## Project Documentation – Final Year Project Report Document

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## Project Title

### Birds eye new image analysis using OpenCV

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# Abstract

This interim report presents the current progress of the final year project “Birds eye new image analysis using OpenCV”. The purpose of this report is to write about literature review and summarize preceding work done for this project. Reading this report reader will get a basic understating of what the OpenCV is as well as associated to its software and different technologies. As a leading software for this project is python programming language. Python in this case is just a wrapper for entire library of c++ coded tools. Certainly, main advantage is very quick adaptation of most of available tools without time consuming programming prior to testing and seeing results.

This project consists of several phases, accordingly to plan provided in the project requirements, the first stage was an initial planning and discussions as well as interviews and meeting with people that possibly would be provide some feedback to the project.

Following step was research and literature review which will be described in this paper, also some software testing was already written heretofore. Next stage of this project will be mostly focused on the software site, including couple of hardware bits such as drone implementation.

Initially proposed ideas about crowd behaviour did not shaped well into this project, hence couple of small changes were made toward the direction of this project. While the new concepts have succeeded in reaching a deeper level of understanding of the problem undoubtedly delivering to myself new perspectives with reference to this task.

OpenCV is an open source library for picture and video examination, initially presented more than decade back by Intel. From that point forward, various software engineers have added to the latest library advancements. The most recent real change occurred in 2009 (OpenCV 2) which incorporates fundamental changes to the C++ interface. These days the library has >;2500 enhanced calculations. It is widely utilized far and wide, having >;2.5M downloads and >;40K individuals in the client gathering. Despite whether one is a tenderfoot C++ software engineer or an expert programming designer, ignorant of OpenCV, the primary library substance ought to enthusiasm for the graduate understudies and analysts in picture handling and PC vision territories. To ace each library component it is important to counsel many books accessible on the point of OpenCV. Be that as it may, perusing such more far reaching material ought to be simpler in the wake of fathoming a few nuts and bolts about OpenCV from this paper.

OpenCV (Open Source Computer Vision) basics without having to go through the lengthy reference manuals and books. OpenCV is an open source library for image and video analysis, originally introduced more than decade ago by Intel. Since then, a number of programmers have contributed to the most recent library developments. The latest major change took place in 2009 (OpenCV 2) which includes main changes to the C++ interface. Nowadays the library has >;2500 optimized algorithms. It is extensively used around the world, having >;2.5M downloads and >;40K people in the user group. Regardless of whether one is a novice C++ programmer or a professional software developer, unaware of OpenCV, the main library content should be interesting for the graduate students and researchers in image processing and computer vision areas. To master every library element it is necessary to consult many books available on the topic of OpenCV. However, reading such more comprehensive material should be easier after comprehending some basics about OpenCV from this paper.

Tremendous numbers if terms of offense statistics show that crime is rising in London itself and beyond. In Great Britain, the statistics do not look impressive from the point of citizens' safety. Police-recorded crime has raised by 10% crosswise over England and Wales - the biggest yearly ascent for 10 years - as identified by the Office for National Statistics (2017).

The most recent crime figures for the year are March likewise demonstrate a 18% ascent in brutal crime, incorporating a 20% surge in weapons and blade crime reported by Theguardian newspaper (2017).

The conclusion of the analysis carried out by specialists in collaboration with police and experts is simple; security needs to be strengthen.

This project is intending to finish with developed system that could help combat this crime. In essence, the goal for this project is a large community of people for example; football matches, concerts train stations, airports, public events, tourist attractions, marathon, protests, et cetera.

Police takes various preventive measures of crime. The possibility of monitoring the environment for many years has increased the chances of detecting a potential threat to people. In recent years, the advancement of technology has gone a long way towards making the most of accurate recording and automatic detection of dangerous situations. This causes alarm to the observer and reactions from the security services.

The objective of my project is to build a system that will observe human’ behaviour, and analysis it in disparate ways. According to Sjarif et al. (2014), crowd analysis consists of four phases: crowd density estimation, crowd motion detection, crowd tracking and crowd behaviour understanding.

The system will search for patterns from data collected using a thermal camera and choose which patterns are the most relevant for given aim. In the first place an aim is to develop a system to perform anomaly behaviour detection. This project will be carried out with the hope of initiate the drone, subsequently after having a good software base.

The result of this analysis may be data that can be represented in different forms, such as row in tables, graphs, histograms, plot area, 3D technology.

Collected data, will be also substituted to algorithms for behaviour anticipation.

The primary motivation for this project is the fact that along the way, for instance: planning, development, testing and evaluation, will hopefully come across the real-world problem that could be only accomplished using this software and these devices.

# 1 . Introduction

Within last couple of years, the plague of fly-tipping has increased and started to spread to the country. Fly-tipping statistics for England, 2016/17, shows that this become serious problem for governments as well as local communities. Since, the big number of this type of incidents occurs on the motorways, this problem has also considerable impact on number of accidents on the motorways. “For the 2016/17 year, local authorities in England dealt with around 1 million (1,002,000) fly-tipping incidents, a 7% increase from the previous year.”

In the initial project proposal, I have proposed number of problems that relates to the crime as well as inappropriate behaviour of people. Likewise, in project proposal, the number of potential solutions was presented. During the initial software development, I have encounter number of different issue that would not allow me to finish my project on time, hence, with the approval of my supervision I slightly changed project direction. However, I would like to use all knowledge I gained so far, and apply to the new problem, which is very similar in some sense to what was proposed at the beginning.

The current problem is more focused on detection and recognition of either cars or dumps. Successfully detection these objects would potentially help to identify delinquents and potentially decrease occurrence of this type of incidents.

The system will recognize mentioned objects and run certain algorithms depends on type of behaviour recognized. System may not be able to able to fully understand the environment or be sure of accuracy of detected object, hence stuff may need to be involved in order to system be fully working.

**Keywords:** image processing, image analysis, surveillance, object tracking, object detection, openCV

system main flow

components

# 2. Background and literature review.

In 2015/2016, local authorities dealt in England somewhere in the range of 900,000 occurrences of fly tipping, which is a 5.6% expansion on numbers from the earlier year. In addition, more than 60% of fly tipping episodes included household waste. What's more, it's costly. In 2014/2015, local authorities in England spent almost £50m on clearing fly tipping. That is an expansion on 11% contrasted with the earlier year. Also, local government burned through £17.6m on requirement activities. So, fly tipping is a major issue that is just deteriorating.

This project proposed a certain solution to this problem, namely, by constant mapping of fly-tipping areas should improve ability to identify who is behind these acts and reduce number of this incident.

This will be achieved by deploying a drone up in the air and which then will have ability to see the scene and using a camera and specifically designed software detect these accidents.

The hardest part of this project is write a software in order to perform mentioned above tasks.

OpenCV seems to suit very well to this purpose because of couple of reasons.

First of all, it is a free and open source software. Secondly, global community provide a certain support, it is well known framework and has been already implement in various of similar projects by many titled people.

Thirdly, many researchers have already accomplished great work using this library. One of the most inspiring article I came across was about training detectors and recognizers in Python and OpenCV in which [Joseph Howse](http://ieeexplore.ieee.org.ezproxy.mdx.ac.uk/search/searchresult.jsp?searchWithin=%22Authors%22:.QT.Joseph%20Howse.QT.&newsearch=true) (2014), decribes how to train own detectors then recognize desired objects in given either video stream or single frame. One cannot deny that

we must distinguish carefully between couple of terms when dealing with this software. Based on my personal experience, many time I found these terms confusing during either reading or using this library. Saying that I am referring to following terms; detect, recognize and track. First term refers to finding a location of given object in an image. Second, decide the subtype or the remarkable character of a detected object. Lastly, track checks if the same detected object appear in an array of images.

This author points is adopting two types of the detection models. This project also will be based on these types of detector. Namely, he talks about Haar Cascade and Local binary pattern (LBP). Haar cascade Detects light-to-dark edges, corners, and lines at multiple scales. Much reliable what leads directly to more accurate results, however this model is more time consuming. Local binary pattern model is definitely faster in comparison with previous but less accurate. Both of these training detector return XML format. The main reason why this system needs to have own detector is because, desired objects in this case cars, could potentially be situated in various different positions. These detectors allow us to train our classifier according to provided data. And this is what will be attempting to achieve in further parts of the project. [Joseph Howse](http://ieeexplore.ieee.org.ezproxy.mdx.ac.uk/search/searchresult.jsp?searchWithin=%22Authors%22:.QT.Joseph%20Howse.QT.&newsearch=true) (2014) in his project was working on face detections. It does not make any significant difference what type of the object we are detecting. The principles of training detector stay the same.

The system needs to be endowed with strong detection features, due to required high accuracy for identifying objects. Cyrel O. et al. (2015) prove that this is current technology this task becomes not only effortless to accomplish but also it can result in higher accuracy and performance. Even when using such a “small” in size technology. It’s called Raspberry Pi. His article talks about processing data using OpenCV for detection. The webcam was utilized to catch pictures progressively. The pictures were handled at the microchip. At the point when people on foot were recognized, the chip played the recorded voice and yields it to the interfacing speaker to advise those walkers or the person on foot to hold up before intersection until the point when such time. Assumptions of this system are nearly identical. Our drone is going to act as a flying bird. Having little computer chip like raspberry on the board would be able to receive the images from the camera attached to it. Following by processing this data, recognising, gather evidences and lastly alert adequate people about occurred event. At this stage of the project, the team is not able to answer the question whether simple Raspberry Pi or even other single board pc with a better capability will be enough to perform these heavy calculations. Therefore, it still could be used as a device to transfer data from a drone to another machine, which then would perform these tasks. Object detection from a certain distance, moreover, very often background of scanning area will be either uniform such as; landscapes or cities or too colourful. One of the examples would huge cornfields. Where homogenous type of the field is leading in the image background. In order to mitigate this issue certain algorithms, need to be entwined into our program. Leader in this section seems to be detection of moving objects through color thresholding.

In image processing area and segmentation algorithms in view of thresholding, the force of the picture (grayscale) is normally gotten keeping in mind the end goal to separate the regions of the items and the background. The segmentation on the threshold functions admirably when the picture has a high intensity in the contrast, this trademark is vital to make a decent characterization of the pixels. All of these procedures where very well explained by Luis Barba-Guamán et. at. (2017). These techniques, not only will be implemented when detection of the object, but can be used in live mode. Live mode will be explained in detail later in this paper. But briefly saying this mode allows to view in current time what the camera from the drone is currently viewing. This possibly will help a user to resolve unrecognised objects or situations. In the project proposal introduces the importance of surveillance, I would like to underline this term again because even though the project direction has changed slight, but the problems that we are trying to solve have similar origin. Therefore, different methods of surveillance will be applied in certain ways to this project.

A viable security and surveillance framework can give essential early notices in the event of any sort of unwanted event. Nonetheless, if the observation framework is fit for wandering inside the region of surveillance, more area of intrigue can be seen with ideal number of surveillance gear under compelled spending plan. This what this system is going to do. Advantages of real-time surveillance is reaction time. Nothing would be quicker and easier to find out than having a live time detection system. Nazmul Hossain et. at. (2015) were targeting this issue. they

# 3. Project overview

# 4. System Features

# 5. Implementation and Testing

# 6. Development Progress

# Analysis and Design

# Objectives

Our objective is to develop a system which can observe, identify successfully recognize fly-tipping frauds. The next step, following the recognition of probably incident is gathering of any evidences that accompanied to this event. Mainly it is going to be a video recording or pictures. However, it could also be a representation of data in numbers and displayed in different forms; such as row in tables, graphs, histograms, plot area, 3D technology.

* Observation
* Scanning
* If goal has been detected
  + Record evidence
  + Alert staff
* Otherwise
  + Keep scanning
* Access to live mode
* Multiple view modes
* Quality of image

The fully developed product is targeting on government or institutions and organizations that are looking for this specific type of system.

# System Design

Observation mode:

Allows users to see the image from the camera. This mode is fully flexible, user can zoom in/out, change view mode.

Available options in live view mode:

* Greyscale
* Colour
* Zoom in
* Zoom out
* Canny Edge Detection
* Image Gradients
* Contours in OpenCV
* Interactive Foreground Extraction using GrabCut Algorithm

Scanning mode:

This if default mode for this system. Once the system was deployed altogether with a drone it will be set to scan videos for an object that is set a goal. Drone would need to be provided with an area to be scanned. However, this is not part of this project. We will use a drone just for testing purposes and area to be scanned will be randomly chosen. In the future, the environment will be based on likelihood of this type of accident to occur. Information of this character is provided by governments. “Consistent with previous years, the most common place for fly-tipping to occur was on highways, which accounted for almost half (49%) of total incidents in 2016/17. The number of highway incidents has increased by 4% from 2015/16.” {Referencing}

Gathering Evidence:

When system detects desired level of confidence that current view consists of potential incident or identify any suspicious objects within a recording, this would be recorded. Recording has an option of accessing information from past. Since this mode is continuously recording an environment. Actions undertaken when objects found == true:

* Timestamp taken
* Geo-location saved
* Staff alerted

# Methodology

## Hardware requirements:

Surveillance systems regularly are equipped with either near-infrared (NIR) or far-infrared (FIR) cameras. Previous researches have been done by Lee et al. (2015) in this area proving that thermal cameras are effective for this purpose. Very often surveillance systems are unreliable, even most advance software is still not able to always identify seeking objects in video or images. Neither, able to faultlessly classify images. The results vary on many factors: quality of equipment, software, environment in which a system have to operate.

Another researcher, Leykin et al. (2008) contributed to this particular subject. They were comparing two different types of cameras, RGB and thermal camera. In their studies, they shown an effective way of tracing pedestrians using two methods one of them is the novel probabilistic model of the scene background and second is based on back- ground model.

Above examples are cogent sufficiently and for this project will be used Lepton LWIR module with FLiR’s thermal imaging sensor.

* LWIR sensor, wavelength 8 to 14 μm
* 51-deg HFOV, 63.5-deg diagonal
* 80 (h) × 60 (v) active pixels
* Thermal sensitivity <50 mK
* MIPI and SPI video interfaces
* Two-wire I2C-like serial-control interface
* Fast time to image (< 0.5 sec)

Low operating power, nominally 150 mW (< 160 mW over full temperature range)

Furthermore, since thermal imaging cameras produce a clear image in the darkest of nights, no integral technologies like lighting or infrared illuminators need to be installed. Not only does this limit the amount of civil works that needs to be executed, it also reduces the maintenance cost. Although, the initial contribution may be significantly more expensive, in long term and in comparison, with an operating result is less costly than the other types of camera.  
Thermal imaging cameras also generate fewer false alarms which is a common problem with CCTV cameras combined with Video Motion Detection or Video Content Analysis software.

As mentioned above, there is a plan of implementing a drone at some stage, therefore a quick orientation in terms of drone specification will be useful.This project will require to use a drone in order to capture an image or video from a certain height. Because of the time limitation, project’s team decided to choose a quadcopter Parrot Air Drone 2.0 or another similar drone set. These devices are easy to operate and have already running Linux on them, hence will be effortless to integrate with raspberry pi and additional equipment. One of the biggest challenge will be to maintain a drone up in the air for a long time. Parrot quadcopter is providing approximately 18 minutes of flight time each. While project, there will be attempted to extend a system and try to solve a problem with short flight time. Perhaps, additional system to autonomously change a battery set for a device. Or multiple drone flying interchangeably.

Software requirements:

OpenCV is an open source computer vision library. This library is written in C++ and C programming language. It is cross-platform software. Supports wide variety of different algorithms, many of them have been proved and tested by Bradski and Kaehler (2008), below are some examples:PhotogrammetryTransforming images Segmentation images and shape matchingPattern recognition, including object detection of disparate shapes2 or 3D motion trackingThese are only certain from many different benefits that come with OpenCV. Its great is that supports many programming languages, hence it can be more efficient.The crucial part of recognizing objects on video is to subtract current frame from a background scene, following by marking these objects individually in order to keep track of has been already identified by Davies A et al. (2005).The software will definitely play a crucial role in this project. Following elements will rely on the coding; tracking and recognition of people. Automatic recognition of conduct examples will enhance, with the goal that it will move toward becoming easier to detect and predict both legitimate and anomalous behaviour. Automatic analysis of gestures then comparing with current behavioural patterns will allow to be more precise and gain more accuracy in terms of predicting any suspected movements from crowd.OpenCV comes with variety of different built-in functions that allow a user to detect any object from an image(video) or perform other image processing tasks. Moreover, it also ships with a pre-trained Histogram of Oriented Gradients and Linear Support Vector Machine models that can be used to perform pedestrian or desired object detection in both images and video streams. Picture processing consist of methods that are applied on imported images, with a specific end goal to obtain an improved picture or to separate valuable data from it. It is a type of flag preparing in which input is a picture and output might be picture or qualities/highlights related with that picture. Picture or video processing essentially incorporates the following three stages: Importing images or video stream, this can be accomplished using variety of different tools or software, for this project it is not so crucial, however it is imperative to make sure so that an input will not lose its quality and will be successfully transferredImage analysis and its manipulation in order to achieve best result Output in which result can be modified picture or report that depends on picture investigationVideos(data) will be primarily saved on a hardware device attached to the drone, if conditions permit, data will be transmitted in live time to the machine based on the ground. This will allow to have a live view from a camera and control a drone.The figure below shows the image-processing flow, this is broken into smaller chunks, hence more details can be seen. Figure 1 Graph represents a flow of image processingIdeally the software should be able to identify and learn patterns that are classified as normal for human behaviour, subsequently comparing any pattern which will poses any suspicious behaviour with already recognized patterns and alert a user (see Figure 3 for an example). The figure below represents an example of both behaviours. Software development will be carried out using Iterative method (see Figure 2 for an example). This method allows us separating the product advancement of a substantial application into littler parts. In iterative method, include code is planned, coded and tested in repeated cycles. With every cycle, extra highlights can be outlined, developed and fully tested until there is a completely software programming application prepared to be conveyed to clients. Evaluation Software is not dissimilar to other physical procedures where inputs are provided and returning an output. Although programming contrasts in results of failure. In case of failure for most physical devices it will be predicted or it will happen in small range of ways. However, when considering this project where device will be flying and interacting in some sense with people, it is very important to reduce or totally eliminate any failure. In case of failure system will need to be prepared to handle this event. By differentiate, programming can fail in numerous strange ways. Therefore, for both software and hardware, it is very critical to perform multiple *formative evaluations.*One of the goals during evaluation will be to examine what is a margin of admissible error. It needs to consider a difficulty of measuring a correct result from unstructured dataset, consisting of crowds and unknown background properties for images or video, as well as natural conditions.After completion of project, preferably two or three *summative evaluation* will take a place, for the same reason as mentioned above. The quality of product is very significant.For the quality of testing and the final results, this project will require triangulation method to use. This provides a checking out the consistency of findings generated by different data collection methods to the project. A single technique can never sufficiently shed light on a wonder. Utilizing numerous strategies can help encourage further understanding. At the beginning of the project, a formative evaluation will take a place in controlled environment where, the output will be known for an output. Most probably it will be a room with some artificial elements set up only for the purpose of the project. Data set will be exact, and clear for a camera and software. The following elements will be considering during this evaluation:Usability NavigationError checking Correctness according to requirementsEase of installation System requirements Pedagogic aspects of the projectPotential roleClearly stated objectives Assessment and feedbackChallenge and motivationAs a method of evaluation for this project, the checklist seems to be most suitable. In this scenario, at the stage of writing a software, a project developer will need to write a system requirements for each of the units. For every unit, it will be required to perform a testing as well as conform whether software is following requirements. At the final stage, evaluation report needs to be written in a clear and consistent way. This report will also need to conform with a *summative evaluation*Milestone Other and Future Funding**Name of productUnit Cost (£)Qty.Cost**Drone4001400Extra equipment2001200Camera1002 200***The budget includes funds for a drone pack containing Parrot Air Drone 2.0, along with attached camera and controls to operate this drone. Two raspberry pi computers. One Lepton LWIR module with FLiR’s thermal imaging sensor. Extra: Parachute system, most probably Skycat brand which offers wide variety of different products. Accurate GPS module, GPS HAT (124-5481) should be in our scope of precision.* Future Extensions:**After completing this project there are multiple fields where could be used and help people. Furthermore, adding extra bits would make this drone even better. Nowadays, on high demand 3D modelling, 3D Scanning or Active Reality Capture, would be a great idea. This would help to reproduce a real scenario vision on current objects. Adding extra infrared depth sensors like the Structure Sensor to the professional white light scanners, would extremely improve the quality of picture and allow easily create a 3D model on any scanned model. It is called photogrammetry. ConslusionList of references:Begga R., Kamruzzamanb J. (2004) ‘A machine learning approach for automated recognition of movement patterns using basic, kinetic and kinematic gait data’, *Journal of Biomechanics*, 38, pp: 401–408, Elsevier - Melbourne.Bradski, G. and Kaehler, A. (2008) *Learning OpenCV: Computer Vision with the OpenCV Library.* Gravenstein Highway North: O'Reilly Media.Davies A., Velastin S., (2005) ‘A Progress review of intelligent CCTV Surveillance Systems’, *IEEE Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications*, 0-7803-9446-1/05, Sofia*.*Lee H., Choi J., Jeon E., Kim Y., Le T., Shin K., Lee H., Park K. 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