ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF INFORMATION TECHNOLOGY AND ENGINEERING

DEPARTMENT OF INFORMATION TECHNOLOGY

G-5 Modernizing Public Security Systems

Project Proposal

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ACRONYMS

PMP - Project Management Plan

CNN - Convolutional Neural Network

CAE - Convolutional Autoencoder

ML - Machine Learning

DL - Deep Learning

CCTV - Closed-Circuit Television

LSTM - Long Short-Term Memory

ABSTRACT

Constantly sitting behind a desk looking at a screen connected to surveillance cameras is surely an infeasible task for humans. However, this task is quite important for ensuring the safety of public spaces. In most cases, abnormal behavior is left unnoticed which largely compromises the safety of people especially in crowded spaces. Hence, we propose to work on this project where we can build a system that would alert the person behind the screen when an unusual behavior is detected.

In summary, this project should involve a web app which a security guard can monitor along with the actual CCTV footage. An unsupervised model would be integrated with the web app actively learning from incoming visual data. Once an abnormal action is detected by the system, the app would alert the guard of unusual behavior which now the guard can assess and decide whether a harmful action is taking place. Note here that the model would not learn whether an action is harmful or not, it only learns whether a particular action is peculiar to previously learnt behavior and consequently calls for expert interference to analyze the situation. Once the expert flags the situation as dangerous, he/she can alert all police officers or dedicated personnels nearby to attend to the scene. This project is not meant to replace the involvement of humans but considering our limitations a system that would aid with such monotonous tasks would largely complement human capabilities.

1. INTRODUCTION

1.1 Background

Crimes/Accidents have unfortunately been a frequent occurrence throughout human history. With the emergence of structured societies, tremendous efforts have been put forth in order to minimize this frequency or prevent it altogether. However, the limited capabilities of humans to predict, attend or prevent an accident or a crime has largely resulted in frustration amongst the public and lack of trust in security systems. We believe that complimenting human efforts with machine efficiency could largely enhance the effectiveness of current security systems and thereby increase the public's trust.

1.2 The Existing System

Existing security systems are largely ineffective due to the constant human monitoring that needs to take place. This in turn compromises human safety since if no person calls for the police to stop a possible crime event, the crime will take place without anyone's knowledge.

1.3 Statement of the Problem

In this project, major challenges to be addressed are as follows:

1. Effectively predicting anomalies in video data
2. Alerting dedicated departments once an anomaly is flagged as dangerous

This reduces the overall time needed to attend to a scene where public security is being jeopardized. Moreover, statistically speaking, a large fraction of crimes are unreported or unnoticed (such as kidnapping, pick pocketing and so on) and an even greater number of accidents are not attended to until too late. Having a system that would alert humans once an unusual behavior is detected and enables taking immediate action by directly alerting police phones would surely increase public security at large and disincentivize criminals from taking such a course of action.

1.4 Objective of the Project

1.4.1 General Objective

The ultimate objective of this project is to build a system that would spot and take immediate action once public security is deemed to be at risk.

1.4.2 Specific Objective

Specifically, the two objectives or sections of this project include:

1. Predicting abnormal events from incoming streams of video data
2. Building a connected system that would alert dedicated personnels physically close to the accident location

1.5 Proposed System

We propose a system that would learn to detect abnormal behavior from streams of video data by effectively learning normal data using motion in videos and later singling out any anomalies. This can be achieved in three steps:

1. Extracting dense optical flow maps from videos
2. Feeding the extracted map and training a CAE on normal data to reconstruct the flow map
3. During inference, video frames with high reconstruction errors are regarded as abnormalities

1.6 Feasibility Study

1.6.1. Economic Feasibility

1.6.1.1. Developmental cost

Considering the type of technologies we are planning to use for the system, this system will not pose an economic challenge to the team because almost all the resources needed to develop the system are within reach. These resources that are required during the developmental phase include datasets, hardware and software components. However, training the system using CAEs might pose a computational challenge considering the size of the dataset. This will be overviewed and alternative architectures might be favorably implemented.

1.6.1.2. Operational Cost

A smartphone, CCTV cameras and a monitoring screen would be required to operate the system fully.

1.6.2. Technical Feasibility

We believe that the knowledge we acquired within the past 4 years will help us build the system. Although some members are new to machine learning, we will thrive to learn by using online resources and become qualified enough to implement the solution.

1.6.3. Schedule Feasibility

We listed the overall time schedule plan for the project under time management plan. Provided there are no exceptional cases we are hopeful we will finish the project within the imposed time frame.

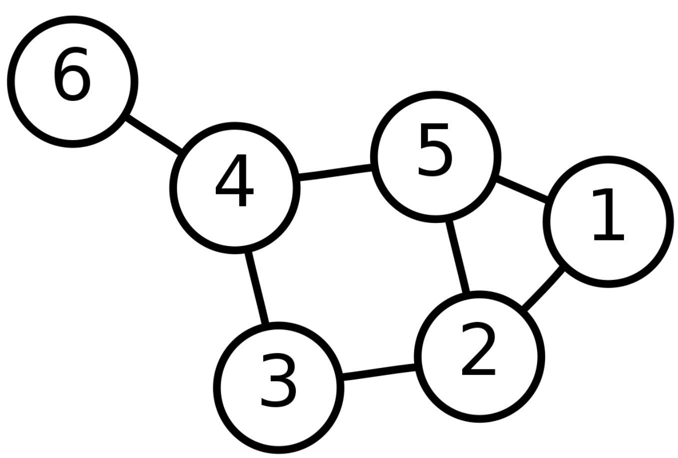
1.7 Scope

The overall scope of this system is constrained upon the major assumption made initially which is that abnormalities are characterized by significant motion. This assumption is made considering the overwhelming majority of anomalies depict abrupt motion that is usually drastically different from motion occurring during normal events.

1.8 Methodology

For building this system, we utilize the concepts of optical flow and image reconstruction through convolutional autoencoders. First, for every image frame, we extract dense optical flow maps. We then train autoencoders to learn patterns of flow maps that represent normal motion. However, the autoencoders only learn the spatial patterns, but since videos have another dimension, namely temporal dimension, we make use of convolutional LSTMs in order to learn the temporal patterns. Once the model is trained, it can be used to detect anomalies in videos by flagging the frames with higher reconstruction errors since that infers that such motion is abnormal to the pattern learnt by the model i.e motion pattern occurring in normal videos. Once an anomaly is observed, the human observer can be notified to either alert concerned departments or ignore the signal if the motion is regarded as normal. If immediate action needs to take place, the system automatically notifies concerned persons which are closest to the accident location.

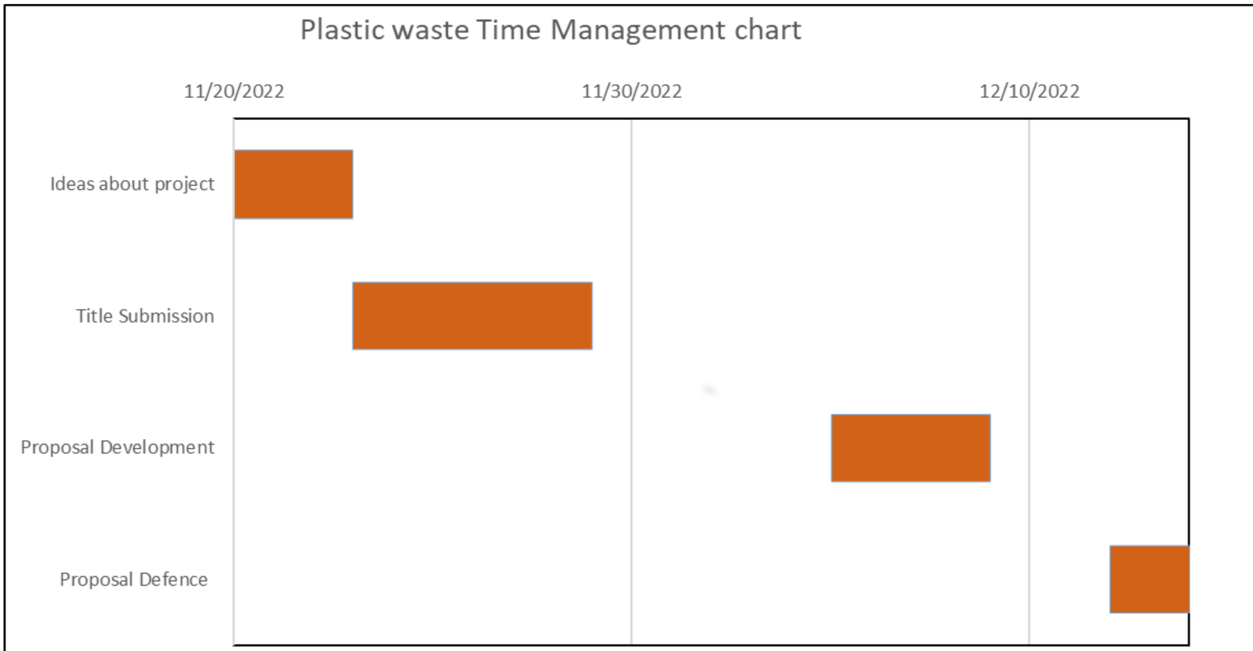
To do this, the system places all concerned bodies in a graph-like structure similar to structures used in networking platforms such as Facebook and Linkedin. This eases and automates the process of searching for closeby people and calling for assistance. Connection between nodes is decided based on the proximity to the accident location. This graph structure between nodes will be computed on the fly once an alert has been issued. This is in order to reduce the complexity and calculation required to track every moving node during a time of inactivity.



1.9 Project Management plan

1.9.1. Time Management plan

The Project Management Plan (PMP) is used to manage project execution. The PMP documents define, prepare, integrate and coordinate the various planning activities. The PMP defines how the project is executed, monitored and controlled. It's also progressively elaborated by updates throughout each day while working on the project.



	Proposal Defence	Proposal Development	Title Submission	Ideas about project
Start	12/12/2022	12/5/2022	11/23/2022	11/20/2022
Duration(Days)	2	4	6	3

1.9.2. Quality Management Plan

Quality is the degree to which the project fulfills requirements. The main part of this project is to do intensive research on how to implement the system and which tools to use to achieve that. Basically, the quality of our work depends on the quality of our research.

Our main goal is products are built to meet agreed-upon standards and requirements. QMP applies to project deliverables and project work processes according to quality standards for our customer satisfaction.

Our project to build a system that will meet with the user requirement as expected according to the plan. It should provide a reasonable outcome with no error. If it has an error also it must give an effective efficient reason.

These are some Project Quality Management components:

Quality Planning: it is identifying the quality requirements for the project deliverables and how the project needs to be managed properly.

Quality Control: it is determining quality requirements to ensure rules are being followed as expected.

Quality Assurance: it is the systemic activities implemented for a product or service that will be fulfilled as making the project meet quality requirements.

1.9.3. Communication Management Plan

Type of Communication	Method / Tool	Frequency/ Schedule	Information	Participants/ Responsibilities
Internal Communication:				
Project Meetings	Google Meeting Telephone Telegram	Twice a week	Project status, problems, risks, changed requirements	Project Mgr Ayda Sultan Biniyam Lemma Gedle Kiristos Teklu Mathewos Worku Murad Abdella
Sharing of project data	Google Doc.	Day To Day	All project documentation and reports	Project Mgr(s) Ayda Sultan Biniyam Lemma Gedle Kiristos Teklu Mathewos Worku Murad Abdella
Milestone Meetings	Google meet	Before milestones	Project status (progress)	Project Mgr Ayda Sultan Biniyam Lemma Gedle Kiristos Teklu Mathewos Worku Murad Abdella

Final Project Meeting	In Person	M6	Wrap-up Experiences	Project Mgr Ayda Sultan Biniyam Lemma Gedle Kiristos Teklu Mathewos Worku Murad Abdella
External Communication and Reporting:				
Project Report	MSWord PDF	Monthly	Project status - progress - forecast - risks	Project Manager Sub-Project Managers
SteCo Meetings	Teleconference	Monthly		Project Manager, SteCo

APPENDIX

Convolutional Autoencoders: Convolutional autoencoders (CAEs) are unsupervised dimensionality reduction models composed by convolutional layers capable of creating compressed image representations.

Optical Flow: is the pattern of apparent motion of objects, surfaces, and edges in a visual scene caused by the relative motion between an observer and a scene.

Convolutional Neural Networks: a class of artificial neural network, most commonly applied to analyze visual imagery.

Convolutional LSTM: type of recurrent neural network for spatio-temporal prediction that has convolutional structures in both the input-to-state and state-to-state transitions.

REFERENCES

1. Elvan Duman and Osman Ayhan Erdem, “Anomaly Detection in Videos Using Optical Flow and Convolutional Autoencoder,” in IEEEAccess , December 2019