Software Proposal Document for project Vigil

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Abstract

Based on the dangerous crime rates and irregularities that have been on the rise in Egypt, specifically, car theft. We decided to create Vigil, an autonomous car theft detection system. The main idea of this project is to develop a system capable of detecting predefined abnormal behaviours that a thief may do when he's about to steal a car or in the process of stealing one using a computer vision approach.

1 Introduction

1.1 Background

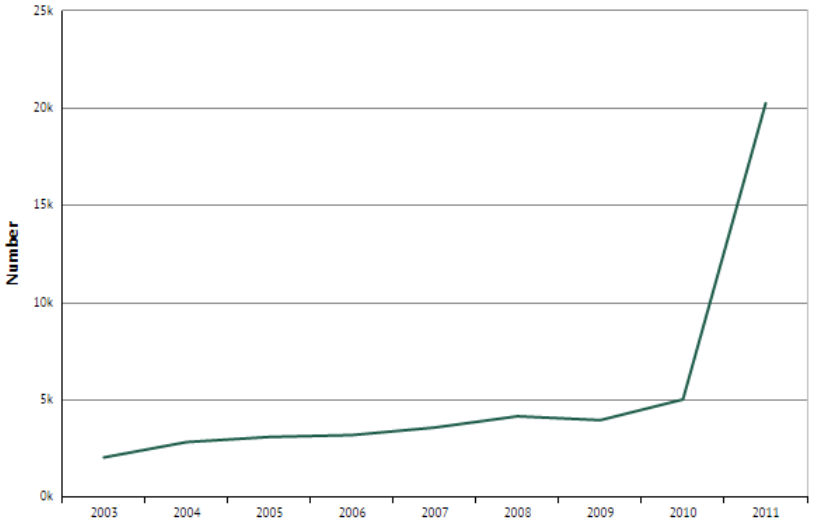
Crime rates have been on the rise in Egypt now. Car theft for example, has been on the rise since 2011 now according to World Data Atlas car theft has seen a rise by 306% since 2011 as well. So, we thought about ways that we can reduce the frequency of these crimes through and we came across an idea, surveillance systems. According to [1] CCTV cameras in the UK reduced crime rate by a 19% ratio, and that was using regular surveillance through cameras and human factor. So, we decided that we should improve upon the basic surveillance system by adding in abnormal behaviour detection to almost automate the surveillance process. And in our example, if a data set is present, we can detect several abnormal behaviors related to car theft.

1.2 Motivation

1.2.1 Market Motivation

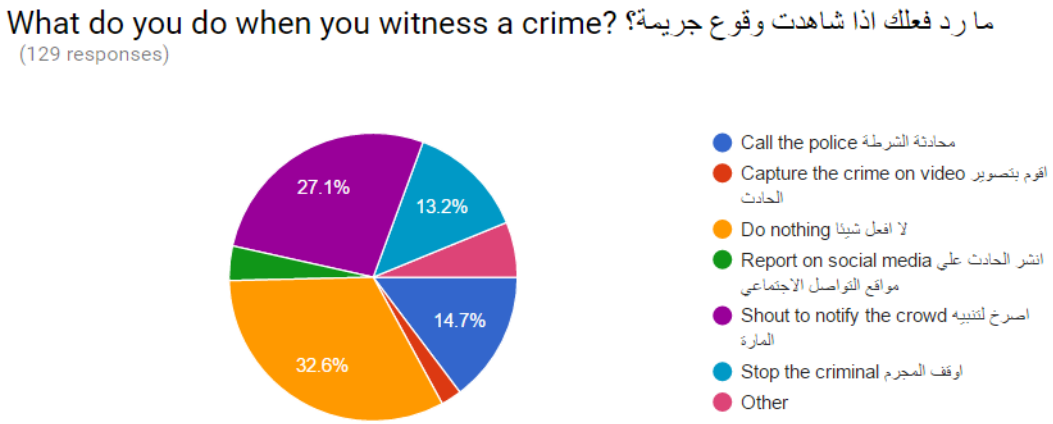
According to the World Data Atlas in 2009 3,914 cars were stolen in Egypt, the percentage of stolen cars in Egypt in the year 2010 rose with Twenty Seven Percent reporting 4,979 cars stolen; And in the year 2011 the percentage of stolen cars tripled to reach 20,231 cars reported stolen. Furthermore, we created a survey to get the general market directions, and from our 129 responses, over ninety percent were Egyptian. Twenty Seven % choose to shout to warn the crowd Fourteen percent call the police and only Thirteen % try to stop the criminal. Surprisingly, thirty Two % stated that when they witness a crime, they do NOTHING, and that was the most voted result.

Fig.1



Date	Value	Change, %
2011	20,231	306.33 %
2010	4,979	27.21 %
2009	3,914	-4.84 %
2008	4,113	16.42 %
2007	3,533	12.34 %
2006	3,145	3.22 %
2005	3,047	9.45 %
2004	2,784	39.62 %
2003	1,994	

Fig2



1.2.2 Academic Motivation

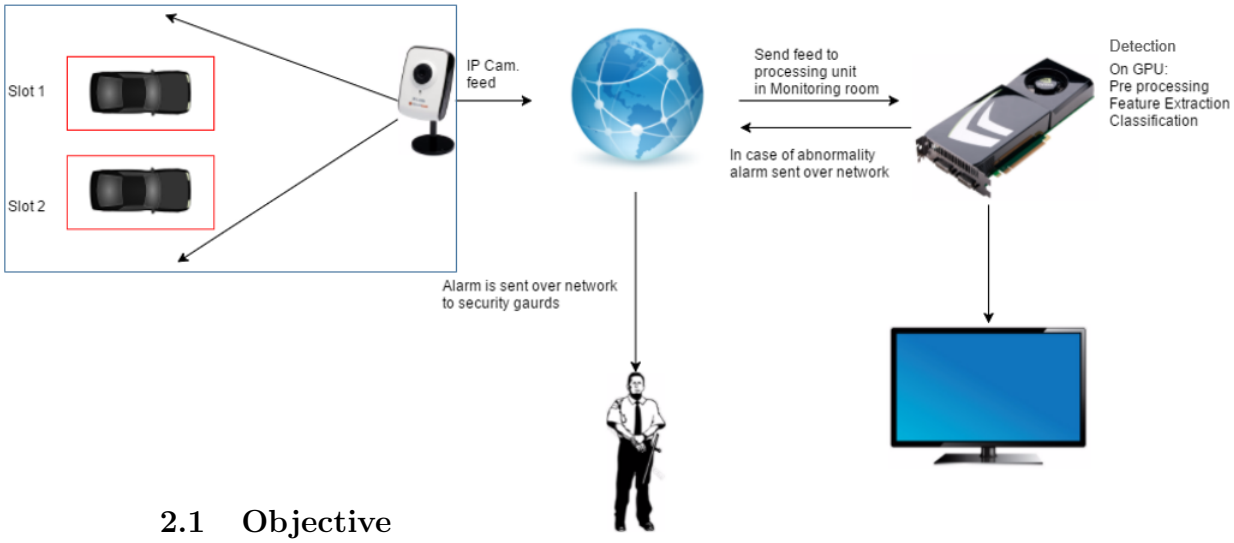
Some of the technical issues we will be facing include but are not limited to the following:

1. Motion detection algorithms.[6][7]
2. Real time processing.[4][11]
3. Object detection algorithms.[6]
4. Training to new data sets.[8]
5. Creating data sets.[8]
6. Accuracy of detection.[6]
7. Performance optimization.[2][3][4][7]

1.3 Problem Definitions

Enhancing the accuracy to processing ratio of detecting abnormal behaviors related to car theft from a live camera using GPU.

2 Project Description



2.1 Objective

Our aim is to reduce car theft crime rates by creating Vigi, a surveillance system that detects predefined car theft abnormal behaviors and responds to it to help prevent car theft.

2.2 Scope

Vigil will work on video feeds or live camera feeds.
Vigil will use mainly one camera.
Vigil will work in well lit environments.
Vigil will detect 3 abnormal behaviors, Loitering around car for long period of time [Fig.A], Jumping into car[Fig.B] , and doing a hand swing.[Fig.C]
Vigil will process over GPU.

Fig. A

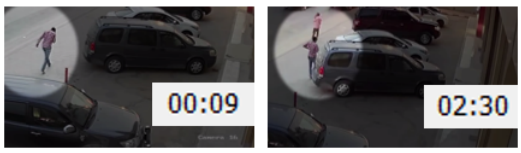


Figure demonstrates loitering around a car for prolonged periods of time.

Fig. B

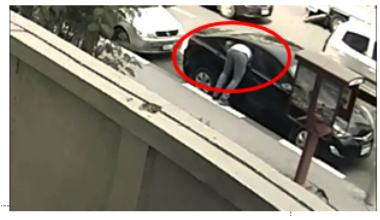


Figure demonstrates jumping into car action.

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Fig. C

Figure demonstrates the action of a hand swing while breaking car window.

2.3 Project Overview

2.3.1 Pre-Processing

In accordance to [12] we decided to use the following:
Resolution: 640x480
Frame use: Use every third frame.

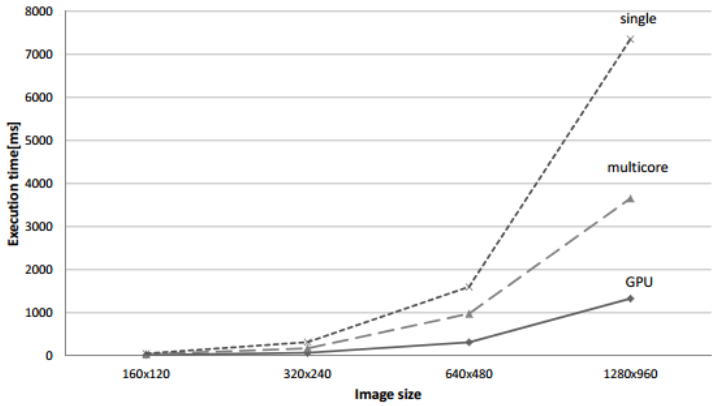
Pre-processing Algorithms:
Region of interest. (Manually set)
Gaussian Mixture Model.

2.3.2 Classification and detection

Name	Feature Extraction	Classification
Loitering for prolonged amount of times.	HoG	Linear SVM, HMM
Hand swing.	HoG	Linear SVM, HMM
Jumping in from windows.	HoG	Linear SVM, HMM

2.3.3 GPU

According to the paper [13] , GPU implementation of HoG using Cuda sped up the processing rate from 3 to 5 times depending on the used graphics card.



3 Similar System Information

3.1 Related Work

Abnormal behaviour detection is one of the most lively sections in research around the world at the moment, this is all due to the interest of analyzing crowd behaviours and for the limitless applications of such systems which include fighting crime and terrorism. Naturally, a big amount of research has been done on the topic up to now. Naturally, given it has a lot of research ongoing, that means the detection field has a lot of issues. We personally got in contact with such issues when developing our prototypes so we had to read about methodologies to solve these issues.

The first issue we came across is the performance issue, much of the detection algorithms require a huge amount of processing power to be able to detect anomalies in real time, therefore, we ran across multiple papers helping us with insight to solve this problem in the future. Dynamic Hierarchical Dirichlet Process(HDP) [2] was a very good approach to this problem; the researchers arrived at the conclusion that their proposed dynamic based Bayesian model was superior in performance to the normal parametric static HDP model [3] as the abnormality decision is based on predictive processing instead of detecting the static. Another team decided to implement another approach [4] using Holistic features; they presented an approach where they extract the features and then run Gaussian mixture model and then Support vector model on them to detect abnormalities in occupied cells only, their results were excellent, they managed to detect abnormalities on speeds up to 40 frames per second.

The second issue that we came across was accuracy. To create accurate detection algorithms, you run across the resources issue then onto the accuracy issue itself. To improve accuracy, some researchers [5] proposed using a mixture of Von mises distribution to detect trajectories of people to detect abnormalities, which gave a 100% abnormal detection rate and 95.6% for normal movement detection rate. Another proposed method [6] proposes the usage of Gaussian Mixture Model and MRF with the addition of Optical flow and Histogram of Optical flow Gradients (HOG) to achieve more precise results. The results showed improvement by 2% in the error rates.

And finally, we read some papers to give us general knowledge about common approaches and how mixing them can yield decent results. For example, the escalator system [7] proposed combined points of interest algorithms with heat maps and optical flow to detect abnormal behaviours on escalator and analyze people's behaviours when getting off the escalators to detect their knowledge level of the safety rules. One other system [8] proposed machine learning tech-

niques to have the system auto learn patterns about patients and detect if they made an abnormal behaviour. Other references gave us general knowledge of techniques or methodologies to help in detection or our detection environment. The method in [9] gave us a general idea of how to look at abnormalities, we can either detect abnormality from a certain abnormalities data set, or, we can detect the normal, and anything that isnt normal is abnormal. The proposed system [10] gave us yet another approach to detecting abnormalities by trajectory using Gaussian calculations after subtracting fore ground and back ground. The system in [11] proposed the detection of abnormal crowd behavior by using image segmentation which allows us to not need to train the system while having excellent detection rate.

3.2 Comparison with Proposed Projects

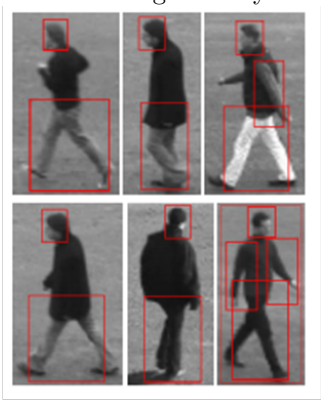
The table below shows their system to be compared with our system.

	Detection Algorithms	DataSetSize	Real Data?	Accuracy
Vigil	Hog Linear SVM HMM Cuda	51	Yes+Training	??(To be investigated)
Motorbike Theft detection.[14]	GMM	187 sequences	Yes	74.11%
HMM Action Recognition.[15]	HMM	7 videos	Yes	60 to 100%,Depending on action.
Motion &,Appearance features system.[16]	Hog Optical flow	98 videos	Yes and training	Equal Error rate reduced by 2%
Deformable,template model pedestrian detection. [17]	Hog Linear SVM Ctf search	2032 images	Yes	100% abnormal, 94% normal

3.3 Screen Shots from previous system

Bike theft detection system:

HMM Action Recognition system:

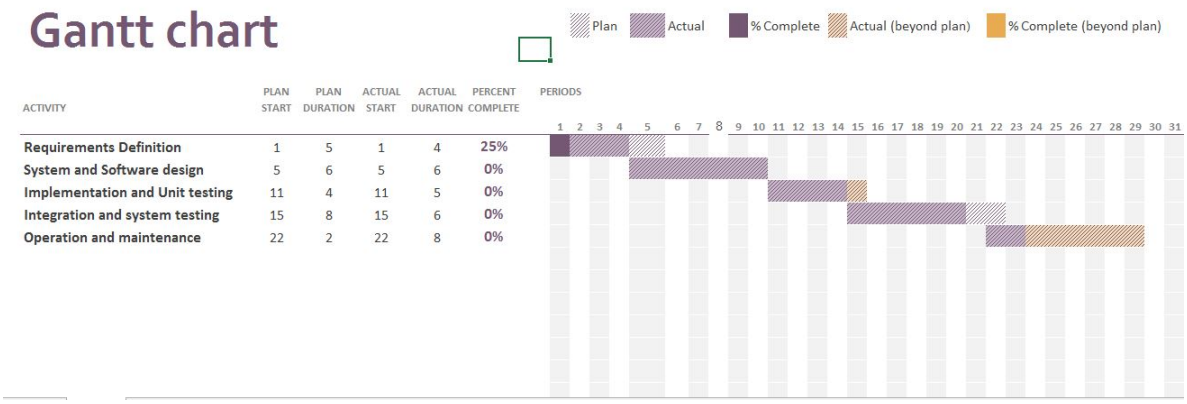


Deformable template model pedestrian detection:

4 Project Management and Deliverables

4.1 Tasks and Time Plan

Tasks will be handled according to the waterfall model since we have abundant time and this is a graduation project. We will go through its 5 phases which consist of the following:



Our time plan is around 9 months, distributed accordingly over the 5 phases of a waterfall model according to each phase's own need.

4.2 Budget and Resource Costs

Currently our budget includes the following:
1- Gtx 970M GPU [18]- 507 USD
2- D-Link DCS-2102 1.3 MP IP Camera [22]- 87.37 USD
Total Budget: 594.37 USD equaling 10,341.1 EGP.

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