**Department of Computer Science and Engineering**
**The University of Texas at Arlington**

Team: Patrol Crusaders

Project: Neighborhood Patrol Drone

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# Document Revision History

| Revision Number | Revision Date | Description | Rationale |
|---|---|---|---|
| **0.1** | 10/08/2014 | System Requirements Specification Initial Draft for submission. | Initial draft of SRS |
| **0.8** | 10/27/2014 | System Requirements Specification second Draft for submission | Revisions made after instructor, TA, and peer feedback |
| **0.9** | 10/28/2014 | System Requirements Specification Third Draft for submission. | Revised Schedule Analysis |
| **1.0** | 10/28/2014 | System Requirements Specification Fourth Draft for submission | Formatting mistakes corrected and page numbers updated |
| **1.1** | 11/07/2014 | System Requirements Specification Final Draft for submission | Revised SRS after review from Professor and peers during Gate Review |
| **2.0** | 11/07/2014 | System Requirements Specification Initial Baseline Submission | Proof read and formatting corrected |
| **2.1** | 11/14/2014 | System Requirements Specification Baseline Submission | Added input-output for new added requirement and updated product concept |
| | | | |

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# 1. Product Concept

This section provides the purpose, use and the intended audience for the Neighborhood Patrol Drone. The purpose of the Neighborhood Patrol Drone is to provide added security to a neighborhood. It does so by patrolling over a predefined path and record video as well as take pictures. Once it has taken a picture or a video, real time image processing is conducted on the video to detect any irregular activities. The video is streamed to a server where the user can access it via a mobile phone using an Android application or from a website. The recorded videos are stored on the server for five days for reviewing purposes.

## 1.1 Purpose and Use

The Neighborhood Patrol Drone flies in a predefined path over a neighborhood. The Neighborhood Patrol Drone will be able to do so with limited to none human interaction. The Neighborhood Patrol Drone contains one on-board camera. The camera can record videos as well as still images. The video is streamed to a server where the user can access it via a mobile phone using an Android application or from a website. The videos are stored for five days so that the user can go back and refer to it in case such a need arises.

Real time image processing is done on the streamed video to detect any unseemly activities. For example, if a vehicle stops in front of a mailbox, an alert is sent to the resident of the house which the car has stopped through a text message and an email. This allows the resident to know who is stopping by their mailbox. A notification is sent to the resident confirming that their mail has been delivered when a mail delivery vehicle stops in front of the mailbox. If multiple stops are made in front of different mailboxes in the neighborhood over a period of time, an alert is sent to all of the residents in the neighborhood through a text message and an email. The alert is sent out to prevent the theft of mail.

By default, the Neighborhood Patrol Drone flies on auto pilot mode. The user has the ability to override the auto pilot and control the Neighborhood Patrol Drone using a remote control. The Neighborhood Patrol Drone has the ability to land at a specified location automatically when low on power. This prevents the Neighborhood Patrol Drone from crashing when power runs out. The Neighborhood Patrol Drone has the ability to hover and fly at night on minimum power.

In summary, the Neighborhood Patrol Drone is a roving security system that enhances the safety and security of the area that it patrols. It does so by video surveillance and image processing.

## 1.2 Intended Audience

The intended audience for the Neighborhood Patrol Drone are residential neighborhoods and business buildings. The user is concerned with security and safety of their neighborhood. The Neighborhood Patrol Drone provides security to the user by acting as a mobile surveillance system. The prototype of the Neighborhood Patrol Drone is intended for deployment in a specific neighborhood in Keller, Texas

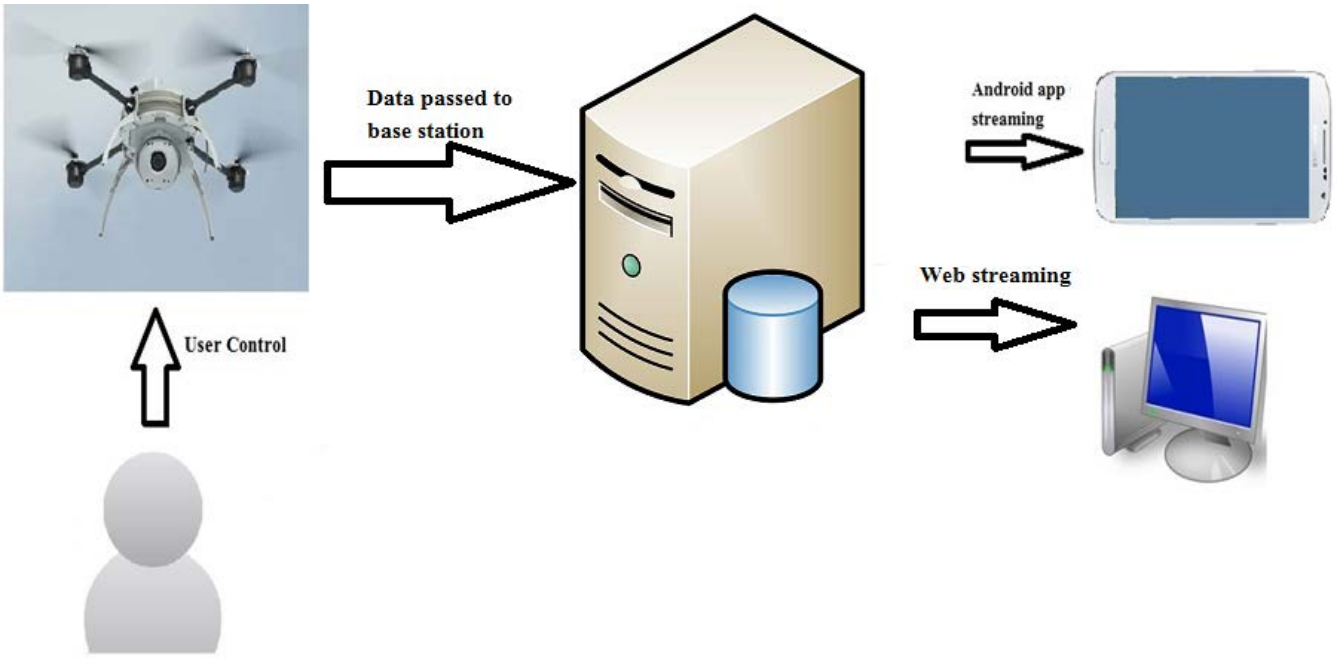


**Figure 1.1 Conceptual Drawing**

# 2. Product Description and Functional Overview

This section provides an overview of the Neighborhood Patrol Drone. The primary operational aspects of the product, from the perspective of end users, maintainers and administrators, are defined here. The key features and functions found in the product, as well as critical user interactions and user interfaces are described in detail.

## 2.1 Features and Functions

The main features and functions of the Neighborhood Patrol Drone are:

- Fly on a fixed path with limited to none human intervention.
- Capable of flying at night on minimum power.
- User will have the option to override the autopilot when a situation arises.
- In the state of an emergency, the Neighborhood Patrol Drone will be provided with a specified location for emergency landing.
- Neighborhood Patrol Drone will consist of an on-board camera to conduct live video surveillance.
- All videos will be stored in a local base station.
- The base station works as a server to the system and landing station.
- The base station will allow the user to take still images and will conduct the image processing.
- The solar panel will be used to generate energy and recharge the batteries of the drone.
- User can access the video and image libraries from the server via an Android application or website.
- Suspicious activities will be notified to the user as alerts.

## 2.2 External Inputs and Outputs

| NAME | TYPE | DESCRIPTION | USE |
|---|---|---|---|
| Remote Control | Input | Remote control for the Neighborhood Patrol Drone to control speed, trajectory and height. | The remote control is used by the user to control the Neighborhood Patrol Drone when autopilot is off. |
| Video camera | Input | Camera fixed on the Neighborhood Patrol Drone | The camera is used to stream videos to the user and still images |
| Applicatio n- Android | Output | The Android application for the Neighborhoo d Patrol Drone on phone | The Android application is used to view the video streamed by the Neighborhood Patrol Drone and access old videos. |
| Applicatio n - Web | Output | The web application for the Neighborhood Patrol Drone | The web application is used to view the video streamed by the Neighborhood Patrol Drone and access old videos. |
| Server-Store Video | Input / Output | The server used to store the streamed video | The video streamed by the Neighborhood Patrol Drone is stored for a specified time by the server. It can be accessed by the user whenever needed. |

| | | | |
|---|---|---|---|
| Base Station | Input / Output | The base station takes videos as input and streams it via web or Android app. Does image processing. | The video streamed by the Neighborhood Patrol Drone is used to detect any unwanted activity in the area and alerts are sent appropriately. |
| Solar Panel | Input | Takes solar energy. | Capture solar energy and pass it to the converter. |
| Converter | Input/ Output | Takes the solar energy from solar panel and recharges battery. | Converter takes solar energy as input and converts it into ac current energy and recharges the battery unit of the drone. |

**Table.2.1 Inputs and Outputs**

## 2.3 Product Interfaces

The Neighborhood Patrol Drone consists of two Graphical User Interface (GUI) and four hardware components. The hardware components are: remote control, camera, Neighborhood Patrol Drone, and the base station. The input is conducted using the remote control while the output is displayed in the GUI for the user. The video will be used as an input for the image processing which is done on the base station. The proposed Graphical User Interface for the Android application and the website are represented by Figures 2.1 and 2.2, respectively.

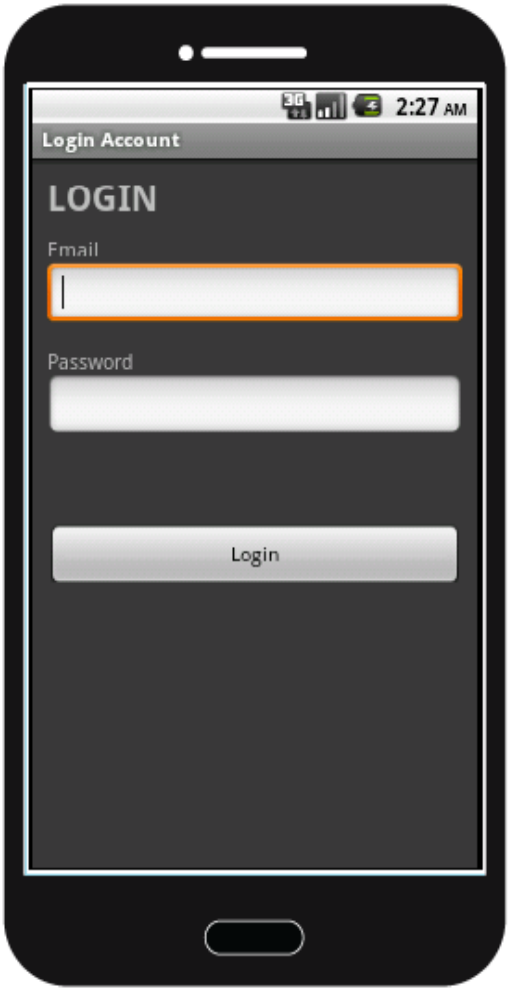


**Fig. 2.1 Android User Interface**

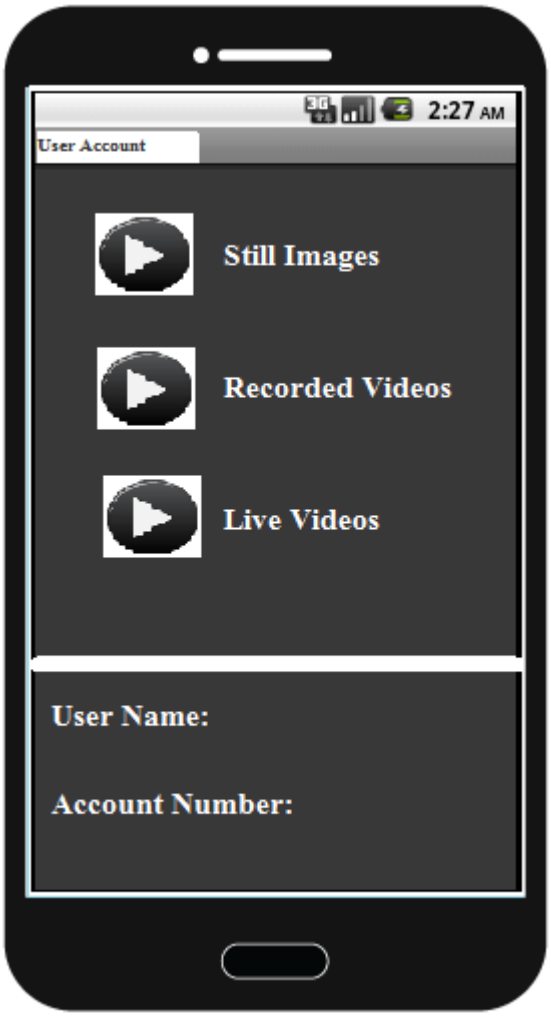


**Fig. 2.2 Android User Account**


**Fig. 2.3 Android Still Image**

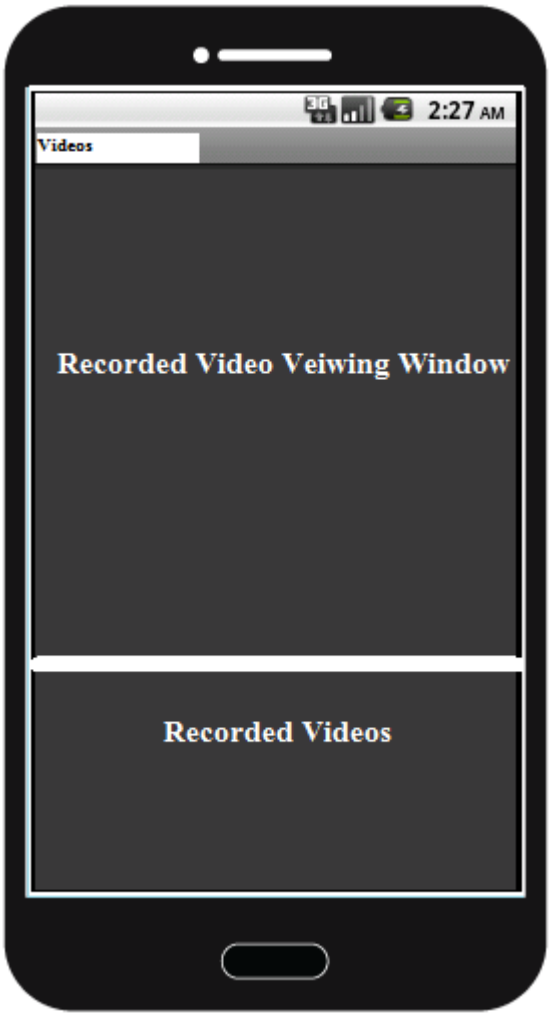


**Fig. 2.4 Android Video**

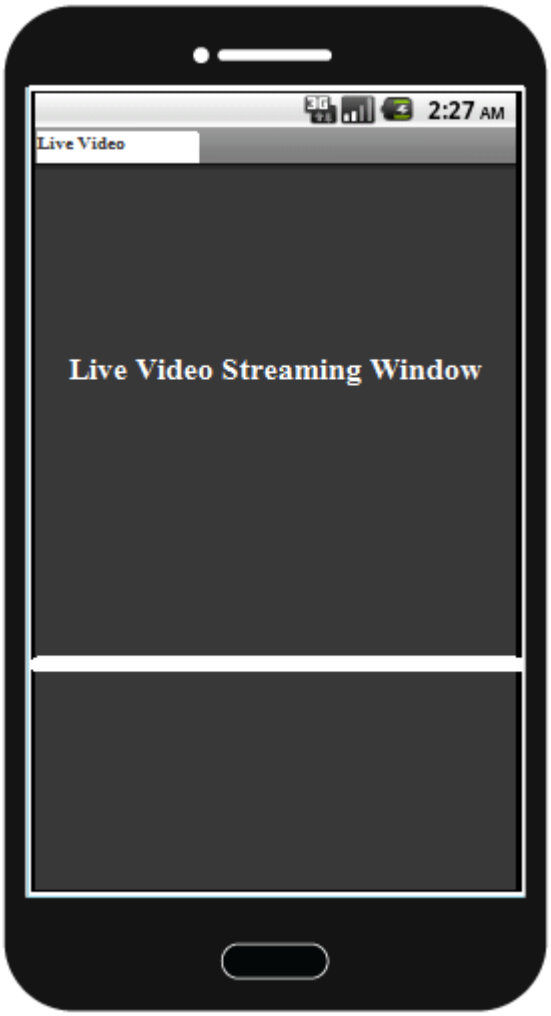


**Fig. 2.5 Android Live Video**

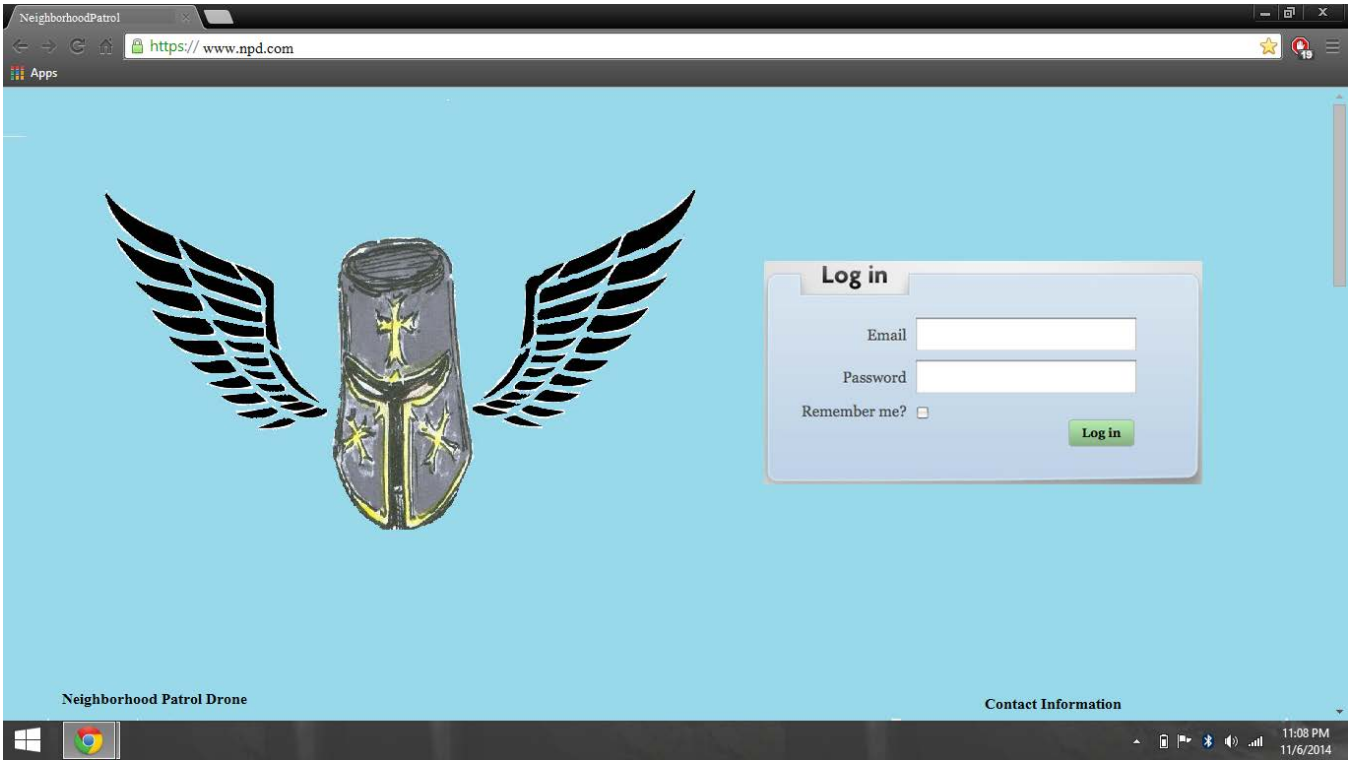


**Fig. 2.6 Web User Interface**

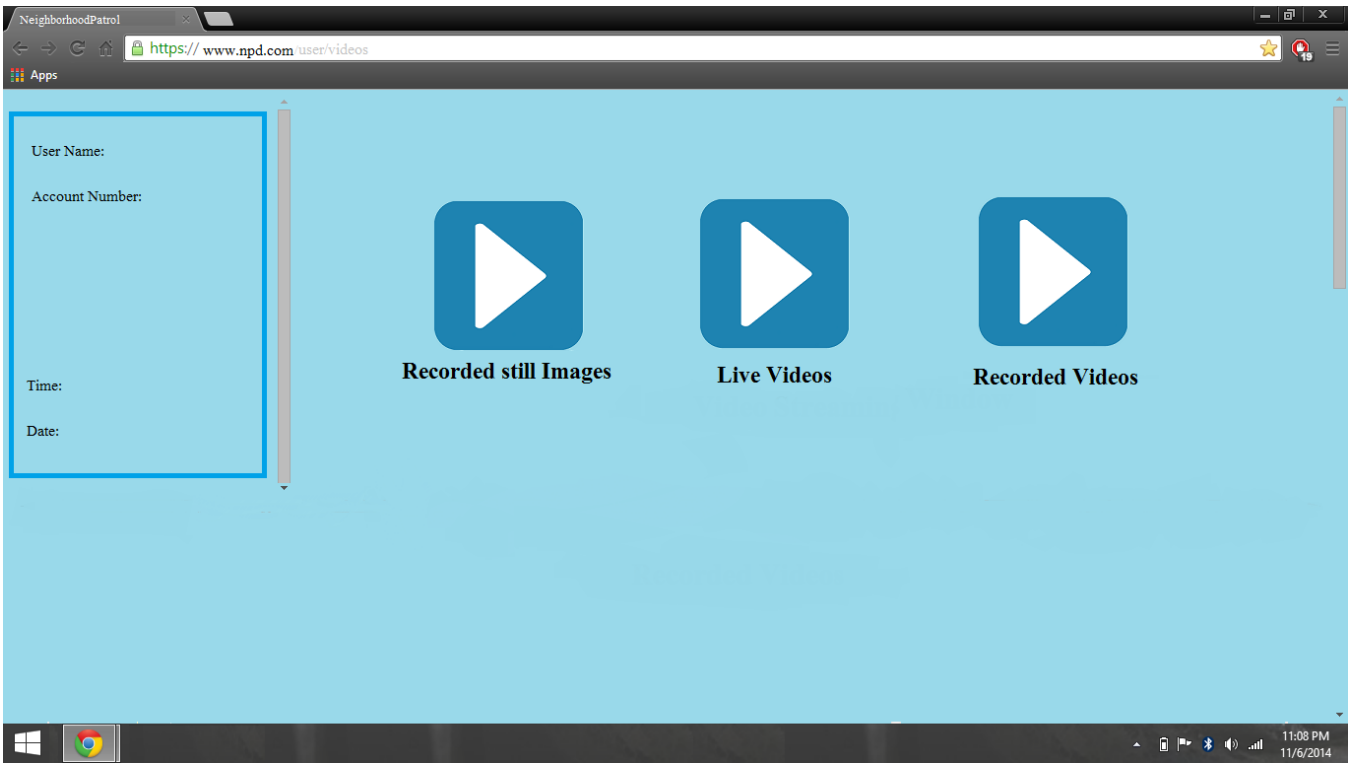


**Fig. 2.7 Web User Account**

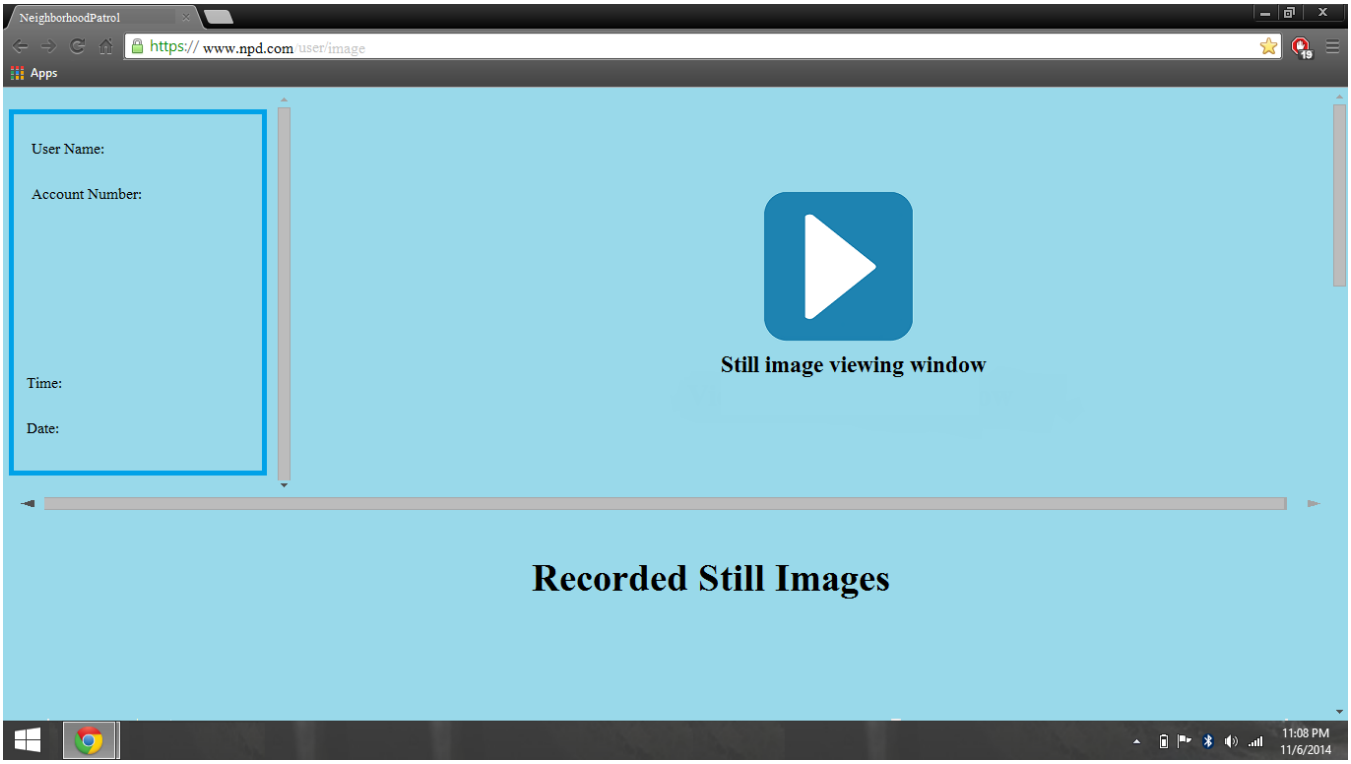


**Fig. 2.8 Web User Still Image view**

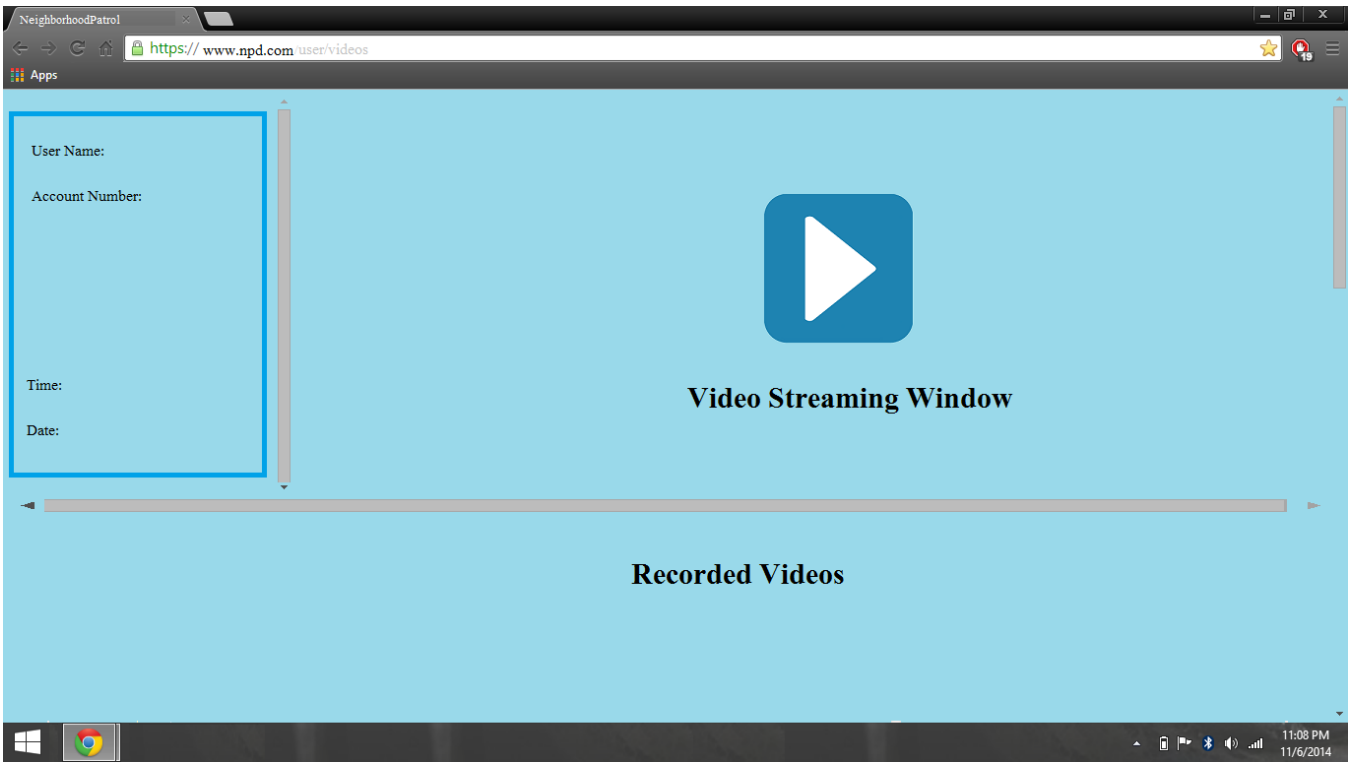


**Fig. 2.9 Web User Video View**

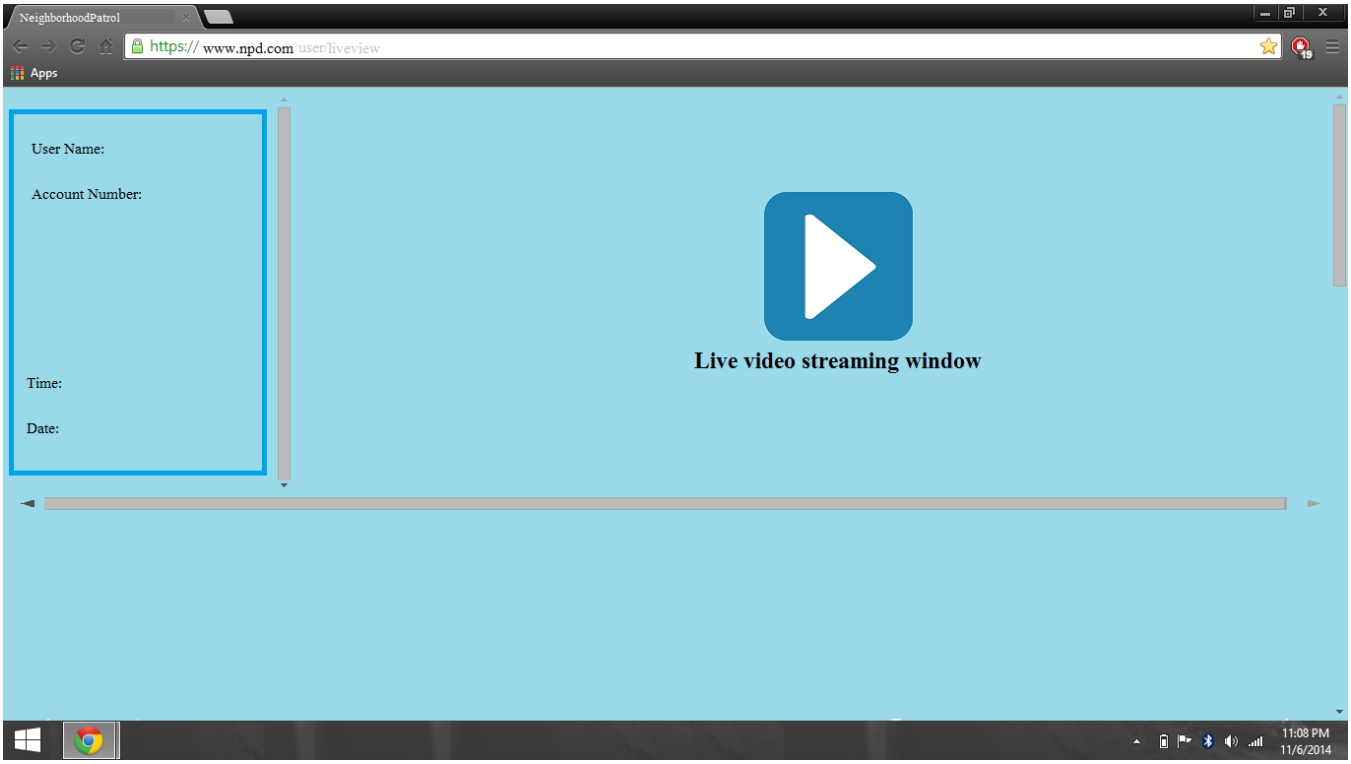


**Fig. 2.10 Web User Live Video View**

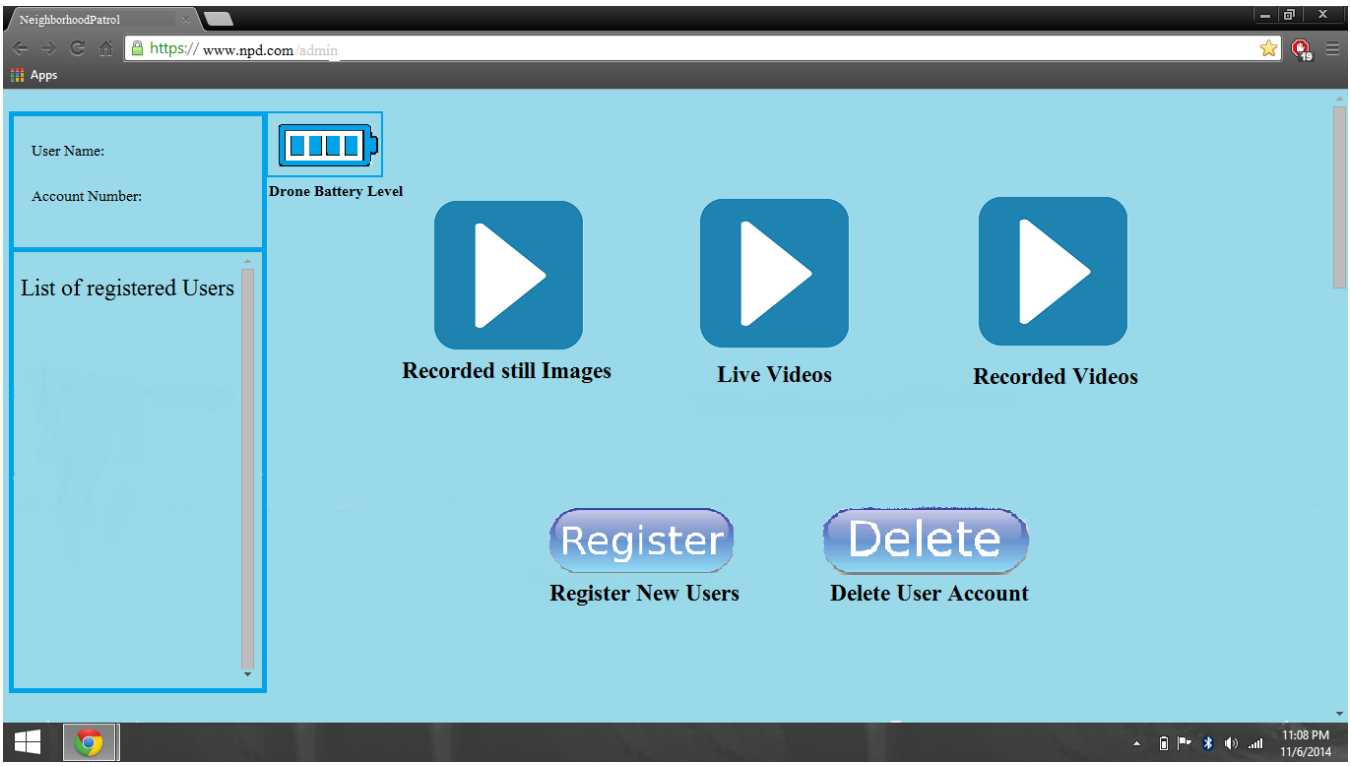


**Fig. 2.11 Web Admin Account**

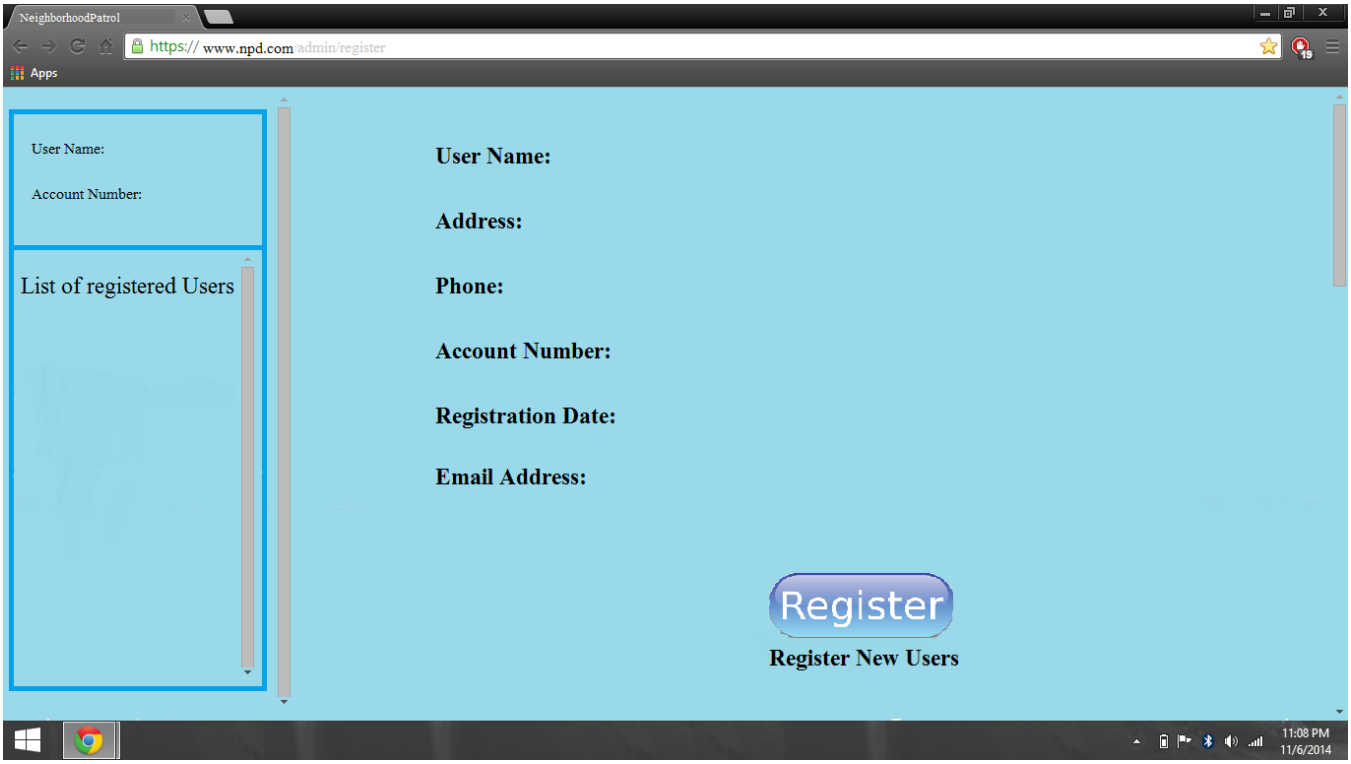


**Fig. 2.12 Web Admin New User Register**

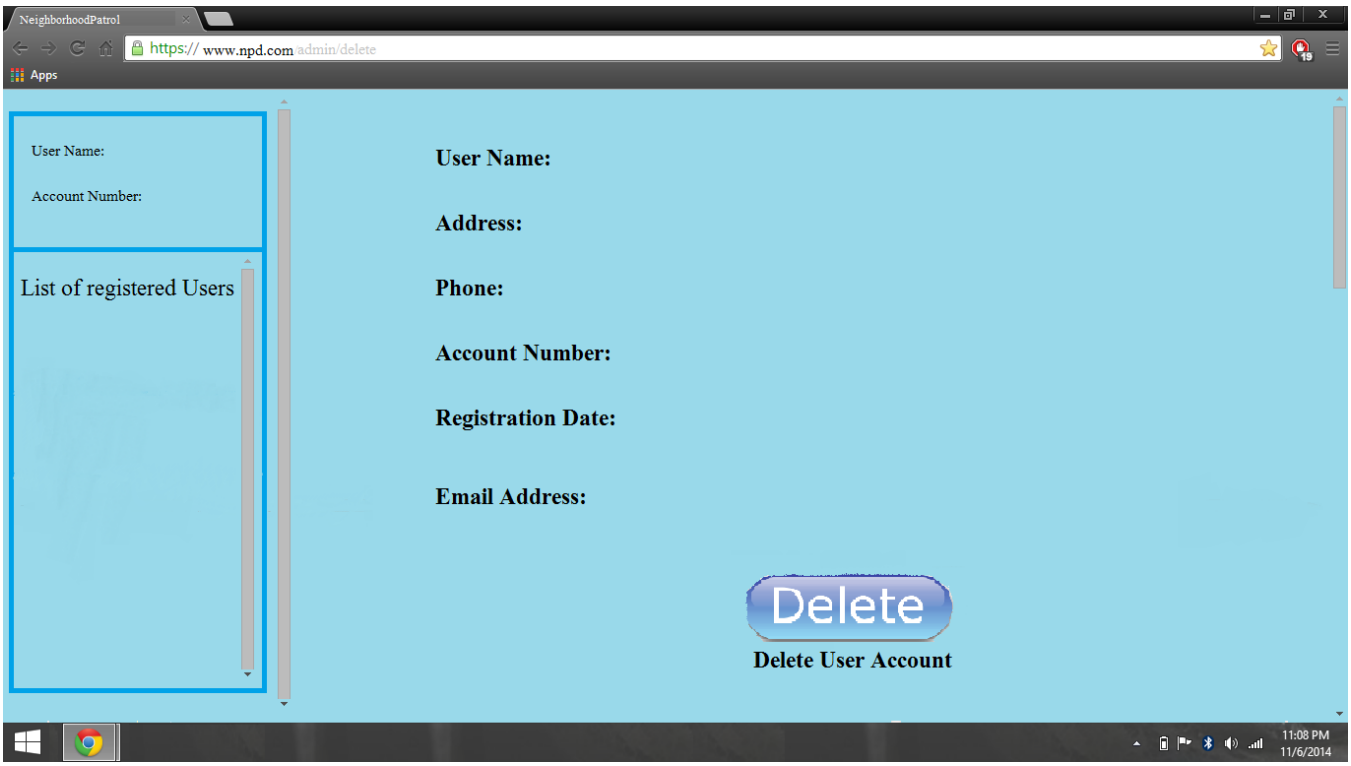


**Fig. 2.13 Web Admin User Account Delete**

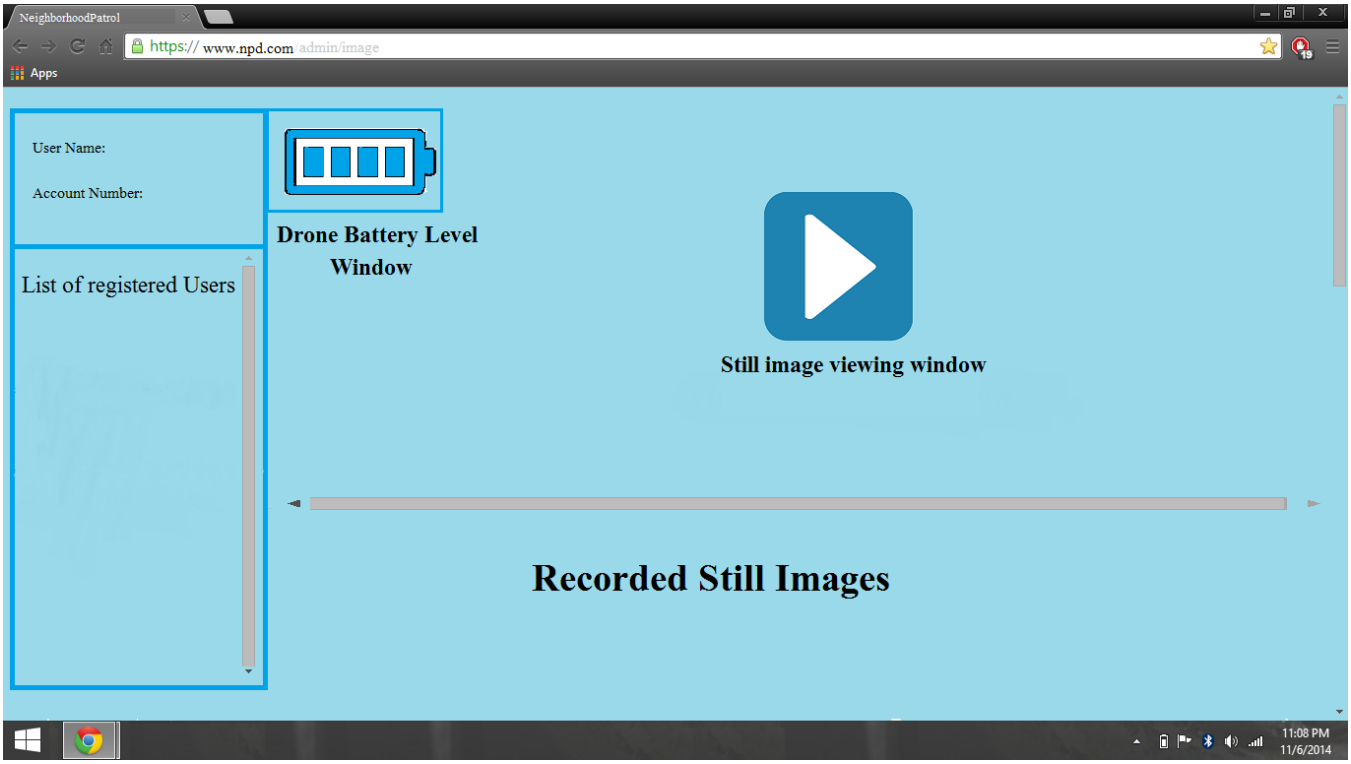


**Fig. 2.14 Web Admin Still Image View**

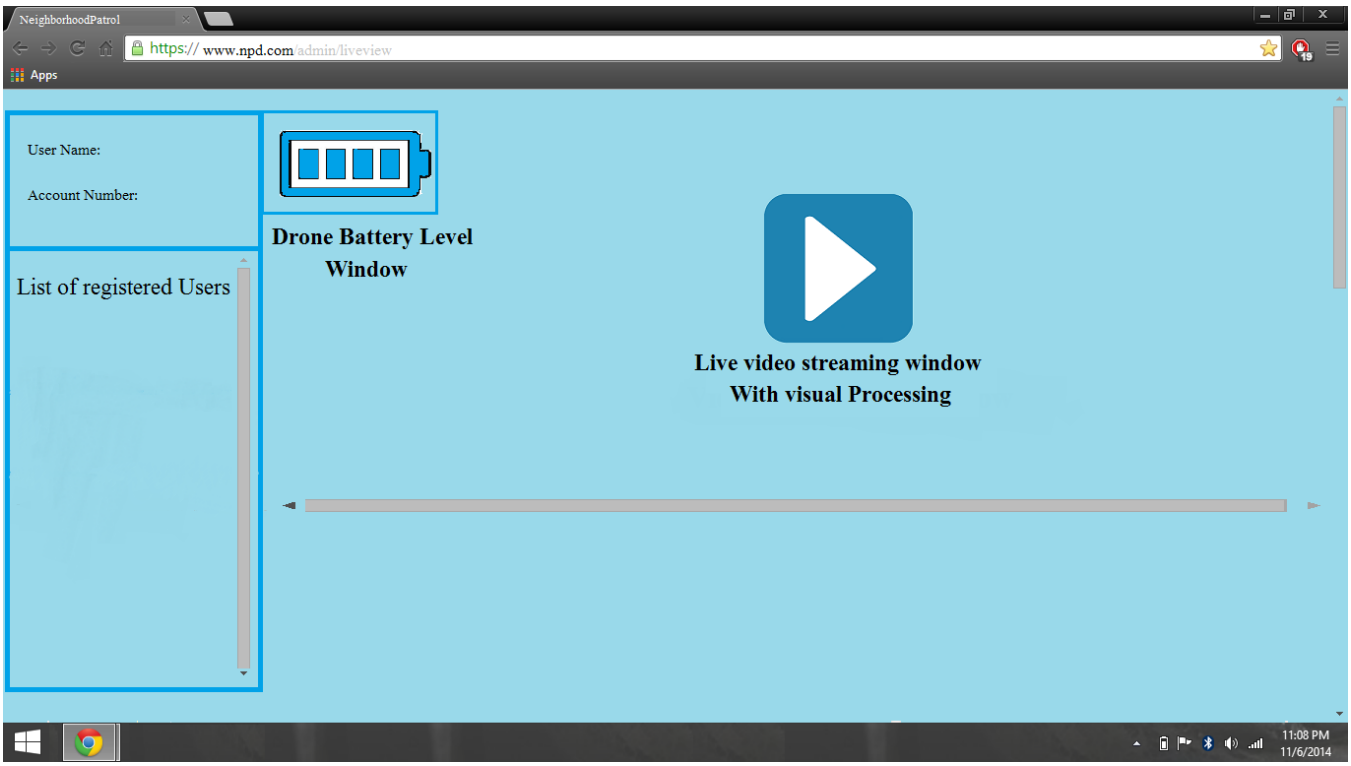


**Fig. 2.15 Web Admin Live Video View**

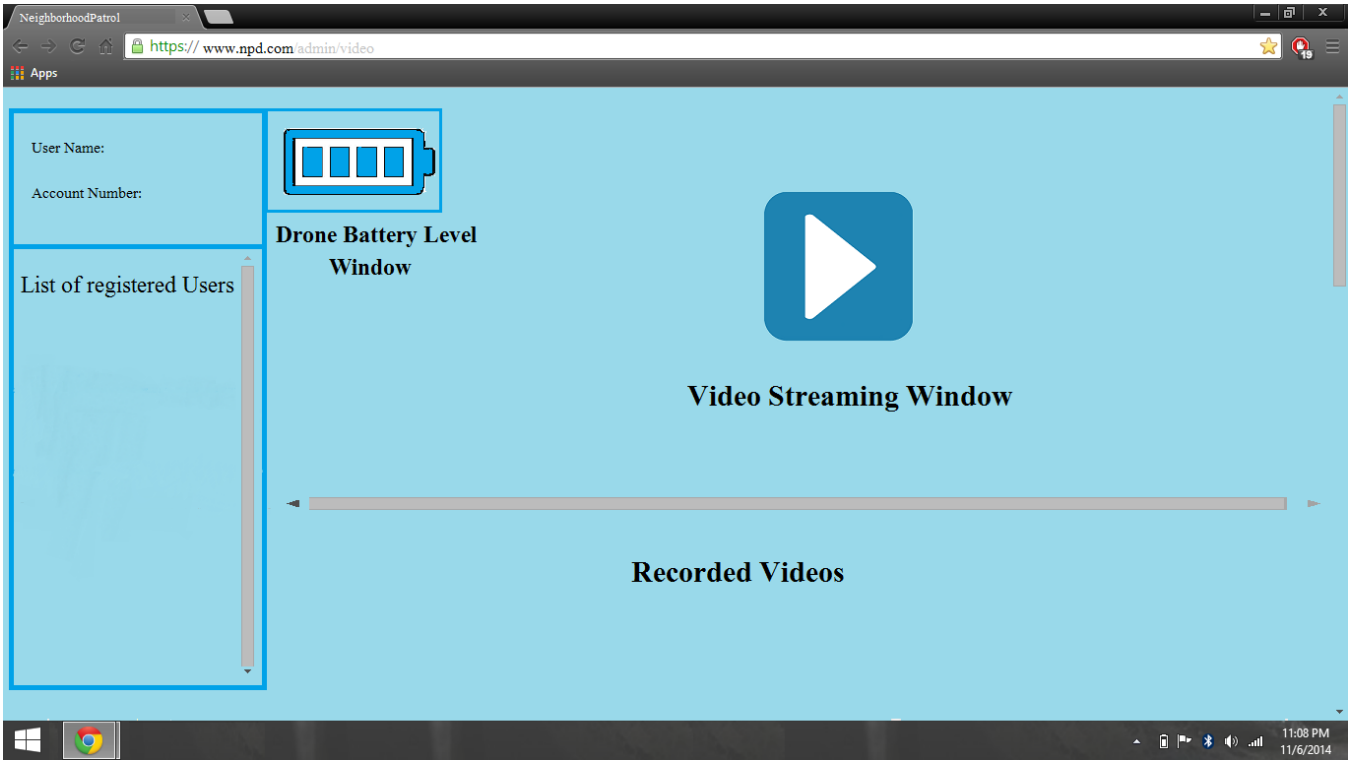


**Fig. 2.16 Web Admin Video View**

# 3. Customer's Requirements

Customer's requirements describe the basic usability, functionality, and structure of the product being developed for the customers. The each member of Team Patrol Crusaders has derived these requirements in collaboration with the sponsor of our project Neighborhood Patrol Drone, MR. Bill Farley. These requirements are presented after extensive research on the project development and requirements presented at our initial brainstorming sessions. These requirements gives end users what the product is and what are its capabilities including the look and feel prospects of the product. Any decisions to change and reform these requirements will be done by consulting and getting the approval from the project sponsor. The requirements are categorized from 1 to 5 based on their priority where 1 means high priority and 5 meaning low priority.

## 3.1 Flight Trajectory and Height

### 3.1.1 Description

The system shall include vehicle that has the ability to fly forward and hover if necessary as directed in a specified trajectory and height. The vehicle shall include a mechanism to fly and land it safely when needed. The vehicle weight should not exceed more than 6 lbs. and be able to hold camera (weight around 2 lbs). The propeller shall be 8" to 12" and easy to fly.

### 3.1.2 Source

Sponsor

### 3.1.3 Constraints

The vehicle may be unstable due to weight and vibration while flying and may lose its track during the flight.

### 3.1.4 Standards

None

### 3.1.5 Priority

1-Critical

## 3.2 Capturing Live Video and images

### 3.2.1 Description

The system shall have camera that records the videos and save it in the database for 5 days and be able to get images from those videos. The system shall give option for the user to view the live streaming videos, recorded videos, and still images through web browsers and Android phone. The streaming should be done in real time. All recorded images and videos will be saved in the databases automatically. The streaming will be done through server from base stations.

### 3.2.2 Source

Sponsor

### 3.2.3 Constraints

Due to limited budget sophisticated camera cannot be used which can capture the high definition image required for the project. The height of the drone and the placement of the camera on the drone itself will be crucial for capturing the image effectively.

### 3.2.4 Standards

The videos and still images should be clear and easy to scan its contents. The camera should be of resolution of at least 11 MP and should have the capability to record video of at least 1080 * 720 pixels if possible.

### 3.2.5 Priority

1 – Critical

## 3.3 Notification System

### 3.3.1 Description

The system shall have a capability to send an email notification and text message to the admin of the system and the users of the system. The system will send out notifications if it senses any irregular activities while in operation.

### 3.3.2 Source

Sponsor

### 3.3.3 Constraints

The user must be a registered into the database by the system administrator with working email address and phone number to receive the notifications and to view images and videos.

### 3.3.4 Standards

None

### 3.3.5 Priority

1- Critical

## 3.4 Human Override Capability

### 3.4.1 Description

The administrator shall be able to override autopilot system of the drone. After doing so, the user can control the drone using a remote control and will have an option to switch back to auto pilot.

### 3.4.2 Source

Sponsor

### 3.4.3 Constraints

Software error or the error in radio transmission may cause a problem while making the switch from autopilot to manual control

### 3.4.4 Standards

The Neighborhood Patrol Drone should be able to switch between auto pilot and human control within 1-2 seconds.

### 3.4.5 Priority

1 - Critical

## 3.5 Energy Detection Capability

### 3.5.1 Description

The Neighborhood Patrol Drone will have a battery level detection system. This is so that when the battery level goes below a specified amount, the Neighborhood Patrol Drone can auto land to prevent it from crashing. The battery level will be monitored by the system constantly. Admin of the system will be able to view battery level through web application and the system will also have a battery level indicator.

### 3.5.2 Source

Patrol Crusaders

### 3.5.3 Constraints

It may be difficult to get correct reading of battery level. Onboard computational resources may limit the frequency of battery level checks.

### 3.5.4 Standards

The battery power or energy level reading error should have tolerance not more than 1%.

### 3.5.5 Priority

2 – High

## 3.6 The Vehicle Detection System

### 3.6.1 Description

The system shall be able to identify vehicles such as mail delivery vehicles, jeeps, cars, bikes, and trucks. The system will have information about the vehicles, mainly dimension of the vehicle which will be saved in the database by system administrator. This data will be used by the drone in order to make distinguish between known and unknown types of vehicles. The comparisons will be done using dimension of the vehicle.

### 3.6.2 Source

Sponsor

### 3.6.3 Constraints

The selection of camera that fits within allocated budget for our project and the program needed to do visual processing may cause difficulties.

### 3.6.4 Standards

None

### 3.6.5 Priority

3 – Moderate

## 3.7 Registration

### 3.7.1 Description

The admin can add new user to the system as a local user who can view live streaming videos, captured still images and videos, and get notification.

### 3.7.2 Source

Patrol Crusaders

### 3.7.3 Constraints

None

### 3.7.4 Standard

None

### 3.7.5 Priority

1 – Critical

## 3.8 Log In/Log Out

### 3.8.1 Description

The admin and user can log into the web application and android application to view the live streaming videos, captured still images and videos.

### 3.8.2 Source

Patrol Crusaders

### 3.8.3 Constraints

Network error may cause problem while login and while processing data from the database.

### 3.8.4 Standard

None

### 3.8.5 Priority

1 – Critical

## 3.9 Battery Power

### 3.9.1 Description

The vehicle must fly for at least half an hour before needing to recharge.

### 3.9.2 Source

Patrol Crusaders

### 3.9.3 Constraints

The cost for the battery needed for high performance may be high, thus choosing a low cost battery may decrease the flight time of the drone.

### 3.9.4 Standard

None

### 3.9.5 Priority

1 – Critical

## 3.10 Solar Energy to Recharge Battery

### 3.10.1 Description

The vehicle shall utilize solar energy to recharge its batteries. Solar panels will be used as an

extra source of energy to recharge drone on board batteries. The system will store excess solar energy in on board backup batteries if the main batteries are fully charged.

### 3.10.2 Source

Sponsor

### 3.10.3 Constraints

The cost of solar panels, inverter, and convertor must be within budget. Adding extra component may increase the weight of the system and may decrease the performance.

### 3.10.4 Standard

None

### 3.10.5 Priority

4 – Low

# 4. Packaging Requirement

This section describes the packaging requirements for the Neighborhood Patrol Drone. There will be two types of users i.e. admin and local user. Admin will be the in charge of the system where as local user can only view videos and pictures. This product includes hardware, software and a user manual which should be delivered to the user. The package will contain a drone, Go-pro camera, rechargeable battery, remote controller, website, an android application, user manual, installation disk, and baseline station. The battery will be included separately in the package to conserve the energy of the battery and to avoid any possible short circuit in the system.

## 4.1 Drone

### 4.1.1 Description

The package shall include pre-assembled drone, Go-pro camera and rechargeable batteries for Go-pro and drone, remote controller. The rechargeable battery will be included separately in the package to conserve the energy of the battery and to avoid any possible short circuit in the system. The weight of the drone will be atleast 6 lb.

### 4.1.2 Source

Patron Crusaders

### 4.1.3 Constraints

None

### 4.1.4 Standards

None

### 4.1.5 Priority

1-Critical

## 4.2 Android Application

### 4.2.1 Description

Android application will be released on the Google Play as a free downloads to watch captured video and pictures for the users.

#### 4.2.2 Source

Patrol Crusaders

#### 4.2.3 Constraints

The application should meet criteria for publishing on the Google Play.

#### 4.2.4 Standards

Google Play standards.

#### 4.2.5 Priority

1 – Critical

## 4.3 Web Application

#### 4.3.1 Description

A website will be created to access videos and pictures captured by the drone for the user.

#### 4.3.2 Source

Patrol Crusaders.

#### 4.3.3 Constraints

Website is not applicable for Internet explorer.

#### 4.3.4 Standard

Firefox and Google Chrome publishing standard.

#### 4.3.5 Priority

1 – Critical

## 4.4 User manual

#### 4.4.1 Description

The final product will have a user manual printed in English. The user manual will include information on how to assemble the device as well as installation software for the system. It will have complete information about the specifications and features of the product.

### 4.4.2 Source

Patrol Crusaders

### 4.4.3 Constraints

The language used to describe how to use the product should be understandable by a novice for our hardware.

### 4.4.4 Standards

Standard U.S. English

### 4.4.5 Priority

1 – Critical

## 4.5 Base station

### 4.5.1 Description

The base station will consists of a computer and a running server which will be used for image processing and broadcasting videos and images to the web and android applications. The base station will also works as a final resting place and charging station for the drone.

### 4.5.2 Source

Patrol Crusaders

### 4.5.3 Constraints

None

### 4.5.4 Standards

None

### 4.5.5 Priority

1 – Critical

## 4.6 Source Code Disk

### 4.6.1 Description

A source code disk will be included in the package. This disk will contain all the source code for the system and digital version of user manual.

### 4.6.2 Source

Patrol Crusaders

### 4.6.3 Constraints

Corrupted disk

### 4.6.4 Standards

None

### 4.6.5 Priority

1 – Critical

## 4.7 Connecting Cables

### 4.7.1 Description

Power cable and Ethernet cable will be included in the final packaging. Their intended purpose is to be used with the central control unit.

### 4.7.2 Source

Patrol Crusaders

### 4.7.3 Constraints

None

### 4.7.4 Standards

NEMA 5–15R power connector, cat5e Ethernet connector

### 4.7.5 Priority

3 – Moderate

# 5. Performance Requirements

The performance requirement is a crucial aspect of any project thus correct documentation process is necessary as it will be used to evaluate the overall functionality of the system. The performance requirements for the Neighborhood Patrol Drone are listed below:

## 5.1 Video/Photo Streaming and Storage

### 5.1.1 Description

System should be able stream uninterrupted video and save captured videos and pictures in databases for five days. Database will have maximum size of 1TB.

### 5.1.2 Source

Patrol Crusaders

### 5.1.3 Constraint

Legal issues involving live video and picture capture. Failure of network may fail to stream video.

### 5.1.4 Standard

None

### 5.1.5 Priority

1- Critical

## 5.2 Video Streaming Latency

### 5.2.1 Description

While streaming live videos there will be a latency of at least 5 seconds.

### 5.2.2 Source

Patrol Crusaders

### 5.2.3 Constraint

Network error may fail video streaming.

### 5.2.4 Standard

None

### 5.2.5 Priority

2 – High

## 5.3 System Response Time

### 5.3.1 Description

The system will have a fast user interface. There will be a delay of maximum 5 seconds.

### 5.3.2 Source

Patrol Crusaders

### 5.3.3 Constraint

Network error may increase system response time.

### 5.3.4 Standard

None

### 5.3.5 Priority

3 - Moderate

# 6. Safety Requirements

The safety is always a concern for anyone who is developing a product for the extensive use purpose. Therefore, the safety requirements of the product shall be notified as they will not be affected by the product while testing and using it. These requirements are usually to control the misuse of the product and any hazard that can occur while testing. It consists of adherence to external and internal standards that may be constraints or limitations of the product as a whole or the part of the product to maintain certain standard and protection to its users. These requirements should be provided in the user manual and also warning labels should be placed in the product packages.

## 6.1 Rotor Blades

### 6.1.1 Description

System will have 4 rotor blades, when in operation it may injure any person or an animal if came in contact.

### 6.1.2 Source

Patrol Crusaders

### 6.1.3 Constraint

Lack of user attention to safety guidelines and attention while operating the system may cause some problem.

### 6.1.4 Standard

None

### 6.1.5 Priority

1 – Critical

## 6.2 Auto Land System Failure

### 6.2.1 Description

The vehicle will be able to auto land when it detects low battery power. But, if an error arises in auto land functionality, the vehicle may crash and hurt someone.

### 6.2.2 Source

Patrol Crusaders

### 6.2.3 Constraint

Failure to perform regular maintenance and update of the vehicle may degrade the functionality of the vehicle.

### 6.2.4 Standard

None

### 6.2.5 Priority

1 – Critical

## 6.3 Drone Speed

### 6.3.1 Description

System should be able to fly with top speed of at least five mph and should be able reduce its speed to zero in order to hover.

### 6.3.2 Source

Patrol Crusader

### 6.3.3 Constraint

Failure in vehicle’s component (rotor blades) and software error may limit vehicle from performing to its full capacity.

### 6.3.4 Standard

None

#### 6.3.5 Priority

1 – Critical

## 6.4 Drone Height

#### 6.4.1 Description

The maximum flying height of the drone will not exceed 30 feet and the lowest will be 20 feet.

#### 6.4.2 Source

Project Supervisor (Dr. Odell)

#### 6.4.3 Constraint

None

#### 6.4.4 Standard

None

#### 6.4.5 Priority

1 – Critical

## 6.5 Safety Guide

#### 6.5.1 Description

Safety guide will be provided, which will have detail description of safety measurements that needs to be followed while operating the drone.

#### 6.5.2 Source

Project Supervisor (Dr. Odell)

#### 6.5.3 Constraint

None

### 6.5.4 Standard

None

### 6.5.5 Priority

2 – High

## 6.6 Error in GPS reception

### 6.6.1 Description

While flying, if the system loses its GPS reception, the system will auto land. And the system will notify the system administrator with its last known location so as to ease the manual retrieve process.

### 6.6.2 Source

Patrol Crusaders

### 6.6.3 Constraint

Network error may cause problem while transmitting notification to system administrator.

### 6.6.4 Standard

None

### 6.6.5 Priority

2 - High

# 7. Maintenance and Support Requirements

Every product needs to be maintained during its lifetime, since our product is complex it will require extensive maintenance and support in order to keep the system running to its full capacity. The only possible thing that can be done to keep it working properly is to provide continued maintenance and support. Since, this product comprises of both hardware and software components like drone, cameras, web page, Android app which needs to be maintained and checked during the time frame of products' use. The following requirements have been identified as the possible solution for the effortless maintenance of the system.

## 7.1 Patrol Crusaders shall fix software errors

### 7.1.1 Description

Software error in both surveillance system and in drone may surface during the time frame of drone operation. Patrol Crusaders will provide CD-ROM which will have software to fix any software error and return system to original setting.

### 7.1.2 Source

Patrol Crusaders

### 7.1.3 Constraint

Software debugging period expires on May 31, 2015.

### 7.1.4 Standard

None

### 7.1.5 Priority

2 - High

## 7.2 Patrol Crusaders shall fix all hardware failure

### 7.2.1 Description

Some hardware may fail during the period of system use. Patrol crusaders will provide all required documents which will have information about maintenance of the system.

### 7.2.2 Source

Patrol Crusaders

### 7.2.3 Constraint

Onsite maintenance period expires on May 31, 2015.

### 7.2.4 Standard

None

### 7.2.5 Priority

2 - High

## 7.3 Troubleshooting Guide

### 7.3.1 Description

The team will provide all the details of system configuration and maintenance procedure to the user as a CD ROM disk and written troubleshooting guide. It will consist of all the required material for hardware reconfiguration and software reconfiguration. The data recovery procedure is also provided in a guide if any data loss occurred during the products usage.

### 7.3.2 Source

Patrol Crusaders

### 7.3.3 Constraint

CD may be corrupted and written guide will not be in other languages except US English.

### 7.3.4 Standard

None

### 7.3.5 Priority

1 - Critical

# 8. Other Requirements

This section defines additional optional requirements that are provided by our sponsors and by the team for the completion of the project.

## 8.1 System Operation

### 8.1.1 Description

In order to operate the system, some legal issues need to be taken into consideration that is why the system will not be operated outside specified area.

### 8.1.2 Source

Sponsor

### 8.1.3 Constraint

After handing over the system to the customers, Patrol Crusaders will not be able to monitor how the system will be used.

### 8.1.4 Standard

None

### 8.1.5 Priority

1 – Critical

## 8.2 Documentation

### 8.2.1 Description

All documents and measurements shall be done in U.S. standard.

### 8.2.2 Source

Patrol Crusaders

### 8.2.3 Constraint

Contents in any document related to the project shall be written clearly for everyone to understand.

### 8.2.4 Standard

None

### 8.2.5 Priority

3 – Moderate

## 8.3 Water Proofing

### 8.3.1 Description

The vehicle shall be prevented from water in order to prevent from damaging its components. The water proofing is to ensure that the vehicle can be brought back to the base station if it is raining.

### 8.3.2 Source

Patrol Crusaders

### 8.3.3 Constraint

Budget for waterproofing must be within project budget range.

### 8.3.4 Standard

None

### 8.3.5 Priority

2 – High

## 8.4 OS Support

### 8.4.1 Description

The user interface software shall be designed to run on windows and android applications.

### 8.4.2 Source

Patrol Crusaders

### 8.4.3 Constraint

The application shall have Android application standard and regular web application standard.

### 8.4.4 Standard

None

### 8.4.5 Priority

2 – High

## 8.5 Initial Set Up

### 8.5.1 Description

System will be preassembled. User will only need to download application for phone and download surveillance software in the computer and go through provided user manual to use the system. To access the system through web or android application, user must login using login information provided by the patrol crusader or the system administrator.

### 8.5.2 Source

Patrol Crusaders

### 8.5.3 Constraint

Error in the system database or the lack of network may barge users from login and accessing the system through web or android application.

### 8.5.4 Standard

None

### 8.5.5 Priority

2 **–** High

## 8.6 FAA Regulation

### 8.6.1 Description

To operate drone lawfully, user will have to obtain permission from FAA.

### 8.6.2 Source

Patrol Crusaders

### 8.6.3 Constraint

Unable to acquire the permission from FAA.

### 8.6.4 Standard

None

### 8.6.5 Priority

1- Critical

# 9. Acceptance Criteria

Acceptance criteria are the specific requirements that must be demonstrated to the sponsor and the customers' as they are the ones who are using the product. In this section the specified requirements are listed which are must for the product in order to be accepted by the sponsor Mr. Bill Farley.

## 9.1 Verify that the system will fly in a given trajectory and height

### 9.1.1 Requirement(s) addressed

Requirement 3.1 "The system should fly in a given trajectory and height": The system should be able to fly in the given path and height as given by the administrator.

### 9.1.2 Verification Procedure

After the completion of flight of the vehicle, the customers will inspect the actual flight path and compare it with given flight path.

## 9.2 Verify that the system will stream live videos and recorded videos and still images

### 9.2.1 Requirement(s) addressed

Requirement 3.2 "The system should be able to stream videos in the web or Android devices and save in the database": During the flight period the system will record videos and stream it to the web or Android app and will save it to a database.

### 9.2.1 Verification Procedure

The customers will check the videos using android app and web and will also check the recorded video and images from the database.

## 9.3 Verify that the system can send notification to the user

### 9.3.1 Requirement(s) addressed

Requirement 3.3 “The system shall send message through email and text”: The system will send out email and text to the customers if the system senses any irregular activities during surveillance.

### 9.3.2 Verification Procedure

The system will be provided with an incident during its surveillance period so as to show customers the functionality of the system.

## 9.4 Verify that the system can be controlled by human operator if required

### 9.4.1 Requirement(s) addressed

Requirement 3.4 “Human control for Automatic pilot overriding”: The system will have a human override functionality which will be used to manually control the vehicle or stop it operations.

### 9.4.2 Verification Procedure

The customers will be given a remote control using which the vehicle will be controlled manually. The customers will be shown a demonstration that will showcase the switch between autopilot and manual control of the vehicle.

## 9.5 Verify that the system will be able to detect battery level

### 9.5.1 Requirement(s) addressed

Requirement 3.5 “Energy detection system”: The system will be able to sense its battery level and will auto land when the battery level is critical.

### 9.5.2 Verification Procedure

The system will keep on flying until the battery level drops to critical level and will safely auto land.

## 9.6 Verify that the system is able to detect foreign vehicle

### 9.6.1 Requirement(s) addressed

Requirement 3.6 “Vehicle detection system”: The system will be able to detect vehicles which are unknown to the system.

### 9.6.2 Verification Procedure

The system will be introduced with an unknown vehicle and the system will send warning message to the customers.

## 9.7 Verify that the system is able to register new users

### 9.7.1 Requirement(s) addressed

Requirement 3.7 “Registration”: The system will be able to register new users when needed.

### 9.7.2 Verification Procedure

The customers will be added as a new user. The customers will get notification that they are added to the system.

## 9.8 Verify that the Log In/Out can be done in the system by its current users

### 9.8.1 Requirement(s) addressed

Requirement 3.8 “Log In/Out”: The system shall provide feature for user to log in and watch streamed videos and captured images.

### 9.8.2Verification Procedure

The customers will be shown asked to log in to their current account or demo account and watch the live videos and captured images.

## 9.9 Verify that the vehicle is able to fly for half an hour without recharging the battery

### 9.9.1 Requirement(s) addressed

Requirement 3.9 “Battery Power”: The system shall fly for half an hour without replacing current battery or any power supply unit.

### 9.9.2 Verification Procedure

The vehicle will be flown for an hour to show customers that the battery replacement is not needed before half an hour.

## 9.10 Verify that the system is functioning normally

### 9.10.1 Requirement(s) addressed

Performance Requirement: “The system flies in the speed as indicated”, captures videos and images as mentioned.

### 9.10.2Verification Procedure

The customers will be shown the demo of the system operation.

# 10. Use Cases

A use case is a written description of how user will perform tasks on the Neighborhood Patrol Drone. It will explain how the system should behave and its process. Each use case is represented as a sequence of simple steps beginning with a user's goal and ending with that goal is fulfilled. TUCBW is the abbreviation of this use case being with and TUCEW is the abbreviation of this use case end with. The users are mentioned as admin and user whereas admin is an abbreviation for administrator who is in control of all the major operation involved in the system and user can view the streaming videos and images from web application or android application.

## 10.1 Flying drone

### 10.1.1 Scenario

The admin sets the specific height and trajectory for a drone to fly.

### 10.1.2 Actor

Admin.

### 10.1.2 TUCBW

The Admin clicks on set parameter for drone's flight.

### 10.1.3 TUCEW

The admin sees the drone flying on the specified height and trajectory.

## 10.2 Log Out

### 10.2.1 Scenario

The Admin/User clicks on the "Log out" button on the home page after he is done with viewing account.

### 10.2.2 Actor

Admin/ User.

### 10.2.3 TUCBW

User clicks on the “log out” button on the page

### 10.2.4 TUCEW

User views the confirmation message that they are logged out of their account.

## 10.3 Capture videos and stream

### 10.3.1 Scenario

Admin sets the camera timer “ON” to capture the picture as the drone starts flying. The streaming starts as soon as the camera starts to capture the videos. Users will be able to see the live streams.

### 10.3.2 Actor(s)

Admin.

### 10.3.3 TUCBW

The admin click on the capture “button” on the camera attached to the drone.

### 10.3.4 TUCEW

The admin/ user sees the video streaming in their logged in account page.

## 10.4 Energy Detection

### 10.4.1 Scenario

Admin sees the flashing red light on the remote controller and drone, then admin takes over the control of drone by remote controller. The admin can see energy level warning notification on their screen of web application and android app.

### 10.4.2 Actor(s)

Admin.

### 10.4.3 TUCBW

The admin sees the flashing red light on the drone and remote control and low battery power low notification in their web application and android app.

### 10.4.4 TUCEW

The admin sees the green light flashing on the remote and drone and battery power increased or charged message in the screen.

## 10.5 Human Override/ Flight Control

### 10.5.1 Scenario

Admin can take charge of the drone and control the drone using remote control at any moment.

### 10.5.2 Actor(s)

Admin.

### 10.5.3 TUCBW

The admin clicks on the ‘control” button on the remote control.

### 10.5.4 TUCEW

The admin takes the control of the drone.

## 10.6 Log In

### 10.6.1 Scenario

To view the captured video and picture user has to log in to the system of the Android application or the website.

### 10.6.2 Actor(s)

Admin/ User.

### 10.6.3 TUCBW

The Admin /user log into the system using their email address and log out pressing log out button in their account page.

### 10.6.4 TUCEW

The admin/user sees their account page.

## 10.7 User Registration

### 10.7.1 Scenario

The admin can open new account for controlling the data flow of the system and get notifications. The user account can only be registered by the administrator using their email address.

### 10.7.2 Actor(s)

Admin.

### 10.7.3 TUCBW

The admin clicks on the register new user button in web page and Android application.

### 10.7.4 TUCEW

The admin sees the confirmation message “New user added and emailed the information to user”.

## System: Neighborhood Patrol Drone

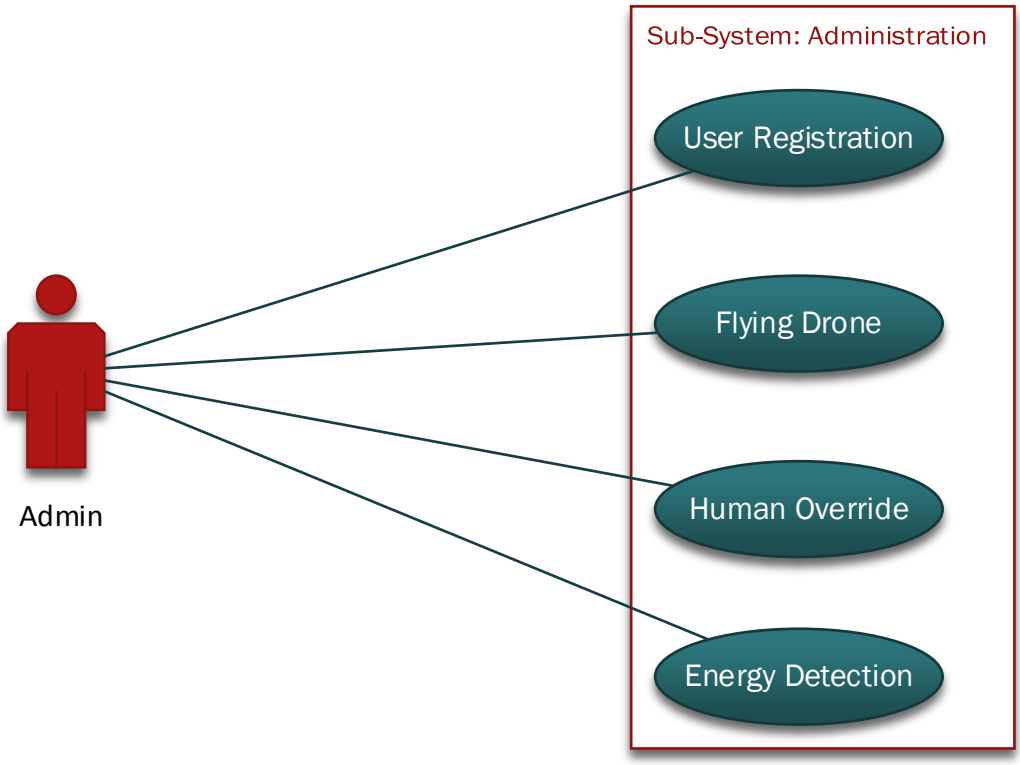


**Fig. 10.1 Use Case Diagram (1)**

# System: Neighborhood Patrol Drone

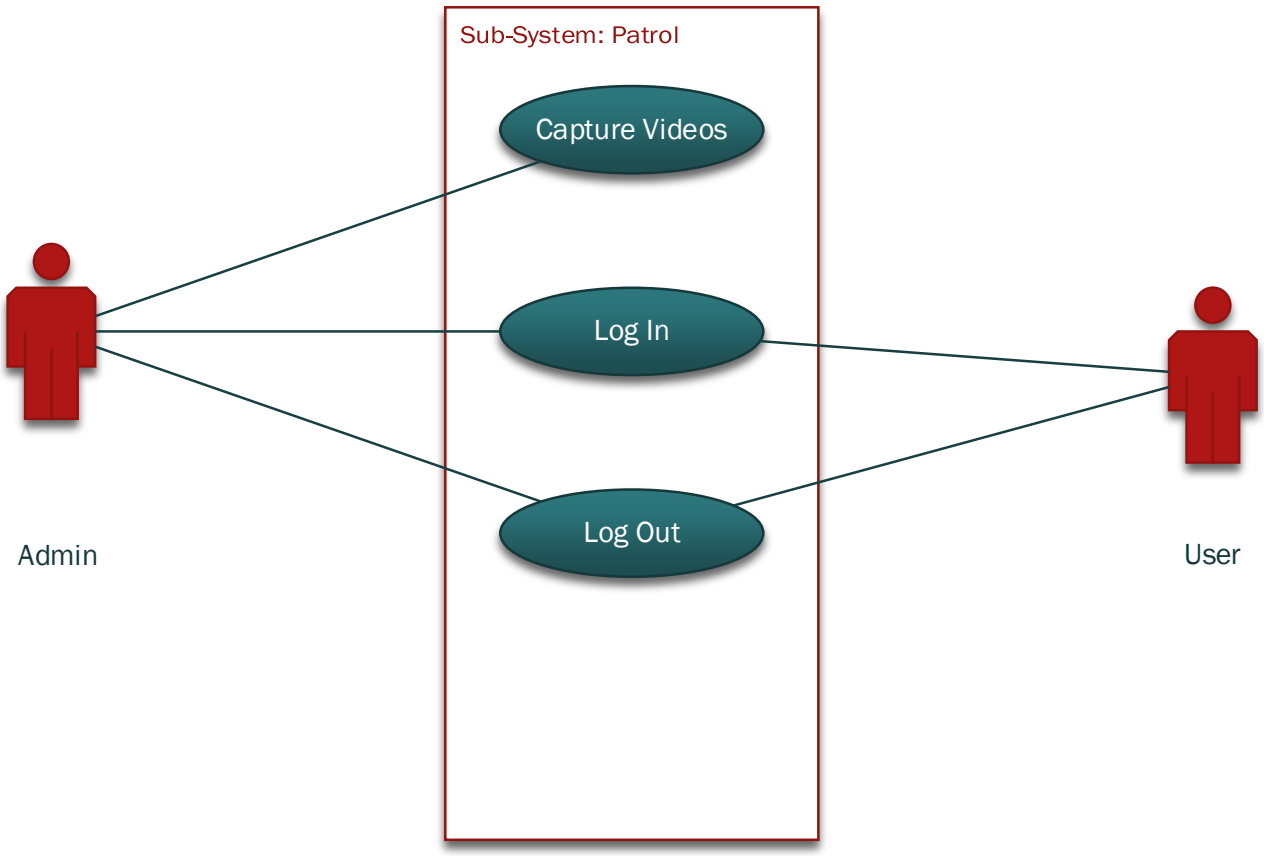


**Fig. 10.2 Use Case Diagram (2)**

# 11. Feasibility Assessment

This section is for evaluating the feasibility of the Neighborhood Patrol Drone. We are in the beginning phase of the product development so this assessment is based on the judgment, knowledge, experiences and research ability of the Patrol Crusaders. Thus, the assessment is made based on the following components: scope analysis, research analysis, cost analysis, resource analysis, and schedule analysis. These components will determine the feasibility of the product as it could be completely developed and delivered on the given time frame of the project.

## 11.1 Scope Analysis

Our team will create a Neighborhood Patrol Drone which will be able to fly in a predefined path and height. The system will stream live videos through web and Android application and will save the videos in a database as well. Beside recording video the system will be able to take still pictures too. The system will have extra functionalities like vehicle detection, human override; send notifications to the administrator and the user. The product is unique and very demanding whereas it could set the tone of future surveillance system. Our research of the few previous projects that involved drone shows the project is doable for the selected requirements.

We have identified critical requirement that needs to be completed for our system to function properly. We have some requirements which we identified as low priority which will not affect the overall functionality of the system. We expect to implement most of the high priority requirements and the low priority requirements are saved for the future implementation. The majority of the work load of our project will be amounted to these four requirements:

- Customers' requirement 3.1 Flight Trajectory and Height.
- Customers requirement 3.4 Notification System
- Customers' requirement 3.5 Human Override Capability.
- Customers requirement 3.7 The Vehicle Detection System.

## 11.2 Research

For this project our team has already started doing research regarding hardware and software that will be used to complete this project. Our research on visual processing technology and hardware components showed that the project is feasible and will be practical for the listed customers' requirements as stated in section 11.1. While studying about other projects which

include drone and surveillance systems we acknowledged that the legal issues could play vital role. Our research has showed that the visual processing requires OpenCv, which is an open source that is used for processing images. Our team also visited UTA's drone lab and gained extra perspective about our project which helped us narrow down our requirements further and distinguish doable and enjoyable requirements. The hardware research is still ongoing as we are searching required parts necessary to assemble the drone. The basic hardware components are drone and controller. The research we conducted showed that using prebuilt controllers is more applicable and feasible than building one. During our study of the projects scope and feasibility we roughly estimated the cost of the project as presented in section 11.4.

## 11.3 Technical Analysis

Since our project involves drone technology which is new to us, it requires extensive research in both software and hardware. The technology required in our project involves high level programming skills and hardware integrating knowledge. For software development we will be using OpenCv for visual processing which will be done in C++ language or python, python for networking and we are planning to use assembly language for our low level programming. For hardware we will be using autopilot module which will have built-in software for flight of the drone. The web development will be completed using html, PHP, and JavaScript programming languages and mobile app development will involve java programming language.

## 11.4 Cost Analysis

Total budget allocated for project is $800 after the initial research our team has found that the allocated budget will be enough. Majority of our cost will be hardware related as software will be developed by our team. Our major cost being the flight control module at $300. All other hardware component will be cheaper and under budget.

| Description | Cost |
|---|---|
| Flight Control Module | $300.00 |
| Video Camera | $150.00 |
| Still Camera | $100.00 |
| Web Hosting | $15.00 |
| Android App. Publishing | $25.00 |
| Solar Panel and converter | $110.00 |
| Other components | $100.00 |
| **Total** | **$800** |

**Table 11.1 Cost Analysis**

## 11.5 Resource Analysis

As mentioned in sections 11.1, 11.2, and 11.3 the project must be applicable and feasible for the users therefore the components being used play vital roles. The resources play vital parts in a success of a project. As we studied the project and analyze the requirements the resources we need to complete this project is categorized in two components.

a) Hardware resources: Drone parts, controller, laptop and Android phone for testing.

b) Software resources: Java programming language, embedded C, C++, and html programming language, assembly language, python, PHP programming language, and OpenCV.

As regards to the hardware components we will buy parts required to build a drone and

controller, and assemble it. We will use our own laptop and Android phone for testing the web app and Android application.

The toughest part of our assignment is assembling the drone for which we are consulting experienced colleague Mr. Clinton and online tutorials. Most of the software resources are available and we have some knowledge as well as experience of working with them. Only one OpenCV is completely new to us and which is required for image processing. Therefore, we are doing online research and also attending a class for tutorials. Our study is still in course and progressing as we expected. The manpower we have for our project is as follows: two software engineer, one computer scientist and one computer engineering.

## 11.6 Schedule Analysis

The delivery of the product on given time frame is must for any developers like Patrol Crusaders. The development of the product can be done on time if the production team can evaluate and estimate required effort, and the complexity of the job that needs to be done. The recent workload has helped us to determine the estimation and will be using the methods like calculating functional points to determine the schedule estimation.

**Size Estimates**

The size of the project was determined using function point estimation and the table below will outline the function point estimation performed on our project:

| Program Characteristic | Low Complexity | Medium Complexity | High Complexity |
|---|---|---|---|
| Number of inputs | **4** x 3= **12** | **3** x 4 = **12** | **2** x 6 = **12** |
| Number of outputs | **3** x 4 = **12** | **4** x 5 = **20** | **1** x 7 = **7** |
| Inquiries | **4** x 3 = **12** | **2** x 4 = **8** | **1** x 6 = **6** |
| Logical internal files | **4** x 7 = **28** | **2** x 10 = **20** | **1** x 15 = **15** |
| External interface files | **5** x 5 = **25** | **2** x 7 = **14** | **1** x 10 = **10** |
| Unadjusted function-point total | | | **213** |
| Influence multiplier | | | **1.03** |
| Adjusted function-point total | | | **219.39** |

**Table 11.2 Function Point Estimation**

The bold numbers indicate the number of function points and then they are multiplied by a function multiplier determined by using *McConnell's table 8-2.

The “lines of code” method was used to estimate the size of the project. Since we are very new to estimating and lack of experience about projecting the amount of a code required, we used ballpark estimation to estimate approximate value. Therefore, we estimated that the size of the project will have 15,000 lines of code. This estimation is based on our study and analysis of the required components of the system, the size of the GUI application, Android application, image processing, networking, and estimated required size of hardware and software parts.

Each characteristics are assigned based on degree of their influence where 0 being low and 5 being high.

| **Characteristics** | **Degree of Influence (0-5)** |
|---|---|
| Data Communications | 2 |
| Distributed Data Processing | 2 |
| Performance | 4 |
| Heavily Used Configuration | 3 |
| Transaction Rate | 3 |
| Online Data Entry | 3 |
| End User Efficiency | 2 |
| Online Update | 2 |
| Complex Processing | 4 |
| Reusability | 2 |
| Installation Ease | 3 |
| Operation Ease | 3 |
| Multiple Sites | 2 |
| Facilitate Change | 3 |
| **Total** | **38** |
| **Value Adjustment Factor** | **1.03** |

**Table 11.3 Influence Multipliers**

To achieve the Value Adjustment Factor, we have used the following formula:

VAF = (38*.01) + .65=1.03

This will help us estimate the Jones First Order to the best of our ability.

Duration = 219.39^0.39 =8.2 months (Best Case)

| Best Case | Average Case | Worst Case |
|---|---|---|
| 219.39^.39 | 219.39^.42 | 219.39^.45 |
| 8.2 Calendar Months | 9.6 Calendar Months | 11.3 Calendar Months |

**Table 11.4 Duration table**

To determine the amount of effort or man-months required for this project, we also used our lines of code estimate along with *McConnell's tables 8-8 through 8-10. Using Table 8-8 titled "Shortest Possible Schedules", it was determined from 15,000 lines of code for the "Systems Product" that it would take 40 man-months to complete the project. We have 4 members on the team which works out to 10 total months to complete the project which is more than our project time of 8 man months. As we began the project on September 8, 2014 and our deadline to finish is May 10, 2014, which is more than 8 months, but it is not enough as the study showed it will take 10 months to complete the project.

**Effort Estimates**

To determine the amount of effort or man-months required for this project, we used our lines of code estimate along with *McConnell's tables 8-8 through 8-10. Using Table 8-8 titled "Shortest Possible Schedules", it was determined from 15,000 lines of code for a "Systems Product" that it would take 40 man-months to complete the project. We have 4 members on the team which works out to 10 total months to complete the project which is 2 months more than specified for our project. We began the project on September 08, 2014 and our deadline to finish is May 12, 2014, which is 8 months. Therefore, making small changes in the schedule can't make up for the required 2 extra months. Thus, it will be very difficult for us to complete all the requirements as specified therefore we will complete all the critical requirements during first prototype development phase of the project.

**Schedule Estimates**

The first method used to estimate the schedule for the project was Equation 8-1 from *McConnell's book. The equation is **schedule in months = 3.0 * man-months^1/3**. As our calculation showed it will takes us **25 man-months** to complete the project, which is about **8.78 months.** This is beyond our schedule as our project is for 8 months. Thus, this is not a good estimate for our project.

In the second schedule estimate, Jones First-Order Estimation practice was used as indicated in Table 8-7 of *McConnell. For this project the function point calculation is **109** and for the "Best" case for a "Systems" product, for a "Shrink-Wrap" product, the schedule turns out to be **8.2 months.** If we adjust here and there during implementation the project can be completed under the given duration of the project.

The third and final method used to determine the schedule estimate was *McConnell's table 8-8. It shows that for the project that consists of 15,000 lines of code it will take **7 calendar months** to complete. If we compare this estimate with the best case for Jones First-Order

Estimation, the schedule comes out to **7.9 calendar months**. This sounds near to our initial estimate of the project. This estimate is based on all of the requirements being met that are critical and high priority for the project.

The summary of the estimates for the project is shown below:

| **Method Used** | **Function Point** | **Lines Of Code** | **McConnell Table 8-8** | **McConnell Equation 8-1** | **Jones First-Order** |
|---|---|---|---|---|---|
| **Size Estimate** | 219.39 | 15,000 | | | |
| **Effort Estimate** | | | 40 Man months | | |
| **Schedule Estimate** | | | 7 calendar months | 8.78 calendar months | 8.2 calendar months |

**Table 11.5 Estimation Method and Results**

*McConnell = A reference to the book “Rapid Development” by Steven McConnell

Our schedule analysis showed that the project is feasible and can be completed within the time frame by implementing the critical and high priority requirements during the initial development phase which is about 8 months. Finally, the project can be developed in the given timeframe.

# 12. Future Items

In this last section, Customer Requirements that are listed as future priorities will be discussed and elaborated on as to why these requirements will not be available when the product is released for the first time.

## 12.1 License Plate Recognition

### 12.1.1 Requirement Description

The system should capture the image of the license plates of the vehicle passing by and compare it in the database and notify if the vehicle is unregistered to the database. The system shall notify the customers or administrator.

### 12.1.2 Constraint

The process is very complex and the time frame of the project is very small. The required tools and programming knowledge are very high level and seems out of scope of undergraduate level students. The cost for the equipment is very high just to capture the image of license plate and the programming is very big area to learn and implement in the given time frame of the project.

## 12.2 Various OS Support

### 12.2.1 Requirement Description

The system shall be able to support various OS like Mac, Linux, IOS, etc.

### 12.2.2 Constraint

Small time frame of the project and high level of research and study is required.

## 12.3 Foreign Object Identification

### 12.3.1 Requirement Description

The system shall have intelligence to recognize the items that it captures using cameras like

guns, human beings, animals, trees, houses, etc. The system should be able to compare new items with the objects present in its database and notify if item is dangerous and save if not present in database.

### 12.3.2 Constraint

The onboard comparisons may be difficult due to the small size of a drone. The short duration of the project and the need of high level technical knowledge contradict each other as other critical requirements implementation must be done during the given project time frame.

## 12.4 Night Time Surveillance

### 12.4.1 Requirement Description

The system shall be able to function properly at night and capture images and videos using night vision cameras.

### 12.4.2 Constraint

Lack of time and budget as it requires night vision cameras or infrared and heat map detector for functioning.