sending

```
1) Create a serial port object for communicating with a
   modem
2) Set the properties of the serial port object
3) Set  phone numbers to which text should be sent
4) Set the text message to be sent
5) Call the function for detecting people
6) If a person is detected
7) Open the serial port object for writing
8) Read the phone number and the message to be sent
```

CHAPTER V: IMPLEMENTATION

5.0 Introduction

We implemented the above pseudo code using MATLAB human detection algorithms for face, upper body, full body detection and SMS algorithm. None of the algorithms on its own can accomplish the task of detecting a person in different postures and so we cascaded the algorithms to allow detection of the most common and natural human postures in order to achieve the objectives of this research. Detection is done sequentially with the upper body coming first followed by full body and lastly the face. This was arrived at based on the understanding that face detection is based on frontal face which require that the person be facing the camera, which may not happen frequently in real life situation. Further, in this research emphasis is on detecting persons and not recognition of faces and therefore body detection is more important and was given priority accordingly.

5.1 Implementation Model

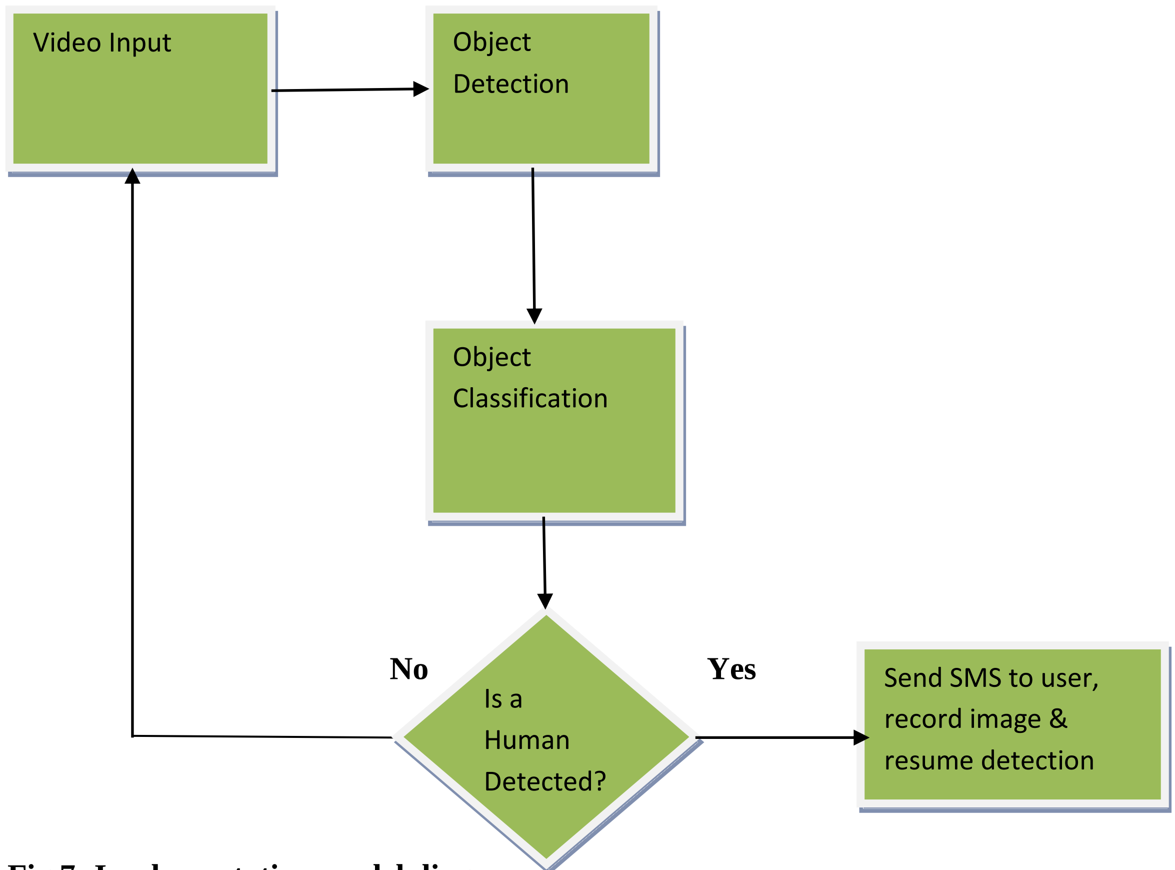


Fig 7: Implementation model diagram

We implemented the system based on combination of the (Viola and Jones 2004) face and upper body detection algorithm and (Dalal and Triggs 2005) full body human detection algorithms in MATLAB. The method proposed by Viola Jones in their paper "Robust Real time Face Detection" offers fast detection and is the current method of choice in the computer vision Open CV library (Theo and Tristan 2003). The decision to use MATLAB language was arrived at in view of its superior computational efficiency of mathematical expressions upon which the human detection algorithms are based.

We cascaded the MATLAB human detection algorithms in the following sequence:

1. Upper body detection algorithm
2. Full body detection algorithm
3. Face detection algorithm

5.2 Code Snippets (Upper body, Full body and Face detection algorithms implementations in MATLAB)

Detecting Upper Body in an image using upper body classification model

```
"% Upper body

bodyDetector = vision.CascadeObjectDetector('UpperBody');
bodyDetector.MinSize = [60 60];
bodyDetector.MergeThreshold = 10;

% Read image

   I2 = imread('visionteam.jpg');
bboxBody = step(bodyDetector, I2);

% Mark part detected

IBody = insertObjectAnnotation(I2,
'rectangle',bboxBody,'Upper Body');
figure, imshow(IBody), title('Detected upper bodies');"
```

Detecting Full body in an image using HOG model

```
"% Read image

     I2 = imread('gantrycrane.png');

% Detect corners

     Corners   = detectFASTFeatures(rgb2gray(I2));
     Strongest = selectStrongest(corners, 3);

% Extract HOG features

     [hog2, validPoints, ptVis] = extractHOGFeatures(I2,
     strongest);

% Display image
```

```
    imshow(I2); hold on;
    Plot (ptVis, 'Color','green');"
```

Detecting Faces in an image using frontal face classification model

```
"%Face.

faceDetector = vision.CascadeObjectDetector;

% Read image.

    I = imread('visionteam.jpg');

% Detect faces.

bboxes = step(faceDetector, I);

% Mark detected face.

IFaces = insertObjectAnnotation(I, 'rectangle', bboxes,
'Face');
figure, imshow(IFaces), title('Detected faces');"
```

SMS function was implemented using the AT commands in MATLAB which enable switching of the modem to send alerts to users. These are AT+ CMGS (send message) and AT + CMGF (message format)

Source code – Please see complete source code for the algorithms in appendix 1

5.3 User Interface

The system user interface is shown below:

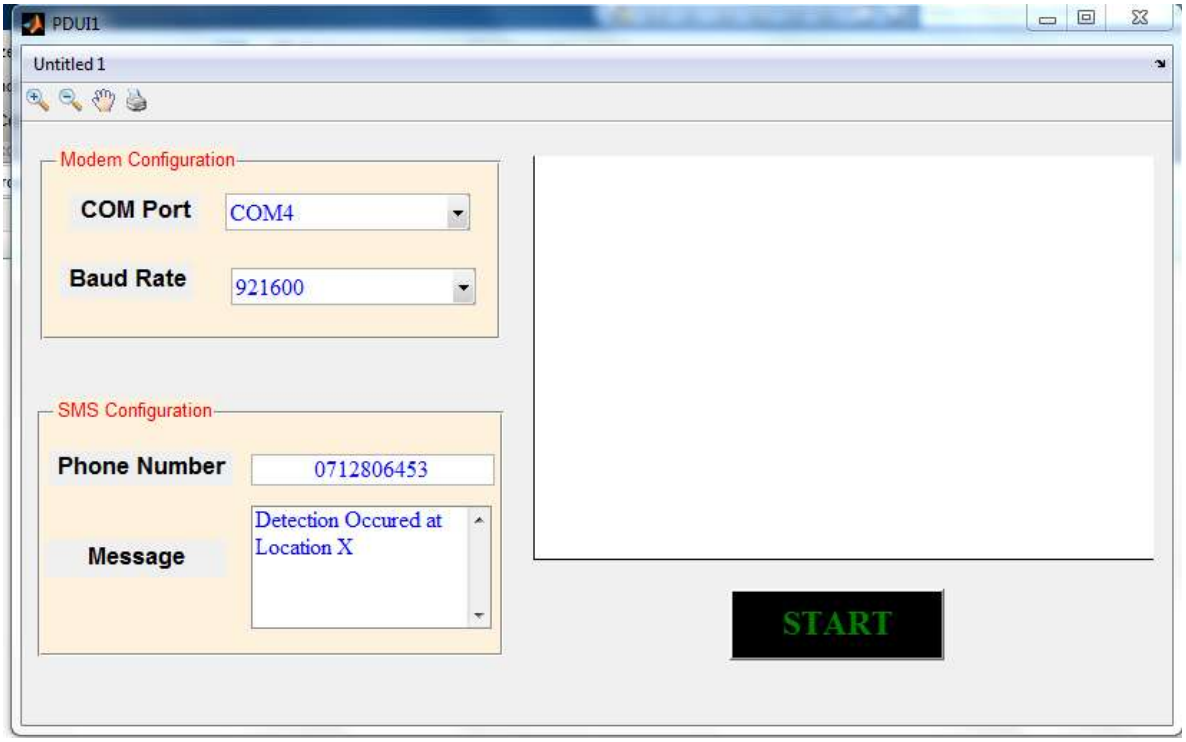


Fig 8: User Interface

5.4 System Requirements

Hardware

1. A PC or Laptop with Minimum Duo core, 2 GB RAM , 64 bit Computer
2. Outdoor USB Camera (we implemented the system using a Laptop with an external PC webcam)
3. GSM Modem (we used Airtel Modem)

Software

Windows OS, Linux (implementation was done using windows 7 Operating system)

MATLAB software (we implemented using version R2013b of MATLAB)

CHAPTER VI: TEST RESULTS

6.0 Experimental Results

The system was tested using both static and video images to check the rate of person detection in different postures and clothing as is likely to happen in real life so as to closely represent poacher characteristics. Tests were conducted in different environments and lighting conditions and the results shown below noted. We implemented the algorithms in MATLAB R2013b on a Laptop running on windows 7, 64bit operating system with AMD duo core processor and 2GB RAM. The application places a rectangle on the area of the human that is detected such as face, upper body or whole body.

For purposes of comparison, we show below detection responses using static images and video images. Further, we show detection results for Video images for indoor detections and for out-door detections to simulate actual deployment environment. Fig 9 shows results of detection on static images in different environments, postures and clothing. Fig 10 shows face detection in sitting posture. Fig 11 shows detection at night in a room lit by a 40Watts element bulb with a person in upright posture. Fig 12 – 14 shows detection in an office environment with limited lighting in various postures such as squatting, bending, sitting and upright facing away from the camera.

6.1 Static Images (Note: Boxes indicate the part that is detected)

Fig 9 (a) Upper body detection

Fig 9 (b) Face detection

Fig 10: Face detection

6.2 Video images- indoor

Fig 11: Upper body detection upright posture

Fig 12: Upper body detection facing the camera (squatting posture)

Fig13: Upper body detection bending posture

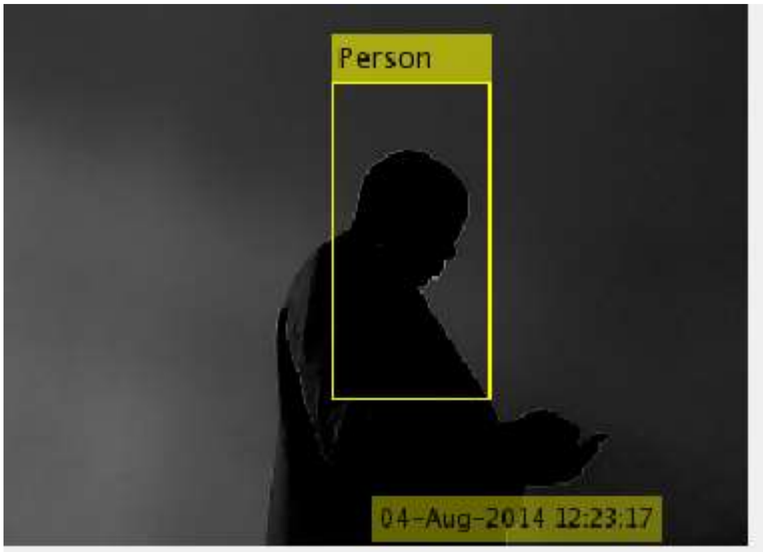


Fig 14: Upper body detection facing away from camera –Upright posture

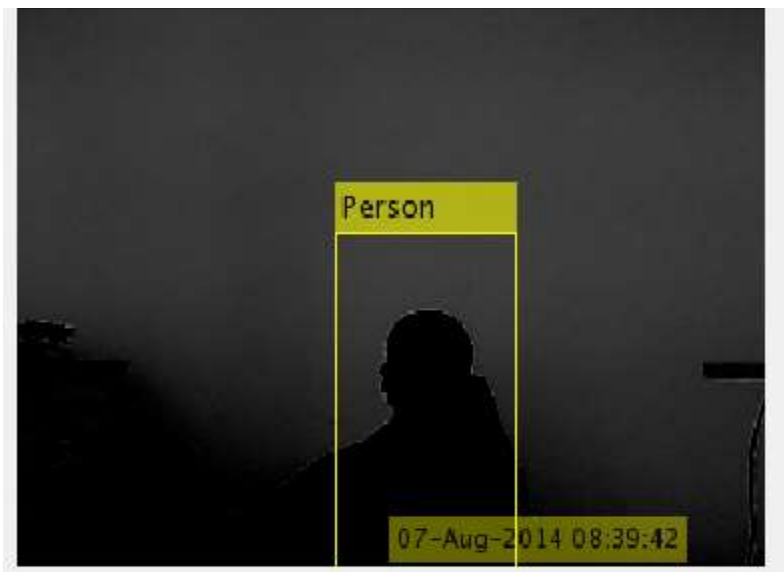


Fig 15: Upper body detection facing away from the camera (sitting posture)

6.3 Video Images – Outdoor (Nairobi National Park)

Fig16: Full body detection in park environment

Fig 17: Upper body detection in park environment

Fig 18: Face detection in park environment

6.4 Summary of Test Results

These results are based on tests conducted indoors and outdoor (inside Nairobi Park). With a good outdoor camera better results can be achieved. The distance at which a camera can acquire an image is dependent on the size of the lens. In our case, we were constrained in doing tests at a longer distance due to the webcam small lens. Hence the requirement to monitor a large area means a camera with a large lens as appropriate will be required.

Results of detections

(a) Indoor Video Tests: Based on 10 detection exposures

Detection Type	Distance from Camera	% Detection Rate	Response Time
Positive Detections	3M	90%	1 second
Negative Detections		10%	

(b) Outdoor Video Tests (inside a wildlife park)

Based on 10 detection exposures

Detection Type	**Distance from Camera**	**% Detection Rate**	**Response Time**
Positive Detections	3M	90%	2 seconds
Negative Detections		10%	

Summary of Detection Results

Detection Type	**Indoor/Outdoor**	**No of exposures**	**Distance from Camera**	**Detection rate**	**Response time**
Positive	Indoor	10	1- 5 Metres	90%	1 second
Negative				10%	
Positive	Outdoor	10	1 – 5 Metres	90%	2 seconds
Negative				10%	
Positive	Outdoor	10	10metres	90%	3 seconds
Negative				!0%	

NB: Negative detection means – did not detect or detected the wrong object

DISCUSSION: FUTURE WORK AND CONCLUSIONS

Future work

Recent incidents of poaching during the night in some parts of Kenya poses new challenges in wildlife protection and require that strategies are implemented to find ways of deploying night surveillance of wildlife areas. Night surveillance was not in the scope of this research and this is a matter recommended for future investigation.

We also learnt that MATLAB ordinarily works with Webcam and USB PC cameras. Further research into how MATLAB can use IP cameras directly will be important to ease networking and allow deployments in a wide area.

Conclusions

A simple, effective video surveillance system for human detection using a combination of face, upper body and full body detection algorithms of the Open CV library has been presented using MATLAB. We have demonstrated that it is possible to achieve efficient detection of humans by carefully cascading different algorithms. The system makes economical use of resources such as storage, as it records images briefly (20seconds) only upon detection of a person before it goes back to scan the area under surveillance. This timing is considered adequate to acquire and store an image without significantly interrupting the camera scanning process. Though some false detection was noted, the overall performance of the algorithm is satisfactory and can be used in real time applications. The system has been tested with images and video under uncontrolled conditions and performs well particularly in indoor environments. Though indoor was not the target environment for deployment, the outcome has shown that the system can find usage in that environment as well. Tests done inside the park with many trees in the background resulted into some delay in detection. This is attributed to the need for the algorithm to evaluate the nature of every object in the background before confirming detection. Further, we used a Webcam which has a very short range and detection from distances beyond 10 metres was erratic. In the context of this research, which aimed at detecting humans in reserved environments the designed algorithm performs well but there is room for further improvement through further training of algorithms and use of higher capacity hardware such as multicore PC (more than 2 core) with at least 4GB RAM and high quality outdoor Video Camera (see sample specifications in the appendix 2) to enhance detection speed.

Some of the environmental factors that can affect system performance include the following:

- Trees Shaking
- Illumination in thickets
- Dust cover on camera lens
- Weather (Rain and mist)
- Insects covering the Lens area

In view of the foregoing, we feel the objectives of this research have been fulfilled.

APPENDIX 1 – SOURCE CODE

```
“functionvarargout = PDUI1(varargin)

% PDUI1 MATLAB code for PDUI1.fig

%PDUI1('CALLBACK',hObject,eventData,handles,...) calls the
local

% function named CALLBACK in PDUI1.M with the given input
arguments.

% Begin initialization code - DO NOT EDIT

gui_Singleton = 1;

gui_State = struct('gui_Name',       mfilename, ...

                   'gui_Singleton',  gui_Singleton, ...

                   'gui_OpeningFcn', @PDUI1_OpeningFcn, ...

                   'gui_OutputFcn',  @PDUI1_OutputFcn, ...

                   'gui_LayoutFcn',  [] , ...

                   'gui_Callback',   []);

ifnargin&&ischar(varargin{1})

gui_State.gui_Callback = str2func(varargin{1});

end

ifnargout

    [varargout{1:nargout}] = gui_mainfcn(gui_State,
varargin{:});

else

gui_mainfcn(gui_State, varargin{:});

end”

“function PDUI1_OpeningFcn(hObject, eventdata, handles,
varargin)

handles.output = hObject;
```

```
% Update handles structure

guidata(hObject, handles);

handles.com_port = 'COM14';

handles.baud_rate = 921600;

handles.message = 'Person Detected at Location X';

handles.phone_number = '0723742734, 0722950574';

%the object detectors

handles.face = vision.CascadeObjectDetector; %face detector
object

handles.body =
vision.CascadeObjectDetector('UpperBody');%upper body
detector object

%face properties

handles.face.MinSize = [25 25];

%body properties

handles.body.MinSize = [100 100];

handles.body.ScaleFactor = 1.05;

handles.person = vision.PeopleDetector;%whole body detector
object

%video device access

try

 %video capture object

handles.vidDevice = imaq.VideoDevice('winvideo', 1,
'YUY2_320x240', ..."

"'ROI', [1 1 320 240], ...

 'ReturnedColorSpace', 'rgb', ...

'DeviceProperties.Brightness', 50, ...

'DeviceProperties.Sharpness', 5);
```

```
Catch

hvid = msgbox('Video capture device is either not available
or is in use by another application.','Warning!');

pause(2)

ifishandle(hvid)

delete(hvid);

end

return;

end

 %dimensions of the videoframes

handles.x = imaqhwinfo(handles.vidDevice,'MaxWidth');

handles.y = imaqhwinfo(handles.vidDevice,'MaxHeight');

%from one frame to another using optical flow

handles.optFlow = vision.OpticalFlow( 'ReferenceFrameDelay',
1, ...

'OutputValue', 'Horizontal and vertical components in complex
form');

guidata(hObject,handles);

% --- Outputs from this function are returned to the command
line.

functionvarargout = PDUI1_OutputFcn(hObject, eventdata,
handles)

varargout{1} = handles.output;”

“functioncomp_Callback(hObject, eventdata, handles)

% Hints: contents = cellstr(get(hObject,'String')) returns
comp contents as cell array

%        contents{get(hObject,'Value')} returns selected item
from comp

contents = cellstr(get(hObject,'String'));
```

```
handles.com_port = contents{get(hObject,'Value')};

guidata(hObject,handles);

% --- Executes during object creation, after setting all
properties.

functioncomp_CreateFcn(hObject, eventdata, handles)

ifispc&&isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))

set(hObject,'BackgroundColor','white');

end

functionphonee_Callback(hObject, eventdata, handles)

handles.phone_number = get(hObject,'String');

guidata(hObject,handles);

% --- Executes during object creation, after setting all
properties.

functionphonee_CreateFcn(hObject, eventdata, handles)”

% Hint: edit controls usually have a white background on
Windows.

ifispc&&isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))

set(hObject,'BackgroundColor','white');

end

functionmsge_Callback(hObject, eventdata, handles)”

“% Hints: get(hObject,'String') returns contents of msge as
text

handles.message = get(hObject,'String');

guidata(hObject,handles);

% --- Executes during object creation, after setting all
properties.

functionmsge_CreateFcn(hObject, eventdata, handles)
```

```
ifispc&&isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))

set(hObject,'BackgroundColor','white');"

end

% --- Executes on selection change in baudp.

functionbaudp_Callback(hObject, eventdata, handles)

% Hints: contents = cellstr(get(hObject,'String')) returns
baudp contents as cell array

%        contents{get(hObject,'Value')} returns selected item
from baudp

contents = cellstr(get(hObject,'String'))

handles.baud_rate = str2num(contents{get(hObject,'Value')});

guidata(hObject,handles);

% --- Executes during object creation, after setting all
properties.

functionbaudp_CreateFcn(hObject, eventdata, handles)

ifispc&&isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))

set(hObject,'BackgroundColor','white');

end"

"% --- Executes during object creation, after setting all
properties.

function pushbutton2_CreateFcn(hObject, eventdata, handles)

% --- Executes on button press in pushbutton2.

function pushbutton2_Callback(hObject, eventdata, handles)

%% The button properties

handles.Strings = {'START';'STOP'};

guidata(hObject, handles);
```

```
handles.str = get(hObject,'String');

handles.state = find(strcmp(handles.str,handles.Strings));

ifhandles.state == 1

set(hObject,'BackgroundColor',[1 0 0]);

else

set(hObject,'BackgroundColor',[0 0 0]);

end

set(hObject,'String',handles.Strings{3-handles.state});

guidata(hObject,handles);

 %recording object

name = ['Scene' num2str(now) '.avi'];

writerObj = VideoWriter(name);

writerObj.FrameRate = 25;

%Infinite loop for detecting and recording

while 1

 %which button

ifhandles.state == 2;"

"disp('interrupt')

 %close the writerobject, if it is possible

Try

close(writerObj)

catch

end

  %close and delete the video device object, if it is
possible

try
```

```
release(vidDevice);

catch

end

 %tell the public what they've done

hstop = msgbox('Process has been stopped.','INFORMATION');

pause(1.5);

ifishandle(hstop)

delete(hstop);

end

exit

%   break;

end

%Detecting people

    %%

    n = 0;

while 1"

" n = n+1;

        %% The alternative

        k = datestr(now);

        %for continuous video, this line should be
uncommented

        %for static images should be commented.

         I = rgb2gray(step(handles.vidDevice));"


"%for static images, uncomment this and break next to end of
the

%while loop
```

```
% I = imread('man.jpg')

%if not first frame

if n > 1;

of = step(handles.optFlow,I); %any detected velocities in the
frames?

lines = videooptflowlines(of, 20);

ifisempty(lines)

continue;

end

end

%Detect people

bboxes = step(handles.body, I);%upper body

ifisempty(bboxes)

bboxes = step(handles.person,I);%full body

ifisempty(bboxes)”

“bboxes = step(handles.face,I);%face

end

end

if ~isempty(bboxes)

  %Annotate detected faces if there is a detection

IFaces = insertObjectAnnotation(I, 'rectangle', bboxes,
'Person');

Im = insertText(IFaces,[handles.x/2 handles.y-
20],k,'FontSize', 10, 'BoxColor', [1 1 0], 'BoxOpacity',
0.4);

break;

end

end
```

```
 %% show the detected image

%     while ishandle(handles.axes1)

imshow(Im);

title('Detected Scene Image');

%     end

 %send sms(es)


text_gsm(handles.com_port,handles.baud_rate,handles.message,h
andles.phone_number);

%enable video writing

open(writerObj);

for index = 1:150;

        k = datestr(now);

        IM = step(handles.vidDevice);"

"   IM = insertText(IM,[handles.x/2 handles.y-
20],k,'FontSize', 10, 'BoxColor', ...

            [1 1 0], 'BoxOpacity', 0.1);

writeVideo(writerObj,IM);

end

release(handles.vidDevice);

close(writerObj);

    %break;

End"
```

SMS Algorithm

```
"functiontext_gsm(com,baud,msg,number)
clc
% global BytesAvail;
% global A;
% global B;
```

```
%% Is the string of the numbers ending in the separation
characters?
if number(end) == ';' || number(end) == ','
number = number(1:end-1);
end

total = [strfind(number,',') strfind(number,';')]';%how many
numbers
total = sort(total);%arrange from first
numbers = cell(size(total,1)+1,1); %cell array of the numbers
for n = 1:size(total,1)+1;
if size(total,1) == 0 && ~isempty(number);
temp = number;
elseif(n == 1 && size(total,1)>=1);
temp = number(1:abs(1-min([strfind(number,',')
strfind(number,';')])));
elseif size(total,1) >= n && total(n) ~= size(number,1);
temp = number(total(n-1)+1:total(n-1)+10);
elseif size(total,1)+1 == n && total(n-1) ~= size(number,1);
temp = number(total(n-1)+1:end);
else
break;
end"
"  %temp is numeric or not
ifisnumeric(temp);
temp = num2str(temp);
end
if length(temp)~=10 && (temp(1)~='+' && length(temp)>10)
temp = [];
end
    %temp carrying anything
if ~isempty(temp);
numbers{n,1}= ['AT+CMGS=' '"' temp '"'];
else
break
end
end
%%
for k = 1:size(numbers,1)
if ~isempty(numbers{k,1})
tx3 = numbers{k,1};
else
continue;
end
try
send(com,baud,tx3,msg);
catch
msgbox('The Serial Port is already occupied by a different
process. Free the device from the applications currently
```

```
using it. This may include restarting MATLAB.','ALERT NOT
SENT!');
return;
end
end
msgbox(['All messages sent at: ' datestr(now)]);
%%
end
%sending sms
function send(com,baud,tx3,msg)
    s = serial(com);
s.baudrate = baud;
fopen(s);
s.terminator = 'CR';
    tx1 = char(13);
    tx2 = char(26);
    tx4 = msg;
    tx5 = 'AT+CMGF=1';
    %set sms mode
fprintf(s,'%s',[tx5 tx1]);”
“wait(s);%wait for feedback from the modem
    %sendsms
fprintf(s,'%s',[tx3 tx1]);
wait(s);%wait for feedback from the modem
fprintf(s,'%s',[tx4 tx2]);
wait(s);%wait for feedback
fclose(s);
end
%waiting for modem response
function wait(s)
b = [];
whileisempty(b)
try
b = fread(s,s.BytesAvailable,'char');
catch
continue;
end
end
end”
```

APPENDIX 2: CAMERA SPECIFICATIONS

Wireless digital USB Camera

Key Features

1. Pixel: 1/4 CMOS 640*480
2.Distance: 1.2km
3.Wireless monitoring systems
4.Digital USB receiver camera

Other Features

2.4GHz USB Wireless Digital USB Receiver uses RF technology transmitting visual and vocal signal to the receiver.

Digitalized and super anti-interference. Instant signals of pictures and sounds with continuous and no distortion.

Supporting two-way voice transmission and photographic or standby in a long distance.

Application

Security, transportation, Industrial monitoring, Hospitals, kindergartens and schools

Compatible with windows 7

APPENDIX 3: RESEARCH BUDGET

No	**Items**	**Estimated cost**	**Total**
2	Stationary	1500	1500
3	Travelling cost	5000	5000
4	Hardware (Modem)	2000	2000
5	Binding cost	2000	2000
6	Telephone charges	2000	2000
7	Contingencies	5000	5000
	Total		**17,500**

APPENDIX 4: WORK PLAN

Activity	Month								
	J	F	M	A	M	J	J	A	Se
Topic identification		√							
Proposal writing			√	√					
Proposal submission, refinement and approval					√	√			
System Design and Implementation						√			
System testing							√		
Report writing							√	√	
Project Report submission for examination								√	

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