NKUJUKIRA Requirements Document (version 2.0)

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**Prepared by: BSE-14 48**

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**Approved By Doreen Tuheirwe**

**Signature…………………………………..**

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# 1. Introduction

Nkujukira is a proposed face recognition security system to be developed in order to alleviate the problem of the low chances of apprehending individuals who steal items at the School of Computing, Makerere University and the recovery of those stolen items if any. This problem also inconveniences most students and staff in the different schools in Makerere University.

This document contains the system requirements for Nkujukira. These requirements have been derived from several stakeholders of Nkujukira including students, CCTV systems administrators, and the Uganda Police.

## 1.1 Purpose of This Document

The purpose of this System Requirement Specification document is to describe the system services and constraints in detail. This document is intended for System end-users, System architects and System developers.

## 1.2 How to Use This Document

We expect that this document will be used by people with different skill sets. This section explains which parts of this document should be reviewed by various types of readers.

### 1.2.1 Types of Reader

This section specifies the types of readers of this requirements document i.e. the intended audience of this document;

* Students at the School of Computing;

Students should read section 3.

* The CCTV administrators of the existing system;

The CCTV administrators should read the entire document.

* The Nkujukira development team;

The development team should read the entire document.

* System maintainers of the system;

The software maintenance team should read the entire document.

### 1.2.2 Technical Background Required

In general readers of this document should have excellent English reading skills. Also a background in systems analysis or systems programming may help the reader understand the more technical aspects of this document.

### 1.2.3 Overview Sections

A general overview of the document can be found in the overview section. However it is advised that the document is read in chronological order.

### 1.2.4 Section Order Dependencies

Sections 2 and 3 may need to be read in chronological order in order to better understand those sections.

## Scope of the Product

This Project will lead to the development of Nkujukira, a face recognition security system.

### 1.3.1 User Scope

The major user of this system shall be the system administrators of the existing CCTV monitoring system. They will directly interact with the system sometimes with the help of a complainant. The complainant does not directly use the system but aids in its use in that he or she reports theft of an item at the School to the CCTV administrator.

### 1.3.2 Geographical scope

Initially, this system will be used within the School of Computing and Information Technology.

This is because the Face Recognition Security System is initially intended to be implemented at this school with a view to expand the scope after evaluation.

### 1.3.3 Technical scope

This system will be developed to run on a computer with the Windows Operating System.

This system will interface with the students’ registration and the CCTV monitoring systems already in place at the School of Computing, Makerere. For the sake of this project and scalability, a dummy registration will be used along with the CCTV footage taken from the existing system. The system to be presented will therefore not interface with the actual university systems because of the sensitivity of the information stored by actual university system.

The system will not replace the current CCTV monitoring system but will improve its capabilities by using facial recognition technologies to improve perpetrator apprehension rates.

### 1.3.4 Functional Scope

The proposed system will do the following;

* It will allow victims of a crime to identify the perpetrator of the crime from the CCTV footage. The face of the individual will be stored for later comparison. Also a search for the individual will be made using the existing student’s registration system in order to find out if the person is a student.
* It will perform real time analysis of video footage taken from CCTV cameras of public areas within the School of Computing, Makerere University. This analysis will involve detecting and recognizing faces of perpetrators in the given scene if they exist.
* It will then generate an alert if a perpetrator is recognized.

## 1.4 Business Case for the Product

This system found its idea from the existing theft problem at the School. The aim is to provide an alternative solution to commercial off the shelf systems that can be very expensive but do not solve the problem. We want to create a system that provides the functionality needed to perform real time face recognition using footage captured from the existing CCTV surveillance system at the School of Computing. In the current approach, when a person’s belongings or possessions are stolen from him/her at the School of Computing, the newly installed CCTV cameras will show the perpetrator of the crime. While this has led to the recovery of some items and the arrest of some individuals, others continue to work ‘behind enemy lines’ mainly because they cannot be identified and recognized. Nkujukira hopes to eliminate these problems.

Below are some of the identified benefits of developing the system;

* The system may lead to a reduction in the number of thefts occurring at the School of Computing through the apprehension of perpetrators of the crimes.
* The system will provide video evidence of the crimes in question and these can be used in convicting of the perpetrator in a court of law.
* The project when complete may offer the police a better chance of finding criminals as it will provide photographs of the perpetrator. These can be used to track down the criminal as well as being used in ‘wanted’ posters.
* This project when complete will offer victims of opportunistic crimes a higher chance of recovering stolen items as the system will ensure facial recognition of the perpetrators of the crimes if they happen to return to the scene of the crime.
* This research is important in many other ways because its results can be used not only in security systems but also in other similar fields. For example in students attendance systems [1] which uses face detection and recognition in order to get the name of a student who has attended a lecture.

## Overview of the Requirements Document

The next section, the General Description section, gives an overview of the functionality of the product. It describes the informal requirements and is used to establish a context for the technical requirements specification in the next chapter.

The third section, the specific requirements section, is written primarily for the developers and describes in technical terms, the details of the interfaces and functional/non-functional requirements of the system.

The fourth section is written in order to describe initial high level system architecture for the proposed system.

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# 2. General Description

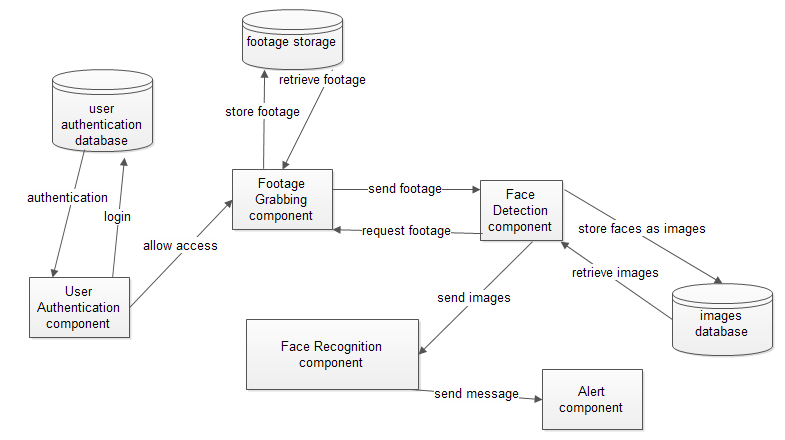
This section will give an overview of the overall system. It will show how the system components interact with each other and will introduce the basic functionality of the system. It will also state the system users and their respective roles. And finally it will have assumptions and system constraints.

## 2.1 Product Perspective

The Nkujukira Face Recognition system will be deployed on a computer that interfaces directly with the existing CCTV system. That computer must be running the Windows Operating System.

The Nkujukira Face Recognition system will be composed of five major components. They include; the User Authentication component, the Footage Grabbing component, the Face Detection component, the Recognition component and the Alert component. All these work hand in hand to perform recognition of perpetrators’ faces and alerting the authorities accordingly.

Figure 1 shows their interactions.



**Figure 1: Nkujukira Interaction Diagram**

* The User Authentication component helps to determine if the credentials provided by the System administrator are valid so he or she can access the system.
* The Footage Component gets CCTV footage from the surveillance cameras at the School Of Computing in real time and then saves it in the footage database. It then retrieves and sends the footage over to the Face Detecting Component when a theft complaint from a student arises.
* The Face Detecting Component on the other hand gets footage from the Footage Component and carries out the detection of faces within the footage. The faces are saved as images and stored in the database for future use when it comes to identifying the perpetrators.
* The images stored in the Face Detecting Component database are fed into the Face Recognition Component which then coordinates with the School’s student database to check whether the perpetrator is a student or not. If the perpetrator is a student, then a message is sent by the alert component to inform the authorities involved of a possible crime. Otherwise, if the perpetrator is not a student, then the System will continue keeping track of the criminal by doing real time recognition; such that, if he or she returns to the school the police is promptly notified and the perpetrator is apprehended.
* The alert Component will be used for generating an alert if a perpetrator of a previous crime is recognized using the face recognition technology.

## 2.3 User Characteristics

There is only one user of the Nkujukira Face Recognition Security System; the School’s CCTV Surveillance System administrator.

The CCTV Surveillance administrator interacts directly with this system. He or she is supposed to monitor the activities of footage capturing, face detection and recognition of faces together with alerting the police of perpetrators.

Unique characteristics of the administrator in order to use the system include;

* username
* password
* email

To be able to interact with system successfully, the systems administrator should also be computer literate, have good communication skills, ability to adapt to a frustrating and stressful environment and ability to learn and adapt to new systems.

## 2.4 General Constraints

Below are the identified general constraints for development:

* The hardware constraints include high performance processors and at least 4GB of RAM.
* High Resolution CCTV cameras may be required in order to improve the recognition rate

With these, Nkujukira will try to meet the real time requirement of high processing speed and performance.

## 2.5 Assumptions and Dependencies

Some assumptions are:

* The faces of the perpetrators are visible enough so as to make the recognition process smooth enough and that the lighting conditions are favorable; that is to say not so dark making it difficult to detect faces at all and also not too bright.
* The CCTV Surveillance administrator responds to all complaints that are reported at the School by the complainants.
* The hardware requirements are favorable for example the CPU speed and frame rate of the footage being grabbed for detection. This is useful for the performance requirements.
* The complainant reports a theft in an area with CCTV surveillance. Areas without CCTV Surveillance do not apply in this regard because no footage is taken at real time of such areas necessarily.

# 

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# 

# 

# 

# 3. Specific Requirements

## 3.1 Functional Requirements

Below are the requirements obtained from interviews conducted with the various stakeholders of the system i.e. the Uganda police, the CCTV administrators, the students of the School of Computing, as displayed in the appendices A,B,C and D respectively. Because Nkujukira will use the SCRUM [2] development methodology, the requirements are organized according to priority. Also note that these are the initial requirements and some non-critical requirements may be dropped and others discovered in later iterations.

**Priority Scale: Very Low (1) – Low (2) – Medium (3) – High (4) – Very High (5);**

**1. Very Low**: Items that can be eliminated should serious system constraints be encountered.

**2. Low**: Items that are extra functionalities and may be evaluated for possible elimination.

**3. Medium**: Items that are strongly desired by the users of the system.

**4. High**: Items which are required in the system in order for lower criticalities to function.

**5. Very High**: Items that are mission critical and that the system cannot function without.

**3.1.1 Display the login interface.**

* **Description:**

After the system has been launched, it shall be able to display an interface with a provision where the user can enter their login credentials (username and password).

* **Priority:**

5

**3.1.2 Validate the system administrator's credentials.**

* **Description:**

After the user has entered the login credentials, the system shall be able to validate whether or not the user has entered the correct password and username.

* **Priority:**

5

**3.1.3 Turn on CCTV surveillance cameras.**

* **Description**

After a successful login into the system, the systems administrator shall be able to turn on the CCTV surveillance cameras in different locations.

* **Priority:**

5

**3.1.4 Capture footage from CCTV surveillance cameras.**

* **Description:**

After the CCTV surveillance cameras have been successfully turned on, the system shall immediately start capturing the footage in real time.

* **Priority:**

5

**3.1.5 Save the captured footage.**

* **Description**

After the system has successfully captured the footage, it shall immediately save it on the hard disk.

* **Priority**

5

**3.1.6 Name the captured footage.**

* **Description**

During the saving, the system shall name the captured footage according to the system date and the time range in which the recording started and ended.

* **Priority**

4

**3.1.7 Read any specified footage already saved on the disk;**

* **Description**

After the captured footage has been saved successfully, the system shall have a provision where the system administrator can browse for the specified footage for viewing.

* **Priority**

5

**3.1.8 Pause, zoom in and out and resume reading of the footage.**

* **Description**

After the captured footage has been read successfully, the system shall have a provision where the user can pause, resume, zoom in and out of the footage.

* **Priority**

4

**3.1.9 Identify the perpetrator of the crime.**

* **Description**

After the claimant has forwarded a claim of a stolen item within the areas under CCTV surveillance, he/she shall specify the date and time range in which the theft happened, the system shall be able to allow the administrator to load a specific CCTV footage and identify the perpetrator in the footage.

* **Priority**

5

**3.1.10. Crop the face of the identified perpetrator.**

* **Description**

After the perpetrator has been successfully identified, the systems administrator shall be able to crop the face of the perpetrator from the CCTV footage.

* **Priority**

5

**3.1.11. Save cropped face of the identified perpetrator.**

* **Description**

After the perpetrator’s face has been successfully cropped, the systems administrator shall be able to save the face of the perpetrator to the database of perpetrators.

* **Priority**

4

**3.1.12. Recognize the cropped face.**

* **Description**

After the perpetrator’s face has been successfully saved, the system shall compare the saved face with faces in the student’s registration database at Makerere University. During the comparison, the system shall try to recognize the perpetrator’s face.

* **Priority**

5

**3.1.13. Check whether the perpetrator is a student.**

* **Description**

After the perpetrator’s face has been successfully compared, the system shall confirm whether the perpetrator is a Makerere University student or an intruder.

* **Priority**

5

**3.1.13. Display the students’ details.**

* **Description**

If the perpetrator has been confirmed to be a Makerere University student, the system shall be able to display his/her details. For example the name, student and registration numbers of the student, the school where he/she belongs.

* **Priority**

5

**3.1.14. Add perpetrator’s face to list of the wanted.**

* **Description**

Whether the perpetrator has been confirmed to be a Makerere University student or not, his/her face is added on the list of those to be tracked on return.

* **Priority**

5

**3.1.15. Real time face detection in live CCTV surveillance footage.**

* **Description**

After the perpetrator has been added on the list of the wanted, the system shall immediately start detecting faces in the CCTV footage captured.

* **Priority**

5

**3.1.16. Real time face recognition.**

* **Description**

After the face has been successfully detected in the footage, the system shall go ahead and compare it with a list of faces to get a match.

* **Priority**

5

**3.1.17. Generate an alarm.**

* **Description**

After the face has been successful recognized as one of the perpetrators’ on the wanted list, the system shall generate an alert to inform the system administrator of the return of the perpetrator.

* **Priority**

**5**

## 3.2 Reporting Requirements

Nkujukira is expected to generate some reports for use by the system administrators.

These are the identified reporting requirements;

* The system shall be able to generate the list showing all wanted perpetrators.
* The system shall generate a report with details including but not limited to; the crime committed, footage of the crime, time of the crime, captured face of person and student status for each perpetrator.
* The system shall be able to generate a report showing all perpetrators apprehended.
* The system shall be able to generate a report showing all perpetrators not apprehended.

## 3.3 System and Integration Requirements

This system shall interface with the CCTV Surveillance system already in place at the School of Computing.The installed CCTV surveillance cameras shall need to be of a high resolution to increase the rate of detection and recognition.

The system shall be able to interface with the Makerere University students’ database to acquire the perpetrator’s student details.

The requirements for the Dummy Students Registration system include;

**3.3.1 Student Registration.**

* **Description**
* The system shall provide an interface where the student shall enter his/her credentials for example name, student number, registration number, year of study, course, school, photo, date of birth, contact.

**3.3.2 Student Details Querying**

* **Description**
* The system shall give room to search for student details using student number and registration number.

## 3.4 Security Requirements

The system’s security shall be ensured by the login component of the system. The administrator shall be able to login and only then can he get access to the other components of the system.

## 3.5 User Interface Requirements

Nkujukira shall have menus with menu items that will allow cropping the identified perpetrator’s face from the footage, saving of the cropped face and one to trigger the recognition process after cropping. In addition the system shall allow zooming in and out the footage, forward, pause and resume loading pre-recorded footage.

The layout of the unspecified part of the user interface is left to the designers of Nkujukira.

## 3.6 Use Cases

The use case diagram can be viewed in the Appendix E. Here after the use cases are described for the benefit of all system stakeholders.

|  |
| --- |
| **Use case:** Turn on the CCTV cameras |
| **ID**: UC1 |
| **Acto**r: Systems Administrator |
| **Pre-condition**: the Systems Administrator is logged in. |
| **Flow of events**:   1. The system displays all active and non-active CCTV cameras 2. The systems administrator turns on only active CCTV cameras 3. The system notifies the systems administrator if he/she attempts to turn on non-active CCTV cameras. 4. The system displays footage capturing in progress on the CCTV cameras turned on |
| **Secondary Scenarios:**  1a. In case the CCTV cameras fail to display, then the systems administrator checks or restarts the cameras. |
| **Post conditions:**  Active cameras are turned on  Turned on cameras start footage capturing |

**Fig. 2 Use Case “Turn on the CCTV cameras”**

|  |
| --- |
| **Use case**: Identify the perpetrator |
| **ID**: UC2 |
| **Actor:** Systems Administrator |
| **Pre-conditions**:  The Systems Administrator is logged in.  There is a saved CCTV footage  The claimant remembers the date, time and location when the loss happened |
| **Flow of events:**   1. The claimant forwards a claim. 2. The system administrator loads the pre-recorded footage of the identified date, time and location by the claimant. 3. While reading the prerecorded footage file, the claimant identifies the perpetrator. 4. After the perpetrator has been identified, the systems administrator crops the perpetrator’s face and has it saved by the system. 5. The system recognizes the perpetrator and confirms whether it is a Makerere university student or an intruder. |
| **Secondary Scenarios:**  2a.If the system fails to read the pre-recorded CCTV footage, an error message. |
| **Post conditions:**  The perpetrator is identified  The perpetrator is confirmed. |

**Fig. 3 Use Case “Identify the perpetrator”**

|  |
| --- |
| **Use case:** View Alert |
| **ID:** UC3 |
| **Actor:** Systems Administrator |
| **Pre-condition:**  The Systems Administrator is logged in.  The systems has recognized the perpetrators  The system has generated an alert. |
| **Flow of events:**   1. The system generates an alarm. 2. Then the system displays a short description of the recognized perpetrator. 3. The systems administrator views the recognized perpetrator. |
| **Secondary Scenarios:**  N/A |
| **Post conditions:**  The systems administrator views the recognized perpetrator. |

**Fig. 4 Use Case “View Alert”**

|  |
| --- |
| **Use case:**  View Perpetrators List |
| **ID:** UC4 |
| **Actor:** Systems Administrator |
| **Pre-condition:**  The Systems Administrator is logged in. |
| **Flow of events:**   1. The system generates the perpetrators list. 2. The systems administrator views the generated list. |
| **Secondary Scenarios:**  N/A |
| **Post conditions:**  The systems administrator views the perpetrators list. |

**Fig. 5 Use Case “View Perpetrators List”**

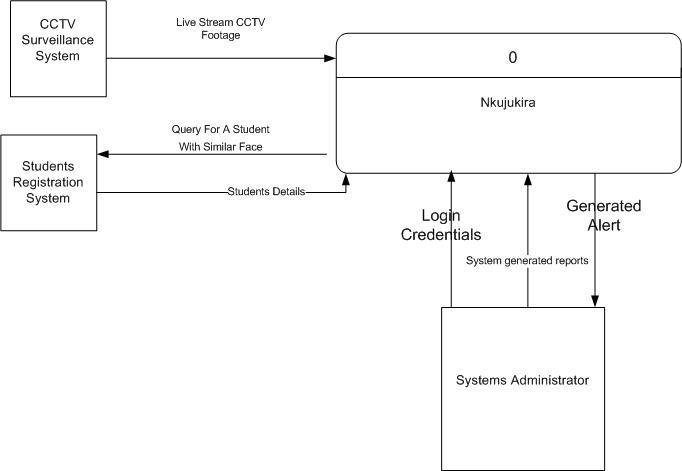
|  |
| --- |
| **Use case:** View a particular Perpetrator Details |
| **ID:** UC5 |
| **Actor:** Systems Administrator |
| **Pre-condition:**  The Systems Administrator is logged in. |
| **Flow of events:**   1. The system generates the perpetrators list. 2. The systems administrator selects a perpetrator from a list of perpetrators 3. The systems administrator views the selected the perpetrator. |
| **Secondary Scenarios:**  N/A |
| **Post conditions:**  The systems administrator views the perpetrators details. |

**Fig. 6** Use **Case “View a particular Perpetrator Details”**

# 

# 4. High-Level Technology Architecture

This section attempts to give a brief overview of the high level architecture of Nkujukira. The high level architecture attempts to give the reader an initial understanding of the proposed system and the major systems it will interface with. Also it depicts the major entities that may use the system either by providing input into the system or may use the output from the system. A context diagram is a diagram normally used to depict high level architecture in software. It depicts the system as a whole and shows the major entities that the system interacts with. The entities may be users of the system or other systems that interact with the proposed system.



**Figure 8: Context diagram for Nkujukira**

The context diagram in Figure 8 shows that Nkujukira will interface with the students’ registration and the CCTV monitoring systems already in place at the School of Computing, Makerere.

It will receive live streams of surveillance footage from the CCTV system along and will be able to query the student’s registration system for a student’s details.

For the sake of this project and scalability, a dummy registration system will be used along with the existing CCTV surveillance system. The system to be presented will therefore not interface with the actual university systems because of the sensitivity of the information stored by the actual university system.

The Nkujukira Systems Administrator will provide a unique username and password combination in order to login and use the system. Also he will provide the face of any perpetrator by cropping his face from pre-recorded CCTV footage.

Nkujukira will produce several types of reports for the System Administrator. These were duly noted in the reporting requirements (section 3.2).

Nkujukira will alert the system administrator if a perpetrator is successfully recognized from the Real time CCTV footage.

# 5. Customer Support

The development team tasked with developing Nkujukira will provide training on how to use the system to the system users.

# 6. Glossary

CCTV Camera-Closed Circuit Television Camera

SCIT-School of Computing and Information Technology, Makerere University

Sys Admin-Systems Administrator

RAM-Random Access Memory

GB-Giga Byte

Open CV- Open Computer Vision Library

# 7. References

[1] K. DONNELLY (2011,may) “A new School Attendance System” Independent.ie [Online]. Available: http://www.independent.ie/lifestyle/education/end-is-in-sight-for-roll-calls-as-schools-face-the-future-26730794.html. [Accessed: jan 4, 2014].

[2] “Scrum (software development)” Wikipedia.org [Online] Available: http://en.wikipedia.org/wiki/Scrum\_(software\_development)‎. [Accessed: jan 4, 2014].

# 8. Appendix

**APPENDIX A**

**Interview of the OC CID Makerere Police Post;**

-**what is the average number of cases of crime recorded per day and per month?**

There are around 20 cases recorded per day and 1500 per month. These include student and non-student cases.

-**What are the steps taken to try and recover the stolen items?**

The most important step is to report the case to the police first and then record a statement with them including details of when the theft occurred and details of the stolen item for instance if it is a phone, a receipt for purchase of the phone is used to certify ownership and the serial number of the phone to try and track the phone location.

Then with this kind of information, then more evidence is solicited for from the CCTV Surveillance footage for instance to add to the report of the crime. This ensures that an individual assumed to have stolen the item is properly declared guilty and aids other students from taking matters into their own hands even when the individual may be innocent.

If the evidence is not sufficient enough, sniffer dogs and fingerprints can be used in the crime scene to collect more details of the crime.

**APPENDIX B**

**Interview of the CCTV Surveillance Administrator;**

**What is the operation of the current system?**

The systems administrator turns on all active cameras positioned in specific locations for example computer laboratories, building entrances, corridors. After the cameras have been turned on, they start recording with immediate effect.

**What challenges are faced by the current operation of the system?**

When power goes off, the whole system shuts down.

There are few cameras positioned in specific locations; for example one camera in the whole corridor which makes it difficult to capture images at a far distance clearly and this makes the viewing of people within the footage hard.

During real time recording the quality of the footage is moderate but lowers by a larger percentage after recording. This makes identification process of individuals in the footage frame too difficult.

It is difficult to recognize the perpetrators of crime after identifying the CCTV camera footage. It involves identifying the individuals who were available at the time of the crime at the crime scene. Then may be that individual can lead them the perpetrator or another individual who can lead them to the perpetrator.

**What criteria are followed by the victim to access the CCTV footage in order to identify the perpetrator?**

The victim reports a claim to the CCTV administrator, he checks for crime scene, the time and date of the crime. After retrieving the footage, the victim is advised to go and file a statement to the Police if he/she hasn’t. Then the victim comes back to the surveillance room with the police to view the footage and identify the perpetrator with a number of witnesses.

**Have you ever recovered any stolen items?**

Yes, but it was a long process.

**How many complaints do you receive on average day?**

0-5 cases.

**APPENDIX C**

**Interview of the Student;**

**What is your name?**

Mubiru Timothy

**Which Course are you taking?**

BIT

**Which year?**

Year 2

**Have they ever stolen any item from you around the School of Computing?**

Yes

**Where?**

I was at block B level 4 next the computer lab entrance.

**Which item was it?**

It was a laptop

**What exactly happened?**

I was doing my course work and it so happened that i received a call. The network signals were not clear so I had to move the extreme end of the corridor. When I came back, my laptop and the sit had disappeared from the face of the earth.

**Did you ever recover that item?**

Yes

**What did you do to recover the item?**

My friends advised me to go and check from the CCTV surveillance camera footage from level 6 block B. When I reached, the administrator in the control room asked me the level, date, and time my laptop was stolen. He searched for the footage, after him viewing the footage, he asked me to first report to the police and come back with the police to view the footage and try and see if I can identify the perpetrator. I observed the guy pick the laptop and the seat. Unfortunately I couldn’t recognize his face. So called up some of my friends to assist me and see if they can recognize the face in the footage. One of my friends recognized the face, but didn’t know the name of the guy. Fortunately this guy used come around the School of computing. So the next morning, we ambush the guy. Fortunately, he came around; we approached him gently. We asked him to come with us to level 6 in the CCTV surveillance room. The administrator played for him the footage, and he first denied being the individual observed carrying the seat and the laptop. We took him to police and he eventually confessed to have stolen the laptop. We went with him to his place and got the laptop.

**How did you find the whole process of recovering the stolen item?**

The process was so hectic. As I left late in the night, I came back very early in the morning and stayed outside observing every human face getting into the building for almost the whole day. Then going to the police, going to the perpetrator’s place and spending a lot on transport fees and airtime. The whole process was frustrating.

**APPENDIX D**

**Interview of the Student**

**What is your name?**

Kitimbo Bilali

**Which Course are you taking?**

BSSE

**Which year?**

Year 4

**Have they ever stolen any item from you around the School of Computing?**

Yes

**Where?**

I was at block B Bag Section.

**Which item was it?**

It was a laptop bag.

**What exactly happened?**

I was going for a test and left my laptop bag in the bag section since they are not permitted in the examination room. On coming back, I could not find the bag.

**Did you ever recover that item?**

No

**What did you do to recover the item?**

I went to level 6 block B in the CCTV surveillance room. I found there an administrator who asked me the time and the level the items were stolen from. Finally the footage was played but the cameras had only captured the individuals getting in and out the room. The cameras did not capture the individual picking the laptop bag.

**How did you find the whole process of recovering the stolen item?**

It did not work for me, so it is not reliable.

**What do you think can be done to improve the system?**

Let them have the cameras well positioned to have a wider area coverage.

**APPENDIX E**

**Analytical Models**

**Use case diagram**

