OBJECT THEFT DETECTION SYSTEM

By

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CERTIFICATION OF APPROVAL

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Nurulain binti Mohd Suffian

ABSTRACT

Often, in our daily life, we sometimes do not notice our belongings which we put it on the table or on the walls are taken or stolen by somebody. In a picture gallery for example, video surveillance are very essential to monitor the arts and pictures which are exposed for viewing to the public. However, human operators often lose his focuses if he needs to monitor the videos, which may probably range from one to more than one, in a long hour. Therefore, when a steeling scenes occurs, they may not be alerted in an instance. Thus, a semiautomatic tools or system to alert the human operator when this type of event occurs may become a helpful method to assist the human operators in performing their job efficiently and effectively. By using object recognition techniques together with video image processing tools available in MATLAB®, this paper discussed the implementation of the available methods to come out with an Object Theft Detection System which can detect stolen object in real-time environment and issue an alarm when emergency occurs.

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LIST OF ABBREVIATIONS

.avi	-	audio video interleave
MATLAB	-	matrix laboratory
FORTRAN	-	Formula Translating System
GUI	-	Graphic User Interface

CHAPTER 1
INTRODUCTION

Stealing can happened almost everywhere. It can happen at the shopping malls, parks, offices even at your own houses. Manual surveillance alone can never assist effectively in detecting the stolen object or recognizing the culprit processes. In the early development and usage of surveillance video camera, data in video format was captured using the video camera and were stored in video tape and are only accessed after a forensic event.

An object theft detection system is applicable in museums, picture galleries or even at homes. A restricted region is determined and qualified to issue a stolen object signal alaram. Usually high-levels of video interpretation tasks related to surveillance are performed by human operators, who have to process huge amounts of visual information displayed in one or more monitors. .[14]

The increase in the number of cameras in ordinary surveillance systems overloaded both the human operators and the storage devices with high volumes of data and made it infeasible to ensure proper monitoring of sensitive areas for long times. In order to filter out redundant information generated by an array of cameras, and increase the response time to forensic events, assisting the human operators with identification of important events in video by the use of "intelligent" video surveillance systems has become a critical requirement. [15]

An intelligent object theft detection system requires fast, reliable and robust algorithms for moving object detection, classification, tracking and activity analysis. In this study, an intelligent object theft detection system with real-time moving object detection, classification and tracking capabilities is presented. The classification algorithm makes use of the shape of the detected objects and temporal tracking results to successfully categorize objects into semantic categories like human, human group and things. [15]

1.1 BACKGROUND OF STUDY

This study is aimed to detect stolen object from a capturing video camera and is able to warn the user of an emergency event of theft detection scene through a process of object detection, classification, tracking, and event analysis.

Often, various scenes are guarded by a single human operator which will led to inefficiency of work as this type of job exposed the operator to long hours of visual monitoring exposure. Decrease in attention may become vital to recognize stealing object situations. Therefore, to support human conduct, a semiautomatic surveillance systems in order to inform the operator in case of stolen objects and to focus his attention on the event. [13]

Object detection requires the system to capture scenes using a working surveillance camera and able to extract the background from the scenes and distinguish between objects groups. Objects are classified into semantics groups in order for the system to do the tracking and event analysis from the captured scenes.

1.2 PROBLEM STATEMENT

In this section, significant and the relevance of Intelligent Object Theft Detection System are to be discussed. There are some issues and problems identified which have led to the development of this project.

1.2.1 Semiautomatic surveillance system to support human operators for long hours duty

A human operator operates his duty on surveillance alone effectively and efficiently for a limited period of time daily. Sometimes, they also need to monitor several monitors from several numbers of surveillance camera which has been installed by their employers. The limitation of working for long hours reduces the reliability to a human operator to do his task on surveillance on 24/7 basis. Thus, a semiautomatic surveillance system is required to assist human operators as extra eyes and machine operators for surveillance duty to detect missing objects from a particular scene.

1.2.2 Detecting stolen object at selected areas in immediate time and grab human operator's attention with emergency alarm

It is difficult for a normal human being alone to detect stolen object at a justified time as one would never know when will the forensic event would take place. Furthermore, if a human operator has to work alone; monitoring several monitors of surveillance scenes; it would be hard for him/her to distinguish between emergency events and normal events. With an object theft detection system, it can assist the supervisor to detect stolen object event when it occurs as the system is capable to work in a real-time based environment. Therefore, the supervisor can take immediate action to the event when emergency alarm is issued.

1.2.3 Tracking the culprit with the ability of playback function

When the alarm is issued, the human operator will need some useful information for the critical event in order for him to recognize the culprit in the stolen object scene. Reliability on the system is crucial for a playback function, providing the human operator the option to playback the emergency event without stopping the system continuing its surveillance duty. This function is beneficial to the human operator to command for backup security force as an immediate response to a stolen object situation thus minimizes the chances of the culprit from escaping.

1.3 OBJECTIVES OF STUDY

i. To identify missing objects from a video scene in a real-time condition.
ii. To post an alarm aligned with the object theft detection for security alert and action.

1.4 SCOPE OF STUDY

The study focuses on the simulation of object detection and recognition in MATLAB®. It is aimed to be a real-time based project where the system should be able to achieve the above objectives. A video camera is used as an input capturing tool to capture the real-time scene, before it sends the input video to the system to be analyzed The input video are to be scanned and filtered to distinguish the important attributes in a scene. Objects are classified into semantic categories such as picture frames, tables, walls etc.

For the system to operate in a real-time based condition; object detecting; tracking ability is crucial to separate blobs current position frame by frame. Event analysis is to be installed in the system to make it able to analyze the scenes from input video. Emergency alarm is then issued if a forensic event occurs for immediate action from the system operator.

CHAPTER 2
LITERATURE REVIEW & THEORY

2.1 OBJECT DETECTION

The input videos are to be processed to detect present objects in current scenes. It is crucial that a streamlined approach to training be used in order for the users to insert new object models in their systems rapidly, in order for the object detection technique to be practical [2]. By training the object detector with Conservative Learning [11],[12], [7], the detection results are used to distinguish between relevant changes and natural occurrences. An update policy is defined as the background model can be updated in real time environment.

2.1.1 Video and Image Acquisition

Areas that contain different objects and where changes occurred are labelled. The procedure of segmentation has to be as simple as possible to guarantee real-time performance of the whole system; it must meet the robustness requirements to allow the system to recognize,, for instance, different partially overlapped objects or an object split by noise [4].

2.1.2 Video and Image Filtering

Properties of blobs, which can be used in the latter modules of the system, are called as features [14].The module includes classifying, tracking and analysis of event. Making use of [14] selected features, it is sufficient to issue alarm signal through the system.

2.2 OBJECT CLASSIFIER

A classifier is implemented by using multilayer perceptron in [5][4] because it involves time constraint and classification of object. Object classifier are to be updated after been tracked to ensure adjustments are made to possible changes in appearance of its targeted object and its background [7].Based on [9] training data for the classifier is created by computing a bank of features for each labelled image, and then sample the resulting filter at various locations and repeated for training purposes.

2.3 OBJECT TRACKING

In order to increase the stability of the object detector, a tracker is used [7].Objects are detected if there are larger changes in its appearance at a timed condition. To initialize the tracker, a detected image region is assumed to be a positive image sample [7],[10],[6]. Negative examples are extracted by taking regions of the same size as the target window from the surrounding background at the same time.

2.3.1 Detecting changes in scenes

The algorithm for this purpose is based on two simultaneous differences [4]. As input, it takes the background image and the current image sequence. The differences between the current image and the previous one allow detecting missing object from the scene. By observing a scene from a static camera, all dynamic changes are assumed to be normal and therefore are learned as an allowed mode [7].

2.4 EVENT ANALYSIS

In a real-time environment intelligent surveillance system, it is essential to have a just-in-time event analysis in order to detect the stolen object on time. This is to ensure the requirement of the system is met and suits the objectives of the project.

2.4.1 Frame Differencing and Alarm Issuing

Stolen object situation is determined if one or more object are missing in an image [9]. To detect the object that have been stolen from a scene, frame differencing technique is used [19].

$$| F2 - F1 | > T$$

F1 is the initial frame, F2 is the following frame and T is the threshold value. An alarm based on the [14] features extracted, it will detect one area alarm which is stolen object. To prevent false alarm, alarm counters are utilized for robustness. Once the counters of an alarm reach the threshold set by the human operator in real-time, automatically the system registers the event as an alarm. The system will trigger the logging mechanism of the system upon the occurrence of an alarm event, and together with its details, is noted in the log visible through the system's user interface [14].

CHAPTER 3
METHODOLOGY

3.1 USING PROTOTYPING-BASED METHODOLOGY

The software development methodology that will be used to develop the project is prototyping-based methodology. There are four phases of development involve throughout the cycle like shown in Figure 3.

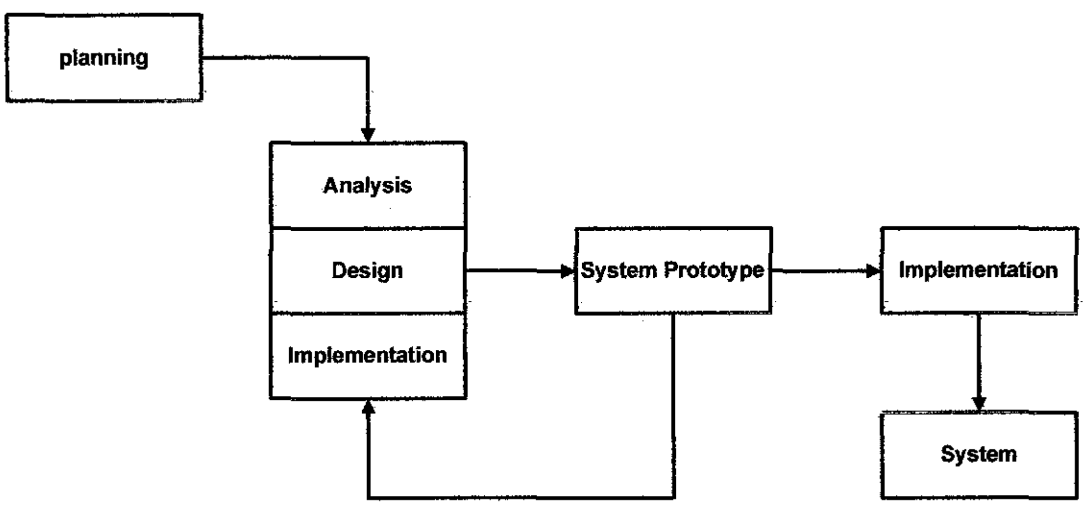

Figure 1 A Prototyping-Based Methodology

Concurrently, the four phases in this methodology are performed. The three sub phases in the analysis and design phase are performed in a cycle repeatedly until the system prototype is developed.

Prototyping methodology is being used in the development of the system as it can reduce the time and cost spend to develop the system. This is due to the early determination of users' needs identification which results in faster and less expensive software.

In addition, prototyping methodology also helps to improve and increase user involvement as it allows interaction with the prototype, thus provide better feedback and specifications. This could prevent misunderstandings and miscommunications that may occur when the user can examine the prototype [21].

3.2 Planning

3.2.1 Technical Requirement

For this system to work efficiently for a real time based condition, at least the following standards need are required. [Note: These requirements are based on the developer's current available resources of hardware components]

Table 1.0 Technical Requirement for the System

Component	Requirement
1. Hardware : Computer	AMD Turion™ 64x2 Mobile Technology TL-58 1.90 GHz, 960 MB of RAM
2. Hardware : Web Camera	Microsoft® LifeCam VX-3000 Model: 1076 ≈ 5V 500mA
3. Software	MATLAB® 7.6 r2008a

3.3 Analysis & Design

3.3.1 System Architecture

The Object Theft Detection System's architecture is shown in Figure 2. A camera is used to monitor the selected area or region; to record video and send the input to system.

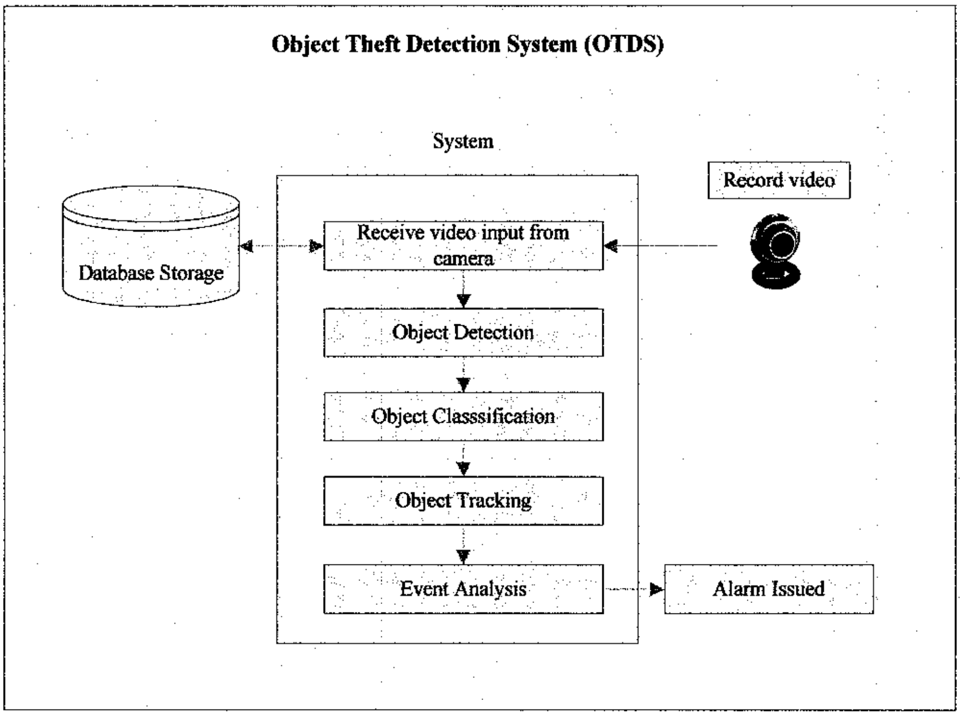

Figure 2 Object Theft Detection System Architecture

3.3.2 The Flow of the System

Figure 3 below is showing the system flowchart on how the system will work.

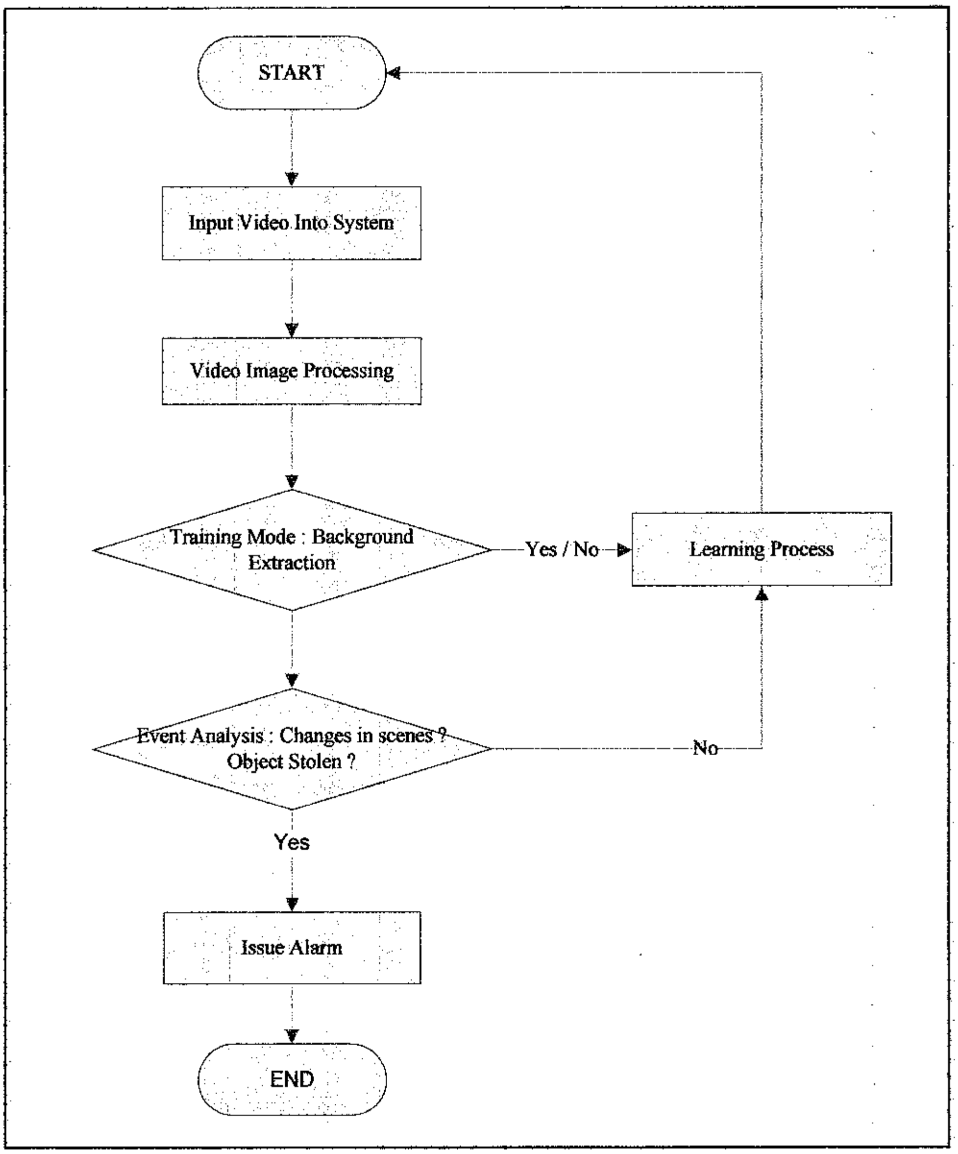

Figure 3 Object Theft Detection System Flowchart

Web camera is a tool or device used to capture scenes of video for a prototype region. The system must be able to integrate well with the device for video processing technique to operate.

After the video is sent to the system, a series of video processing and analysis is performed. The system has to extract the background of the first frames of video scenes captured and keep updating the extraction to followed captured frames. The system analyzes and compare the recent frame with the previous frames. The first 30 frames is captured and stored as the background or the original scene with no stealing event occurring, which is recognized as image filtering technique.

A timely-based classifier is used during event analysis process for each frameset of video scenes to identify the differences between the previous video scenes with the current scenes. A bounding box, which is a rectangular region covering all the edges of the detected object inside it is included in the algorithm to show the user the detected stolen object. The size of this box is determined by the size of the object that it covers [19].

If there are differences detected between the scenes, a security alarm will be issued to alert the human operator of the forensic event. When there are major differences detected between the current scenes of frames with the previous earlier one, the event will be classified as a forensic event, whereby the system will produce an alarm to alert the operator as a stolen object event is detected.

3.4 System Prototype

The system prototype is designed and developed in MATLAB® R2008a. MATLAB® is an integrated technical computing environment that combines numeric computation, advanced graphics and visualization, and a high level programming language. It contains hundreds of commands to do mathematics and it can communicate well with other programming language such as FORTRAN and C [20].

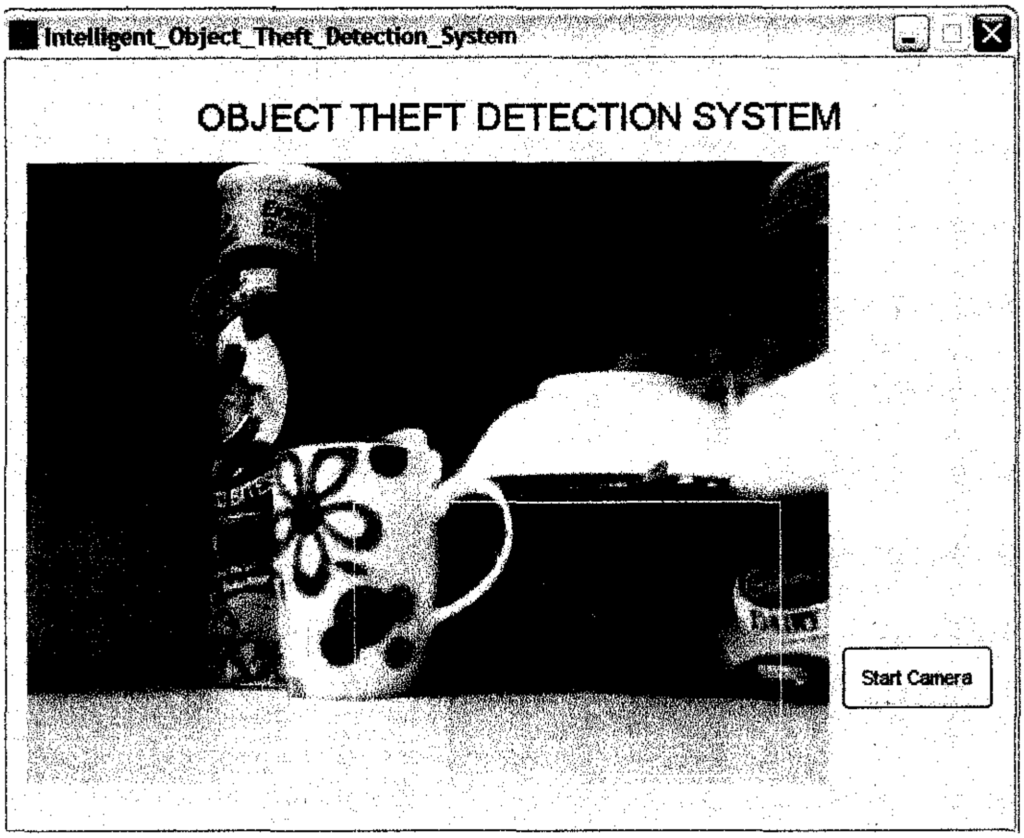

Figure 4 Object Theft Detection System Interface Snapshot

Figure 4 above shows the snapshot of the system prototype. The bounding box as mentioned earlier indicates the detection of the stolen object. The "Start Camera" button is used to start or stop the function of receiving input video from the web camera. The interface is build using MATLAB® GUI.

3.5 Implementation

3.5.1 Testing

The system is tested with five samples video in indoor environment. as the system is expected to be used indoor and are tested for its sensitivity to detect the stolen object. The length for each sample video is about one minute and in *.avi* format. The results of the system sensitivity testing are shown in Table 2.0.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results

Table 2.0 System Sensitivity Testing Result

Sample	**01**	**02**	**03**	**04**	**05**
Detected Stolen Object Frame	212	230	259	260	269
Number of Bounding Box Occurred When Object Stolen Detected (T)	1	1	2	1	3
Number of Bounding Box Occurred While Non-Stolen Object Detected (F)	23	34	39	47	51
Number of Bounding Box Occurrence in the Absence of Any Object Stealing Event (N)	5	3	2	6	6
Total Bounding Box Occurred	29	38	43	54	60

In Table 2.0, the frames shown in row 2 indicate the frame number which the object stolen is detected by the system. While in row 3 it shows the number of detected stolen object by the system. Throughout the testing with the sample video, it is found out that a lot of noise occurs. Noise in this context can be defined as the false bounding box which pops out in the sample video while the system is running. Row 4 and 5 shows the number of the false and neutral bounding box occurred during the system testing.

4.2 Discussions & Recommendations

4.2.1 Filter

Based on the result in Table 2.0, the number of noise (F) occurred is 0.2:4.9, nearly 5 times more compared to the True (T) condition. This is calculated by computing the percentage of T and F for each sample, and computes the average percentage of the testing results. Therefore, it is recommended to include a filter to restrict the occurrence of the bounding box in the false condition. The bounding box should occurred only in a condition where the pixel is above certain value. Taken into example is the sample filter in the system algorithm, written in MATLAB® in Figure 5 below.

```
%% Set parameters for tracking algorithm
% The hardest part will be tweaking our algorithm parameters to maximize
% the number of hits while minimizing false positives.
areaChangeFraction = .15;   % Percent size that an object can vary
centroidChangeFraction = .2;% percent ratio to size an object can move
maxConsecutiveMiss = 5;     % Max number of occluded frames
alarmCount = 40;            % Min number of frames before an object can be
                            % considered stolen
minPersistenceRatio = 0.7;  % Ratio of persistence for relevance
```

Figure 5 Bounding Box Filter Algorithm for the System, StolenObjectDetection.m

4.2.2 Performing a Video Image Processing and Analysis in Real-Time Environment

Since MATLAB® provides a rich text-based programming environment, it has the advantage that algorithm can be rapidly coded and their functionality verified. However, the features that enable the rapid development of algorithms also hinder their real time implementation. The "interpretation of each instruction on-the-fly" characteristic of MATLAB® in fact leads to a slow execution of ".m" source files, especially in loops where even though an instruction has already been interpreted in an iteration, it must be interpreted for every iteration [18].

CHAPTER 5
CONCLUSION & FUTURE WORK

The Intelligent Object Theft Detection System is aimed to assist the human operator as a semi automatic tool to detect stolen object. The system detects missing object through artificial intelligence and neural network methods via object detection approach to detect and classify objects according to semantic classifications.

However, there are a few improvements that can be done in order to develop a more efficient and reliable system. The system has to use a higher resolution of video camera to capture image as this will help the system to recognize object more accurate. Noises from captured video may decrease the efficiency of the system to detect and classify object, thus issuing alert alarm in the case of a forensic event.

It is suggested that this kind of system is integrated with other supporting security devices such as laser and automatic alert to the security force (i.e policeman) in order to provide quicker response to capture the culprit.

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