People Counting Using Surveillance Drone

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CERTIFICATE OF CORRECTIONS & APPROVAL

Certified that work contained in this thesis titled "**People Counting Using Surveillance Drone**", carried out by **Muhammad Umair Ahmad Khan, Syed Hassan Mujtaba Sherazi, Umar Farooq and Atif Ali Hafeez** under the supervision of **Dr Ayesha Maqbool** for partial fulfillment of Degree of Bachelors of Software Engineering, in Military College of Signals, National University of Sciences and Technology, Islamabad during the academic year 2019-2020 is correct and approved. The material that has been used from other sources it has been properly acknowledged / referred.

Approved by

Supervisor

Dr. Ayesha Maqbool

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DEDICATION

In the name of Almighty ALLAH, the most beneficent to our folks, without whose support and cooperation.

A work of this magnitude would not have been possible to our supervisor Dr. Ayesha Maqbool who has given us

Great support and valuable suggestions throughout the implementation method.

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ABSTRACT

People Counting Using Surveillance Drone

In this paper, a multi-modal solution to the people counting problem in a specific region is explained. The multi-modal structure consists of a Drone having a camera installed in and the algorithm to calculate the number of people in the video. Faces in the observation region are noticed by the camera. Two kinds of motion: (i) entry to and exit from the observation region and (ii) normal actions in that region are distin0067uished using the algorithm. The process will be as the drone will be covering a specific area and recording video which will be sent over the system where the algorithm will analyze video and calculate the people count in that area (The result of both recorded video and online video can be generated).

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Section 1: Introduction

Overview

This document contains all the information related to the development of the Software Engineering Bachelor's Thesis.

Determining the amount of populace in a specified region is a critical problem for many observation applications. The presence or nonexistence of an unforeseen number of populace in an observed region may show an unusual condition. Real-time and accurate inference of people in an area can offer substantial information for administrators/managers. Control systems can direct power and energy expenditure efficiently by properly estimating the number of people in the area, e.g. they can regulate climate and lighting situation according to the amount of people present in the area. So following the necessities stated, the solution is presented. The idea is as there will be a drone having a camera installed in it, it will cover the area needed to count the people in, the drone will capture video and send it to the system and the algorithm will calculate the number of people. The project was developed with the purpose of studying the state of the art of the recent computing algorithms centered on artificial Vision.

Problem description

Today, a lot of study has been published to resolve such a difficulty which is to count the number of people using camera(s). This is not an easy task; there are some situations tricky to crack even with today's processor speeds (the algorithm has to function in real-time so it makes limits for the difficulty of methods for recognition and tracking). Maybe one of the most hard is people's occlusions. When inhabitants are entering or exiting the field of view in a group, it is quite hard to differentiate all the human beings in the crowd. There are solutions available in the market but these solutions are too expensive and are for the still cameras, what we are going to make is a reasonable cost drone camera which will count peoples anywhere via online streaming.

- ## Purpose

To develop a system that may be used to identify the number of people present in a particular location by applying Image processing on them and to integrate our knowledge into the implementation of the system explained, and to transform our learning into practical work.

- ## Intended audience

The intended audiences for the People Count Using Drone include the project supervisor, the FYP group (developers), the UG project evaluation team, and other persons at MCS CSE Department. When it is about the user of the project then, the project could be proved helpful to anyone who wants to monitor and analyze population for security purpose, any individual (not specific audience).

- ## Project scope

A system that may be used by media houses as well as government agencies and law enforcement agencies including Army and civil armed forces to detect the gathering count.

- ## End Goal Objective

To develop a system that may be used to identify the number of people present in a particular location by applying Image processing on them.

- ## Deliverables

Table 1 - Deliverables

Sr.	Tasks	Deliverables
1	Literature Review	Literature Surveys
2	Requirements Gathering	SRS Document
3	Application Design	Design Document (SDS)
4	Implementation	Implementation on computer and drone with a live test to show the accuracy and ability and the project
5	Testing	Evaluation plan and test document
6	Deployment	Complete project

- ## Document Conventions

When writing this document it was inherited that all requirements have the same precedence.

This document mostly addresses the general requirements. This document also fulfills the requirements for FYP, CSE Dept. MCS, and NUST.

First it presents an overall view of the project and then all features and functions are analyzed in detail.

In this document we assume that the user needs to calculate the amount of people in a specific area for any purpose (for instance, Management or Security etc. When writing this document it was inherited that no System/Subsystem Specification Document (SSS) or any other contract document exists.

- ## Reading Suggestions and Intended Audience

These requirements contain common information regarding the Project, use-cases, functions, features and particular technologies. It describes in detail all the functionalities it will be intended to design. Functional and non-functional requirements are address separately. System features with use-cases and constraints are discussed in detail. System interface are also discussed in detail.

This document is intended for:

Developers: (Project Group)

To make sure that the relevant project is accomplished that completes all the requirements given in the document.

Testers: (Project Group, Supervisor)

To ensure that all the interface work as specified in the document.

Users: (Buyers)

To grab all the information about the project of how it is designed, how to use/respond in failure situations and can be able to recommend the change which can maje it more relevant and functional.

Documentation Authors: (Project Group)

To understand the features and how they need to clarify, what skilss are essential, how the system will behave in response of a certain user action and what possible system failure may happed and what are the solutions to all those failures etc.

Project Supervisor: (Dr. Ayesha Maqbool)

This document will be used by the project supervisor to check the guide the group about the understanding and implementation of the requirements properly and completely during the development lifecycle.

Project Evaluators: (CSE Dept. MCS)

In order to know the span of the project and assess the project throughout the development.

Section 2: Software Requirements

Introduction

Real-time people flow evaluation can be extremely helpful information for numerous applications like safety or people administration such as pedestrian traffic administration or tourist flow assessment. The utilization of video cameras to track and calculate people raise significantly in the past few years due to the progression of image processing algorithms and technology. People counting systems can be implemented in various domains such as libraries, schools, airports, malls. In school and public libraries, a people counting system can streamline many functions. Rest of the required details of the project is there in the document. Here are presented all the requirements (Functional or Non-Functional) are stated that are necessary to develop the project.

Overall Description

Typically, three stages are involved in a people counter:

a. People detection,
b. People tracking, and
c. Counting.

The factors that can impudence the implementation technique of a people counter include

(a) The scene to be considered,
(b) The position and direction of the camera, and
(c) The goal of the application.

The difficulties include occlusion, overlapping, and merge-split and shadow effect.

- Many step recognition techniques have been developed, such as step matching, model matching, temporal separation, and background diminution. After getting the forefront, we need to divide, if some human images are correlated to each other. The level set and the snake model can be used to dynamically portray a man's outline, but they are so precise that unfinished surveillance can’t be endured. Problems can be resolved by identifying each part of an individual’s body and integrating it into a pre-architectural structure, but defining

human architecture requires many constraints and requires significant calculation time to prove junction.

- In the track tracking stage, we want to get the moving route of each pedestrian. This can be done by adjusting the pavement silhouette among successive frames or shifting the location of the model to achieve the present state. Since the discovery step is not reliable, some predictive or literal models for compensation are useful here. There are numerous common filtering that have a rigid motion to the aim. As a pedestrian regularly travels willingly, the system creates a difficulty in the pursuit of populace. Some versions of the update have been projected to solve the non-linear scheme that can be approximated by the division. Lately, some researchers have revealed that the pursuit of populace is strong.
- After discovering and tracking, the count of people can be attained by calculating the trajectory. This count can be done in two areas. In the first one, the area is clogged and we want to count the amount of people there. Such areas often have an access point where we can observe it and we require to define a cross line to compute it. In an open area, since we cannot describe the inner or outer part, only the normal number can be calculated. The standard amount refers to the number of people who have been detected and is the same to the trajectory number of the scene.

Operating Environment

People counting systems play an important role in a variety of applications regarding security, management, and commerce. Considering a skyscraper, it is important for the security division of the building to know both the total amount of people in the building and the number of people on each floor of the building. Such information becomes vital once an emergency, such as fire, explosion, and toxic gas, occurs in the building. Strategies for effectively evacuating and rescuing people from the spot of emergency heavily rely on the information of people count. Likewise, for the places, such as the public areas of transportation stations, stadiums, museums, and malls as well as the restricted areas of government building military camps, and construction sites, where the control of people count is essential, automatic people counters provide a reliable and persistent tool for governing the number of people in the regions. People counters have also been considered to count the passengers getting in and out of transit carriages, such as buses and

trains. The data provided by the counters can be used to schedule proper times and time intervals of carriage dispatch. Furthermore, the boarding and alighting behaviors at each station can be investigated based on the information on passenger count collected at the station. Accordingly, adequate utilities, as well as facilities, can be suggested for different stations.

System Features

This section demonstrates organizing the **functional requirements** for the project People Counting Using Drone by system features: -

Functional Requirements

It's needed to get as good quality equipments for the project as possible so the project should remain in the estimated budget (*within 1 to 1.5lac PKR*).

People Counting Technology

People-counting is a widely studied and commercially exploited subject. This section briefly reviews the typical technologies used for our project.

Video Cameras

The approach to people counting (and localization) using video camera. The focus lies on extracting the size and moving patterns of individuals passing. By means of motion histograms based on frame-differenced images, the histograms classify detected movements. Probabilistic connection is useful to decide people's count. Normally, the results of multiple cameras are joined in order to form a movement vector for each individual recognized. In contrast, it proposes a solution based on a single camera, which recognizes individuals by background removal of the camera picture. A non-background is recognized, and its size is probable and compared to formerly established bounds of people's pixel extent. The number of people is derived from the outcome of this analysis. The system reaches a claimed accuracy of 98.5%. The major disadvantage of a camera-based system is that it requires an ambient light source and relatively powerful computer resources to perform image processing. This will be our priority to provide best quality computer for better performance.

Drone

Drone aerial photography essentially uses drones. Many extra quad-copters are now improved prepared to hold heavy camera tools due to enhanced technology. Drones are now steady and can take obvious and crisp images. We can capture what the video camera captures directly from our phone or computer system and get high-resolution video recordings for the best results. And as our aim is to cover as much space as we can so this will be achieved using drone technology. It would signify more and more populace can fit in the frame and anyone must get a true aerial vision for people counting. It is indeed probably one of the best utilization of the drone.

Computer System

It gives you enough power to edit the best PC high-resolution photos for image processing purposes, which means they usually come with a special graphics card. Not only do we work with still images; So, we don't need a monster rig, but we're definitely going to come up with a medium or higher graphics card. It is also important to have enough RAM, especially since we need to open several programs and images at once. The best computer for image processing is at least 8GB of RAM. We'll also want a good capacity hard drive for storing so, 1TB will be appropriate enough.

Sample data

There will be needed either some pre calculated sample videos or a calculated crowd to practically run the project.

Few Qualities ought to be present in the project like:

- A high accuracy and better quality service.
- Management of large area.
- Good quality drone with better battery timing and good controls.
- Evolution (in order to add some more features like evaluate the impact of any current feature).

- Reachable from any position (by using a web application associated with the centralized database).
- Easy organization of arrangement.
- Breakdown organization (detect the malfunction machines).
- Use, when it's probable, free technologies to decrease the cost of the system.

Non-functional Requirements

The project focuses on the non-functional requirements as well because the performance of the system is very important. Some of the provided nonfunctional requirements are such as.

1. Performance Requirements

The performance of projects that require real-time computation and contains hardware components is very important. This statement holds true for our project as well. A critical aspect of our project is the algorithm that will permit the drone to fly with the balance over the crowd and calculate them. This algorithm will run on the Computer System or Laptop while the control of the drone will be depending on the user for the rotation, height, and speed. Thus, the routine of this algorithm is pretty necessary. Moreover;

- The video must be continuous and clear to be watched.
- The drone controls must be perfect and long-range service gets positive marks.
- There shouldn’t be any fluctuation during the video surveillance.

2. Safety Requirements

The software along with the hardware is fast and responsive. However, there could be some situations where the system can become unresponsive, like when the shooter shoots the video for a long time or if the height of the camera is too high or if the picture quality is bit blur due to high flight, etc.

3. Security Requirements

Information/data must securely reach from source to destination as the communication mean is wireless so it can be hack-able. There must be security precautions so that the information stays safe.

4. Lighting and visibility conditions

The environment must be well lit and there must not be anything that might hurt visibility.

5. Usability

Most of our target customers include management and security agencies, but we still create a simple enough interface to use. The interface meets the design interface standards, making the user interaction as simple and efficient as possible.

6. Accuracy

The system should present good enough accurateness in order to make the project more handy for carrying out the specified function and also slightly less accuracy will result in the downfall of the project.

7. Legal

People Count Using Drone should follow customer privacy policies strictly.

8. Maintainability

Project maintenance capabilities are a bit difficult to perform and can be damaging if interfaced with other objects. Battery life is another matter.

9. Software Quality Attributes

a. Reliability

The application ought to trustworthy to the user. The product will run firmly given that all the functionalities are examined, fulfilled and running flawlessly. All the fixing and testing ought to be completed. All executions are to be properly managed.

b. User-friendliness and Simplicity

The complete system including hardware as well as the software part must have a better user interface with interactive and eye-catching options/features; in shorts the system must be friendly.

Researches of existing people counting systems

Since our research is Internet-based, we find plenty of websites among companies. Here are the most interesting ones.

Name of the company	*Web site*	*Field*
Acorel	http://www.acorel.com/en/software.asp	People counting systems in public transport, shopping centre
SPSL	http://www.customercounting.com/	People counting, people behaviour analysis
Infodev	http://www.infodev.ca/	People counting in buildings and vehicles
Abtekcontrols	http://www.abtekcontrols.com/	People counting systems with different sensors such as laser beams
Video turnstile	http://www.videoturnstile.com/	People counting systems based on video processing

Figure 1

As you can see above, several companies have developed people counting systems and have integrated a powerful tool for analyzing people's behavior rather than counting how many people are in the building. Nevertheless, we are going to focus on Aerial view of the crowd and people counting systems which is basically counting the crowd by covering more area using Drone.

Section 3: Design and Development

Introduction

It’s an overview of the entire SDD with Purpose, Scope, System Architecture, Data Design, Component Design, Human Interface Design, Requirements Matrix, Acronyms, Abbreviations, References, Unified Modeling Languages (UML) Diagrams and Overview of the project. The aim of this document is to present a detailed account of the project People Counting Using Surveillance Drone which aims to count the crowd in a specific area using a drone for aerial view. The detailed requirements of the People Counting Using Surveillance Drone are provided in this document.

Purpose

This document will define the design of our "Surveillance Drone Users" project. It includes specific information regarding expected input, output, classes, and functions. The connections among the classes to convene the desired requirements are given in the detailed figures in the register.

System Overview

The system will have a drone that will carry a camera i.e., a normal camera with better quality video. The drone will do surveillance over the specified area. It will send images to the base station where the counting algorithms will be applied, and the count will be generated. The objective is to develop a system that may be used to identify the number of people present in a particular location by applying Image processing on them.

System Architecture

Architectural Design

Following are the details of the components used in making of the project.

Drone

Already there has been work done on the idea of people counting but using static cameras, we are adding the uniqueness by using drone technology for better area coverage. Drone aerial photography actually uses drones. Many more quad-copters are now better equipped to

hold heavy camera equipment due to improved technology. The drone must be having good range connectivity and better battery timing and batter flight controller.

Camera

When using the drones for taking the benefit of covering more area, here comes the need to use better quality camera for good quality video/image, so the algorithm could work more efficiently and effectively. The approach to people counting (and localization) using video camera. The focus lies on extracting the size and moving patterns of individuals passing. By means of motion histograms based on frame-differenced images, the histograms classify detected movements. Probabilistic association is applied to determine number of people.

Computer System

It gives you enough power to edit the best PC high-resolution photos for image processing purposes, which means they usually come with a special graphics card. Not only do we work with still images; So, we don't need a monster rig, but we're definitely going to come up with a medium or higher graphics card. It is also important to have enough RAM, especially since we need to open several programs and images at once. The best computer for image processing is at least 8GB of RAM. We'll also want a good capacity hard drive for storing so, 1TB will be appropriate enough.

Sample Data

There will be needed either some pre calculated sample videos or a calculated crowd to practically run the project, for making the system as much accurate as possible.

Decomposition Description

The system Architecture is such as.

1. The Drone which acts like a server sending flight information and video while also receiving flight directions from the controller.
2. A desktop client program which analyzes the data received from the drone and generates People Count according to the video received.

Use-Case (Diagrams & Narratives)

We use a use case to explain a set of predefined actions that can be started by an actor that can be performed by a system and can effect in output to a particular actor. This diagram bases its importance in providing a description of the behavior structure of the system.

In the description we find the following information:

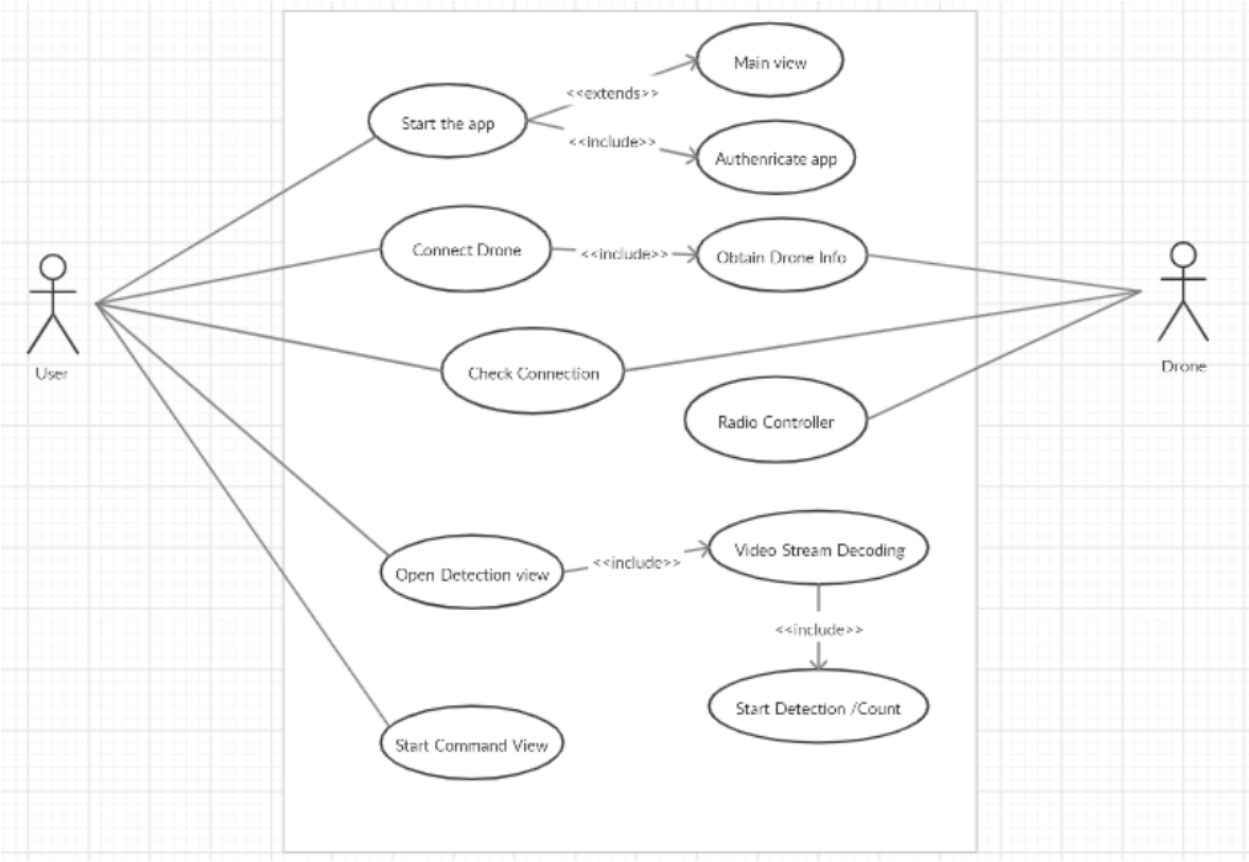

Figure 2 – Use Case

Use Case Narrative 1

No.	1
Use Case Name	Entering the Application/Software
Description	This one explains the application launch, the steps required to validate the

	application and attain the drone information to begin the application.
Primary Actors	User
Secondary Actors	Application administration
Stimuli	User starts the application, opens main view, check application authentication. Also connect Drone and check drone information
Response	Upon validly integrating/starting app and drone connection, Drone availability will be assured, and it's a signal to start drone flight.

Normal Execution	Alternative Execution
1. The user starts the application. **2.** The application is authenticated in server. **3.** The user connects the aircraft/drone. **4.** The system obtains information about drone. **5.** The user opens the **main view**.	4.1. Show error message of not able to obtain information.

Use Case Narrative 2

No.	2
Use Case Name	Detection / Counting
Description	This is done to execute the detection and counting block initiated by the user, and then to execute the video stream decoding and identification threads. Depending on the location of the identified object, the user can start the command mode that the app will start commanding the drone.
Primary Actors	User
Secondary Actors	Application administration
Stimuli	After applications get started and drone's connected, Now the video will be decoded and thread will be created for image detection and people counting.
Response	After the video detection and people counting, the result of crowd count will be shown.

Normal Execution	Alternative Execution
1. The user opens the detection view. **2.** The application starts the video streaming decoding. **3.** The application starts the revealing thread. **4.** The user starts the imposing mode. **5.** The application commands while depending if there is an object detected and considering the object detected position.	

Class Diagram

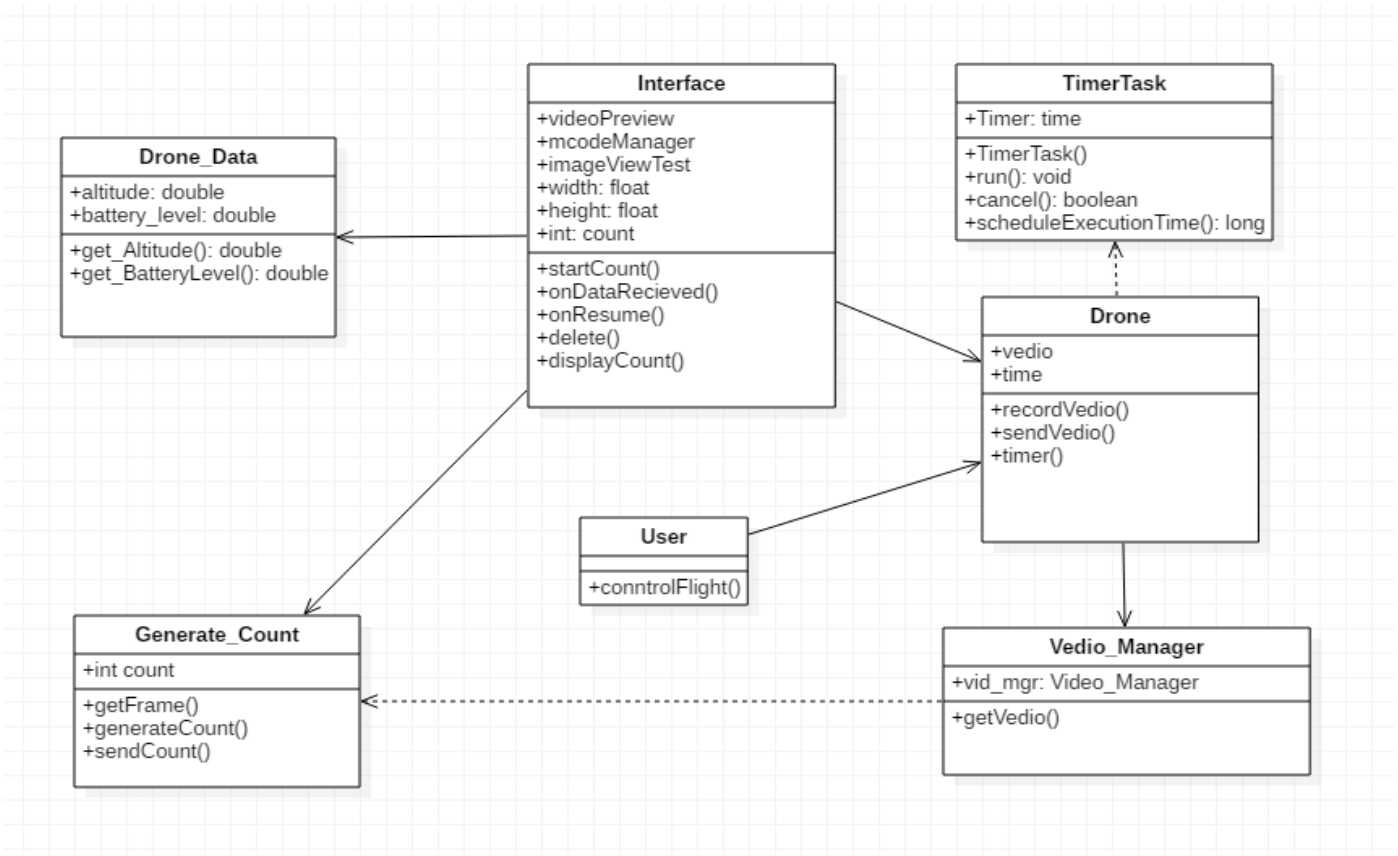

Figure 3 – Class Diagram

High Level System Architecture

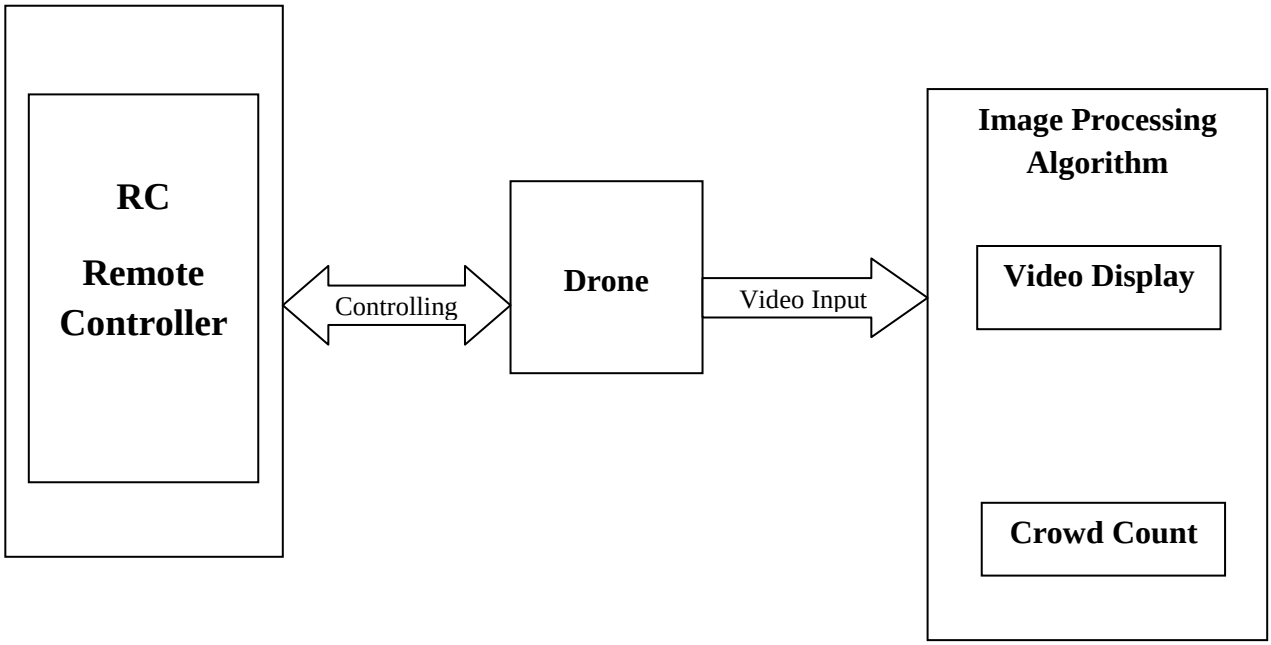

Figure 4 – High Level System Architecture

Data Flow Diagram

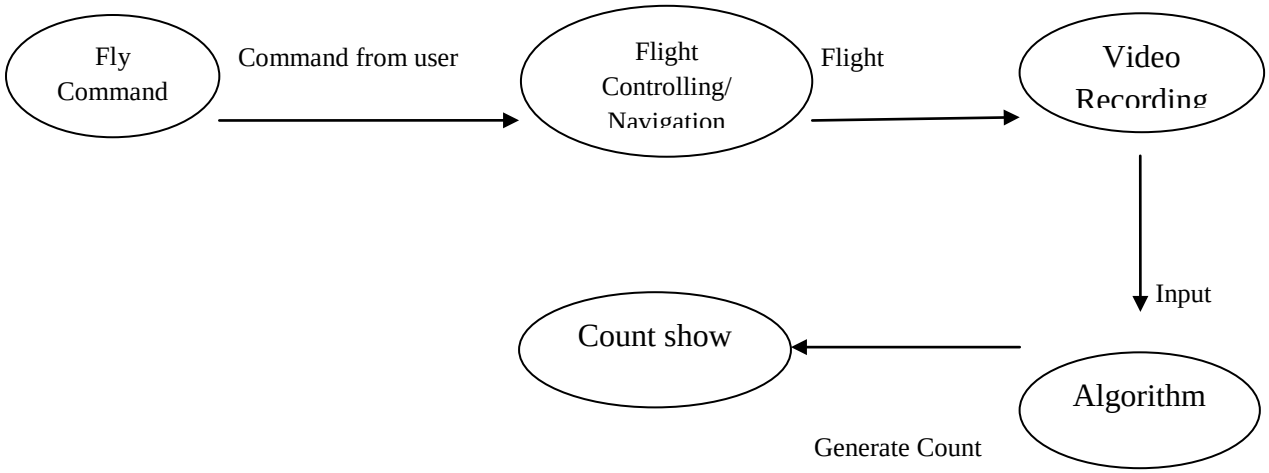

Figure 5 – Data Flow Diagram

Sequence Diagram

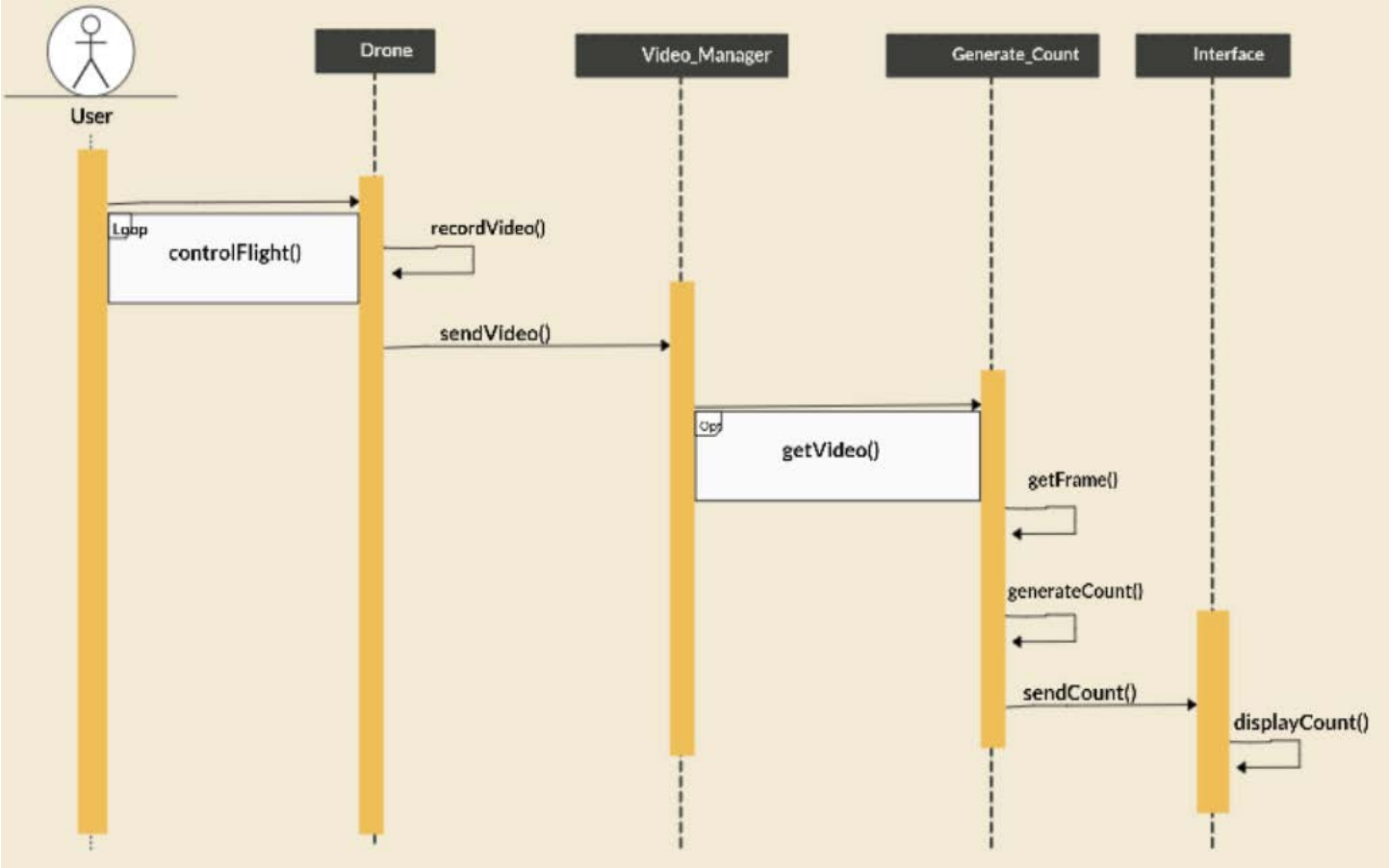

Figure 6 – Sequence Diagram

Design Rationale

In our project, previous work has been done on the same idea but there was lack of camera portability and movement, people count are available with fixed cameras like CCTV etc. We make the system more useful and efficient using drone so it will cover more area and also it can be taken outside if required. Another factor is that we are making a desktop application for counting the crowd strength, while there are many other solutions to count strength like using some kind of sensors or coding in *Raspberry-pi* which will be installed inside the drone and it will count on the spot and send the result to the system and many other methods as well, but making a desktop application is because:

Using Drone

- Using drone will help in covering more area then fixed camera system.
- It can be carried out, not restricted to specific residence/space.

Desktop Application

- This is financially better to make a desktop application rather spending money on the sensors or on *Raspberry-pi*.
- Application will be more compatible and will run on any system while the sensor or raspberry-pi on the other hand might not be able to do so.
- Sensors are mostly not friendly with other working systems such as Windows (There are presently 1.3 billion Windows users about the world.

There are many more reasons and pros in favor of our system architecture/design, but these were enough for us to choose the specified idea for the system.

Data Design

Data Description

The mechanism/phenomena of data storage and information domain is very simple, the video will be recorded and send down where it will be stored in the system (PC or laptop or any portable devices that supports desktop applications),while the video is been recording the process of people count will be carried out at the same time and also will be displayed. After completing the video recording process, the video and its generated count can be stored in the storage (local drives, portable USB or any other storage device) of system.

The mechanism of the generating count is as, Instead of looking at the patch of the figure, let's build an end-to-end deterioration method using CNN. This takes the whole figure as input and produces the number of groups directly. CNNs work well with weakening or classification errands and have verified their value in producing denser maps.

CSR-NET employs a deep CNN (convective neural network) technology that we implement, to capture high-level features and generate high-quality dens maps without expanding network difficulty.

Component Design

Many UML diagrams have been made in like class, sequence, use-case etc. These respective diagrams were for presenting the working and components of the system, the class diagrams description will help in better understanding.

- **Drone**

  Represents the Drone Class.

  RecordVideo:

  - Record the video of the area via Drone.
  - **Pre-Condition:** connection to the Drone camera was established.
  - **Post-Condition:** Store the source in video format.

  SendVideo:

  - Send the video to the Video_Manager.
  - **Pre-Condition:** Video has been recorded.
  - **Post-Condition:** Video_Manager will receive video and apply algorithm.

- **Video_Manager**

  Responsible for the process of Manipulating video.

  getVideo():

  - Refining video by converting video into frames.
  - **Pre-Condition:** connection to the AR Drone camera was established.
  - **Post-Condition:** Return the manipulated video to Generate_Count.

- **Generate_Count**

  Responsible for generating count from the frames.

  getFrame:

  - Convert video into frames.
  - Pre-Condition: reasonable quality video (at-least 240p).
  - Post-Condition: Frames will be generated from the video.

  generateCount:

  - Count numbers of heads from the frames.
  - Pre-Condition: frames must be generated accurately.
  - Post-Condition: Count will be generated.

  sendCount:

  - Sends the number of count to the Interface.
  - Pre-Condition: count must be generated.
  - Post-Condition: Interface will receive generated count.

- **Interface**

  The interface of the application.

  videoPreview:

  - show the video.
  - Pre-Condition: Drone must record the video.
  - Post-Condition: Video must be shown.

  startCount:

  - Press the button of generating Count.
  - Pre-Condition: video must be available.
  - Post-Condition: Count will be generated.

displayCount:

- Count will be displayed on the screen.
- Pre-Condition: count must be already generated to display.
- Post-Condition: count will be displayed.

These were the class operation's description having influence in sequence diagram with a bit of explanation of pre and post conditions and working and purpose of each class.

Desktop Application

Our desktop application view.

Section 4: PROJECT TEST AND EVALUATION

Introduction

The objective of the test document is that it is required for the successful execution of the testing process for a project. The test plan describes the strategies, processes, and methodologies that will be used to plan and execute the testing of the Vehicle Classifier. By providing detailed test information, we hope to reduce the probability of overlooking items and improve test coverage. Testers will be able to use each test case provided in this document to move forward and begin testing.

Manual testing will be done by the tester taking the role of end-user to test the system and identify any unexpected behavior.

The test document includes all the plans, approaches, and methods to test People Count using Drone. The pass/fail for each test item is also defined.

Test Items

Based on the requirements of project, the following are the major modules/ functionalities that should be taken into account during the testing process: -

- Video Processing
- Detect Individuals/peoples
- Classify Individuals/peoples
- Counting
- Display

Features to be Tested

Following are the features being tested:

1. The system shall be able to acquire video in real-time for further processing.
2. The system shall be able to divide the video into frames.
3. The system shall be able to classify individuals by applying to classify individuals' modules.
4. The system shall be able to count individuals in the video.

Detailed Test Strategy

The testing strategy comprises of unit testing using white-box testing and black-box testing. Integration testing is done in order to check the successful integration of the modules of the system.

Unit Testing

In unit testing, individual units/ components of the software are tested. The purpose is to validate that each unit of the software performs as designed. It is done at the code level for specific programming errors, and we have done unit testing for each module/part of our project.

Integration Testing

In integration testing, we test all the previous modules after their integration. It is done to ensure that the modules are functionally normally when combined together. After unit testing, we have done integration testing for better performance.

Incremental Testing

There are four basic modules that are to be integrated. After integration, these modules will form the complete application. Incremental testing will be done to complete the integration. Integration testing will be performed by the developers. The following describes the modules as well as the steps to be taken to achieve the integration. We have done incremental testing for performance accuracy.

Video Acquisition

This module initiates the major functioning of the People counting system. It divides the video into frames after it has been acquired. Each frame passes further preprocessing techniques to detect the vehicle. After the detection frame is passed to the classify vehicle module.

Classify Vehicle Module

After the video has been acquired by the system, the system will select an enhanced frame and apply image processing on these frames to detect the Individuals. This module also counts the People in the video. This module is integrated with the display and count module.

Count

After people have been detected this module counts them in the video feed. We have drawn an ROI line on the video frame, it helps in counting.

Display Module(GUI)

This module will display the classification results and vehicle count on the user interface screen. GUI is designed independently and then integrated with the whole system.

System Testing

System testing ensures that all modules are working, separately and together combined.

Performance Testing

This test evaluates the fulfillment of a system with specified performance requirements. It is done using black-box testing. It will be performed by

- Checking the response time of the system
- Check database read/write time

Item Pass/Fail Criteria

Test case details are specified in section Test Deliverables. Following are the item pass/fail criteria:

- Preconditions are met
- Inputs are carried out as specified
- The results are as specified in output => Pass
- The results are not as specified in output => Fail
- The system does not work => Fail

Suspension Criteria and Resumption Requirements

Whenever a defect is found/introduced, testing will be suspended. Testing will be resumed after the removal of defects.

Section5: CONCLUSION

Overview

In conclusion, this project provides a solution for detecting and classification problems. People counting have 75% accuracy in classifying vehicles and counting them. This helps to easily perform management, security, and administration through the use of camera and drone that have already been installed.

Objectives Achieved

1. Reduce manual surveillance personnel.
2. Easy and efficient monitoring.
3. Providing cost and time effective solution.

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