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| **MAKERERE UNIVERSITY** |
| Software Requirements Document |
| Black spot Traffic Monitoring System |
| By Group BSE18\_21 |
|  |
| **11/22/2017** |

Software Requirements Specification

For

Blackspot Traffic Monitoring

System

Version 1.1

Prepared by Lyada Felix

Group 21

November 2017

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Revision History

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# Introduction

A requirement is an externally observable characteristic of the desired system [1]. This document contains the system requirements for Blackspot Traffic Monitoring System (BSTMS), an embedded and web system that shall help in monitoring of speeding and other incidences on roads. The requirements are derived from several sources, including the Uganda Police Website, Uganda Police Force. Annual crime and Traffic Road safety Report [2].

## Purpose

The aim of this document is to specify all the necessary tools and levels of operation needed to build the Blackspot Traffic Monitoring System (BSTMS) to enable police to remotely access information on poor means of using roads.

The target solution as described in the concept paper is the basis of developing this document. This document covers the requirements for the development of the software including both functional and non-functional requirements.

The purpose of the document is to give requirements for the blackspot traffic monitoring system (BSTMS). In addition, the document provides guidelines on how to use the proposed system. This SRS document is to provide a detailed overview of our software product, its parameters and goals. This document describes the project's target audience and its user interface, hardware and software requirements. It defines how our client, team and audience see the product and its functionality. Nonetheless, it helps designers and developers in developing and maintaining the system.

## Document Conventions

For purpose of this project, we adopted the following convention for naming cameras, the systems users, and other entities in the system.

1. BS-CAM-XX to mean camera at black spot number XX (BS-CAM-XX)
2. BS-RD-XX to mean Black Spot Number XX On road RD (BS-RD-XX)
3. IDE to mean Integrated Development Environment (IDE)

## Intended Audience and Reading Suggestions

This document is primarily for developers of the Blackspot Traﬃc Monitoring System (BSTMS). The Police as the clients and supervisors may read. It is preferred for the readers of this document to take a careful look through each of the speciﬁcations and keywords given in this document. This document contains the following content: - scope of the software, references used with this software, product perspective, product functions, user classes and characteristics, operating environment, design and implementation constraints, user documentation, external interface requirements, user interfaces, hardware interfaces, software interfaces, communications interfaces, system features, performance requirements, safety requirements, security requirements and business rules.

## Product Scope

This software system shall be an integrated system consisting of an embedded system and web application, which shall communicate via Internet and GPRS. The designed system shall maximize the traffic authorities’ productivity by providing tools to assist in automating the traffic monitoring process, which would otherwise have to be manual. By maximizing the traffic authority’s work efficiency and production, the system shall help reduce fatal road traffic accidents

More specifically, the system shall monitor traffic and allow traffic regulatory authorities in managing their work. The software system shall track the speed, overtaking on highways, parking and recognize number plate for motor vehicles. The system shall be able to capture video clips of vehicles that over speed and those that overtake from the wrong side and/or when not necessary and inform the nearest traffic officer of the incoming vehicle. The responsible officers shall review the video clips. The system shall also contain a relational database to store a list of captured clips, location of captured incident, the officer responsible and the type of road offense. The system shall capture a list of these traffic offenses and store them in a database to identify the motor vehicles that committed them based on their registration numbers and other features.

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# Overall Description

## Product Perspective

Black spot traffic Monitoring System shall be an automated service for reporting traffic offenses on selected road points. The system shall facilitate 24/7 monitoring of specific locations of the road for traffic offences, enabling police to remotely monitor poor road usage.

This system is dependent on computer vision library to analyze video of moving cars along the demarcated roads. The cameras are to be near the target black spots. In particular, the black spot BS-RD-XX is a location where the camera BS-CAM-XX analyzes the speed, over taking, parking and number plate of each vehicles passing that location. The cameras shall send the recorded video to a server to analyze the video stream for number plate data, the speed, overtaking and parking of vehicles. The server shall record the data into a database for the streaming applications from the oﬃcers to access it. Figure 1 shows the way the system shall operate.

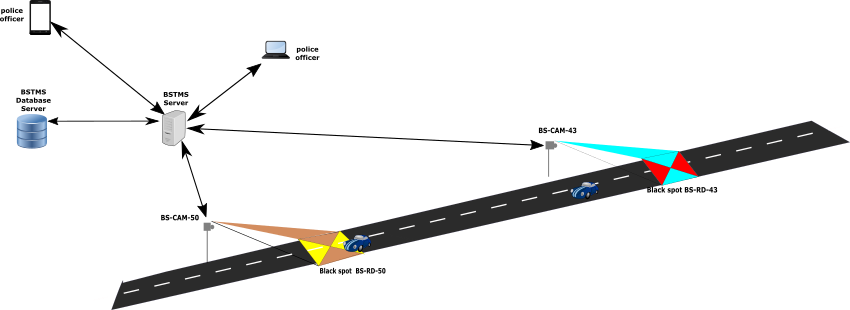


Figure : Black spot traffic monitoring system

## Product Functions

The BSTMS is a top-down management perspective that integrates technology primarily to improve on road traffic management activities hence improving safety on the road. The system shall show all active cameras. The administrator shall receive notification in case of a faulty camera. The system shall collect Real-time traffic data from cameras, which shall flow into a Transportation Management Center (TMC) where it is integrated and processed for incident detection, then notify the responsible police officers to take action. The system users shall be required to login into the system via web platform such as mobile or web application.

## User Classes and Characteristics

Two categories of users interact with this system. Traﬃc oﬃcers who interface at the mobile interface and administrators who seat at the Traﬃc Management centers where they interface via web. Each of these two has diﬀerent use of the system so each of them has their own requirements. The expectation is that a user of BSTMS especially the system administrators have computing experience including at least minimum training in computer basics. The assumption is that the user has a general understanding of BSTMS.

## Operating Environment

The system shall run on Linux distribution Ubuntu 16.04 or Windows 7 and later operating systems. To enable data storage; the system shall require a relational database to store records of incidents of traffic law violation along the blackspots. To run the server software, the user shall have JavaScript enabled in the browser. User interfaces shall be web browsers and alternatively, may use similar software to access the system.

The main components of the BSTMS project are the

1. BSTMS Web Service split into processing engine and the browser is the client
2. The Cameras at black spots
3. The Relational database

The system shall frequently interact with the BSTMS web service, a virtual dedicated server.

The BSTMS database implementation on the server shall be MSSQL.

## Design and Implementation Constraints

* Memory and processing are important to enable fast processing.
* The server shall keep running to analyze video and image to register traffic offences.
* The camera shall have good resolution and night vision capabilities to ensure good quality of images and videos and 24/7 processing.
* The cost of the bandwidth is too high, posing yet another challenge with system implementation.

## User Documentation

The BSTMS Tutorial shall be available as user manual to offer guidelines on how to use the system to enhance usability of the system.

A help menu shall be available on the system user interface with the Frequently Asked Questions (FAQS) to help the users be well acquainted with the system.

## Assumptions and Dependencies

### Time Dependencies

The overall speed of the system shall depend on the speed of the network used to communicate between the embedded system and the other subsystem.

The timely implementation of some system features shall depend on the how crucial they are to the problem being solved.

The final decision whether to implement some features not so crucial to the system shall only depend on the availability of time.

### Assumptions

The following are the assumptions regarding the users and the system itself.

1. User have basic knowledge of computer.
2. Users have Internet access.
3. Cameras used are fully calibrated.
4. Power is available to run the cameras.
5. The roads under monitoring are clearly marked.

# External Interface Requirements

## User Interfaces

The user interface for the software shall be compatible with any web browser such as Internet Explorer, Mozilla Firefox, google chrome, opera, safari and any JavaScript enabled web browser that a user can access to the system.

Both the traffic officers and the administrator should be able to stream both incoming videos and images of road cases on notification.

The user interfaces should have confirmation button option for users to confirm notification

The user interfaces should provide an option for reporting on the action taken after receiving notification. The user interface should categorize cases by date of receipt

The admin user interface should provide an option for registering, deleting and editing other users in this case, traffic officers.

The user interfaces shall provide an authentication option before using the system.

## Hardware Interfaces

All hardware interfaces of BSTMS shall be those for the IP Camera and Server.

### Memory Card

Each camera shall have a memory card that shall be used to save recorded video before it can be transferred to the BSTMS server.

### Solar panels

Since each IP camera depends on power to function, there shall be a solar panel placed for each camera.

### Rechargeable Batteries

Each camera shall use minimum of 5V of power. Batteries shall be attached to power each camera. The batteries shall be charged using solar.

### Wireless Transmitter/Receiver

Each IP camera shall consist a wireless transmitter with a GPRS module to connect via an ISP to the BSTMS server.

### Camera Stand.

The camera shall be mounted on a stand of approximately 4 meters height. There shall be full CCTV camera installation requirements to be followed.

### IP Camera

For the best quality video recording, the camera shall be the Sony SNC-EM602RC, Outdoor IR ruggedized 720p/30 fps camera powered by IPELA ENGINE EX™. It supports day and night video capture. Technical details are on the Sony website [3].

### Server

The BSTMS shall run on a server that shall be of high processing power of 1.4GHz or more, also including 2GB RAM or greater.

## Software Interfaces

### OpenCV API

The BSTMS shall interface with openCV [5] library through the openCV API, to analyze video using computer vision. These libraries, together with BSTMS itself shall interface with the operating system and any other software systems they require.

### Web Browser

The web browser shall be used to display information from the BSTMS server. The same web browser shall be used to configure the server, including camera configuration and user management.

### Number Plate Recognition API

BSTMS shall interface directly with the Number Plate Recognition library for identiﬁcation of which vehicles are passing the black spot.

### Python Tensorﬂow API

BSTMS shall use the tensorﬂow library for machine learning, and improvement in recognition accuracy with time.

## Communications Interfaces

The BSTMS requires a running server application that shall receive video streams from the cameras on the roads. This streaming can be via Real Time Streaming Protocol (RTSP) and an ngnix server to record the video stream.

The video streams shall be encrypted to prevent MITM attacks on the streams. It would be preferable to use a minimum of 20Kbps to transfer data to the server. The traﬃc Oﬃcer app shall connect to the server via HTTPS and may be to upload ﬁles to the server via FTP.

Clients on Internet shall be using HTTP/HTTPS protocol. Firewall security is required for securing the server. TCP/IP protocol is basic need for client side.

The users shall use emails to receive confirmation of their login credentials from the system.

# System Features

## Estimate Vehicle Speed

### Description and Priority

The BSTMS determines the speed of vehicles at the black spot BS-RD-XX using computer vision and analysis of video by use of openCV library [6] . This feature is utilised by when the BSTSM attempts to determine the speed of one car.

### Stimulus/Response Sequences

1. Video input from black spot camera
2. Detection of car(s) in video frames.
3. Speed estimation on single car in video frame

### Functional Requirements

1. The system shall extract location of vehicle at various locations
2. The system shall compute vehicle speed based on average change of location
3. The system shall send number plate of offender to a remote server and signal the nearest police of the offence
4. The system shall provide an interface for entering the speed limit beyond ,which drivers shall be considered to be over speeding

## recognize licence plate

### Description and Priority

The system recognizes the licence number at the blackspot BS-RD-XX at the time of determining the traffic offence. The licence number shall be the unique key for which the suspected motor vehicle shall be identified.

### Stimulus/Response Sequences

1. Video input from black spot camera
2. Detection of car(s) in video frames.
3. Capture image of the licence Plate.
4. System repositions the image
5. Send the image to optical character recognition library.

### Functional Requirements

1. The system shall record the number plate of every suspected motor vehicle.
2. The system shall compute the confidence level of recognition of the number plate

## monitor overtaking

### Description and Priority

The system recognizes an overtaking at the blackspot BS-RD-XX and determines if it is a wrong overtaking.

### Stimulus/Response Sequences

1. Video input from black spot camera
2. Detection of car(s) in video frames.
3. Estimate the direction of motion of cars.
4. No-Overtaking mark on road is observed for both vehicles
5. One vehicle continues moving alongside the other vehicle but beyond the no-overtaking mark for 5 seconds
6. Video evidence is captured

### Functional Requirements

1. The system shall record video evidence of wrong overtaking

## monitor parking

### Description and Priority

While a vehicle stays out of motion at a point in the view of the camera. It shall be recorded as wrong parking.

### Stimulus/Response Sequences

1. Video input from black spot camera
2. Detection of car(s) in video frames.
3. Vehicle stays stagnant over 5 seconds of the video frame
4. Register wrong parking

### Functional Requirements

1. The system shall record a picture evidence of wrong parking

## Data analysis

### Description and Priority

When traffic officers are required to provide proof of offense, they can use their application to find evidence of the traffic offense.

### Stimulus/Response Sequences

1. Traffic officer opens the evidence menu on android application
2. Traffic officer is presented with a search list of all offenses
3. Traffic officer selects the offence
4. Offense video or photo is displayed to traffic officer

### Functional Requirements

1. The system shall provide an interface for accessing traffic monitoring data.
2. The system shall penalise vehicles that shall violate traffic regulations.
3. The system shall organise create a dataset of traffic monitoring information

# Non-functional Requirements

## Performance Requirements

### Response time

The BSTMS shall capture number plate of a car within the continuous video frames this shall take maximum of one minute.

The system shall update the database immediately a traffic violation is registered.

### Capacity

The BSTMS IP camera shall stream video to the server. On average, for maximum-traffic video takes full advantage of the exceptional detail found in high-resolution, full-motion (30fps) 24x7 video streams to recognize visual patterns.

These high-resolution, full-motion 24x7 video streams deliver superlative visual quality, but do so at a price; they consume vast quantities of storage capacity. Using MPEG-4 compression, a single continuous stream at 30fps/1280x1024 resolution fully exhausts the capacity of a 3TB drive in just 24 days, while H.264 encoding delivers approximately 42 days of the same quality video.

To run the system for at least two days while streaming video using one camera and H.264 compression shall require minimum of 50 GB Disk space.

The system shall not store entire video footage of each camera. Only video evidence of traffic violation shall be stored. Where each video shall occupy maximum of 100MB of disk.

### Workload

The BSTMS shall handle multiple camera streams simultaneously therefore, each camera shall create load on the server to analyse the video. Too many cameras with low CPU may breakdown the system.

### Platform

Running on a 64-bit processor shall ensure maximum performance.

## Safety Requirements

BSTMS shall not aﬀect data stored outside of its servers nor shall it aﬀect any other applications installed on the user’s phone. It cannot cause any damage to the phone or its internal components. The following safety precautions shall be taken.

* IP Cameras shall be fenced off to prevent theft or injury of nearby people when the fall.
* The BS-CAM-XX camera installations shall comply with all surveillance regulations and standards in the nation. They should be installed at secure locations with awareness of theft of the camera.
* Each IP Camera shall have protection from lightning since they shall be placed on poles high above the ground.
* The Camera poles shall only be located in areas where they do not create an unsafe situation for roadway users. A location might be unsafe if it protrudes into the traveled way, if there is a risk that vehicles shall crash into the poles, or if the poles obstructs drivers or pedestrians’ sight. The supporting poles should not impede the way of bicyclists and pedestrians

## Security Requirements

1. All users of the web interface shall be authenticated before performing other tasks on the system
2. Only the administrators shall be allowed to edit data in the system.

## Software Quality Attributes

* **Portability:** The system shall be a small and light project so it does shall not need installation itself. All it takes is unpacking from the Zip package. One shall transfer the system in a USB stick. Additional conﬁguration shall be needed for the database only.
* **Usability:** The graphical user interface of BSTMS is to be designed with usability as the ﬁrst priority.
* **Documentation:** The system shall be maintained on VCS. The source code of this software shall be available via a Version Control System most likely GitHub.

## Business Rules

1. A user shall only get notifications after authentication.
2. Communication of the system to users shall only be via internet.

# Other Requirements

OCR libraries for character recognition from images

# Appendix A: Glossary

Deﬁnitions, acronyms, and abbreviations

|  |  |
| --- | --- |
| **Term** | **Description** |
| **AMD** | 64 bit architecture series of computer processors |
| **Android** | An open-source operating system used for smartphones and tablet computers. |
| **ANPR** | a technology for automatically reading vehicle number plates |
| **API** | Application Programming Interface |
| **ASP.NET** | An open-source server-side web application framework designed for web development to produce dynamic web pages. It was developed by Microsoft to allow programmers to build dynamic web sites, web applications and web services. |
| **Blackspot** | A location on a road that is under surveillance of the BSTMS |
| **Browser** | A computer program that can interface a user with the internet |
| **BS-CAM-XX** | camera at black spot number XX (BS-CAM-XX) |
| **BS-RD-XX** | Black Spot Number XX On road RD |
| **BSTMS** | Blackspot Traﬃc Monitoring System |
| **C#** | C sharp |
| **Computer Literate** | Some one that can use a computer system. |
| **CPU** | Central Processing Unit |
| **CSS** | Cascading Style Sheet |
| **CSS3** | cascading style sheet 3 |
| **FR-\*** | Requirement \*. where \* is a number greater than 0 |
| **FTP** | File Transfer Protocol |
| **GNU** | A Unix like operating system. That is free software |
| **GPRS** | General Packet Radio Service |
| **GUI** | Graphical User Interface |
| **HTML** | Hypertext Markup Language |
| **HTTP** | Hypertext Transfer Protocol |
| **HTTPS** | Secure Hypertext Transfer Protocol |
| **ICT** | Information and Communication Technology |
| **IDE** | Integrated Development Environment |
| **IEEE** | Institute of Electric and Electronic Engineering |
| **Internet** | A collection of computers, and software networked |
| **Java** | A general-purpose computer programming language designed to produce programs that will run on any computer system. |
| **JavaScript** | A programming language for client side scripting |
| **JSON** | JavaScript Object Notation |
| **JSP** | Java Server Pages |
| **Md5** | A widely used hash function that produces a 128-bit hash value |
| **MITM** | Man In The Middle |
| **MSSQL** | Microsoft Structured Query Language |
| **MySQL** | an open source relational database management system (RDBMS) based on Structured Query Language |
| **MySQL** | An open sourced database management system |
| **OCR** | Optical Character Recognition |
| **openCV** | A library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage and is now maintained by Itseez. |
| **PostgreSQL** | An open source relational database management system (DBMS) developed by a worldwide team of volunteers. |
| **Programming Language** | A set of rules and tools required to make computer programs |
| **Python** | A programming language for working with AI |
| **R Package** | Helper program written to extend functionality of R programming language. |
| **R Script** | Document that contains R code or instructions. Interpretable by the R engine. |
| **RTSP** | Real Time Streaming Protocol |
| **SDLC** | software Development Life Cycle |
| **SHA1** | Secure Hashing Algorithm 1. A cryptographic hash function |
| **SRS** | Software Requirements Specification |
| **Tensorflow** | an open source software library released in 2015 by Google to make it easier for developers to design, build, and train deep learning models |
| **URL** | Uniform Resource Locator |
| **USB** | Universal Serial Bus. |
| **VCS** | Version Control System |
| **Windows** | operating system by Microsoft corporation |

# Appendix B: Analysis Models

The interview guide used in gathering information from police officers.

**Interviewee: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Interviewee Organization: Uganda Police Force**

**Title of Interviewee: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Greetings, we are students of Makerere University at the College Of Computing and Information Sciences, pursuing a Bachelor of science in Software Engineering. For the fulfilment of the core principles and practices of this course. We are obliged to have a working software solution as a final year project.

On this remark, we have come up with a Black Spot Traffic Monitoring System that shall enable the police to track traffic offenders at black spots to reduce road accidents.

**A black spot is a location where drivers tend to be often careless when driving, causing lots of accidents at this point.**

All data collected shall be treated with utmost confidentiality and only be used to implement the system

1. What time of the day are the police officers deployed?
2. Do you have any methods of monitoring road users to identify those traffic incidences such as over speeding, overtaking and wrong parking? If yes, what are those methods?
3. What do you call wrong parking?
4. What is the maximum speed beyond which it is over speeding?
5. What groundworks are in place to implement a new tech-system to improve in monitoring traffic to reduce road accidents?
6. Are there cases where traffic rules can be broken, mention?
7. What procedure is followed to clear a vehicle or driver from a traffic offense?
8. Will the police fund such a project, to improve its services, provided you have liked it?

**\*\*\* THANK YOU\*\*\***

The members of the BSTMS team

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Use case diagram for the BSTMS

