HARMFUL CHILD ACTIVITY DETECTION AND PREVENTION ASSISTANCE

Project ID: TMP-21-050

Project Proposal Report

Pramodya Hettiarachchi

Bachelor of Science Special (Honors) Degree in Information Technology
Specializing in Data Science

Department of Information Technology

Sri Lanka Institute of Information Technology
Sri Lanka

February 2021

HARMFUL CHILD ACTIVITY DETECTION AND PREVENTION ASSISTANCE

Project ID: TMP-21-050

Project Proposal Report

Pramodya Hettiarachchi – IT18006308

Bachelor of Science Special (Honors) Degree in Information Technology
Specializing in Data Science

Department of Information Technology

Sri Lanka Institute of Information Technology
Sri Lanka

February 2021

DECLARATION

I do hereby declare that this is my work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning, and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

Name	Student ID	Signature
Pramodya Hettiarachchi	IT18006308	

The supervisor/s should certify the proposal report with the following declaration.
The above candidates are researching the undergraduate Dissertation under my supervision.

…… ……..

Signature of the supervisor: Date

ABSTRACT

Accidents happen in a home cause more than 37% of death in children between the age of one and four due to harmful child activities from hazardous objects like fork, blades, knives as well as hot liquid containers has intrigued the notice significant of the public. The advancement of artificial intelligence (AI) technology, especially in image processing and object detection, could be applied to overcome the bottlenecks of the currently existing harmful activities detection devices that often failed to serve as an alerting system for guardians to protect their children from household accidents. To monitor such dangerous child activities, visual hazardous object detection and prevention systems need to integrate with live streaming CCTV cameras in a smart environment.

Most of the approaches have been proposed over the last year, methods based on deep learning have been proved to perform better than the machine learning methods in some fields, with the use of computer vision being the most eminent case. To perform this application, we propose a computer vision framework using a deep learning algorithm to identify hazardous objects and prevention in real-time using a surveillance camera. Using feature extraction and classification approach for hazardous object localization, identifying the hazardous object and its danger level, then classify whether Child is in proximity to a hazardous object or not and finally an alerting system in the audio form was confirmed. Such a solution can be minimized the kid's accident significantly as we can filter down to segments of the surveillance camera footages.

Keywords: Convolutional neural network (CNN), Computer vision, Deep Learning algorithm, Hazardous object detection

TABLE OF CONTENTS

List of Figures

List of Tables

List of Abbreviations

Abbreviation	**Description**
CNN	Convolutional neural network
YOLO	You Only Look Once

1 INTRODUCTION

1.1 Background & Literature survey

Every day, kids' life is having full of danger. Having a kid prompts all parents to have to do everything with their capability to establish a safe environment at home. According to the records 37% of death in children between the age of one and four. Most accidents can be avoided, and most deaths are happed by a chain of events rather than a single occurrence. The chances of having dangerous accidents are increased,

- If the parents are employed, stressed from working.
- If Kids are not getting along with their parents
- If children do not have a safe place to do activities.
- If hazardous or unsafe objects are kept in kids' area accidentally.

When considering hazardous objects accidents, Kids do not have the sense to distinguish hot from cold or sharp from dull. There is a high risk of having danger through hazardous objects. To avoid that we purposed a real-time application using a deep learning algorithm integrated with a surveillance camera.

Surveillance means monitoring human behaviors, activities, movements, and information for controlling, managing, and protecting people from dangers. Over the last few decades, automated surveillances have been growing remarkably with help of new technology and concepts. In recent with the help of a deep learning and intelligent surveillance system many approaches were introduced in surveillance and some of the approaches [1] mentioned below.

- Object discrimination
- Action recognition
- Object and group tracking
- Object detection
- Frame-based detection
- Pixel-level detection
- Feature detection and temporal filtering

None of the above-mentioned methods worked ideally and accurately in real-time. As the complexity of the detections increased with time, the computational power was not sufficient to perform these detections. Later the advancement of the technology gave rise to more powerful methodologies which can handle real-time detection and predictions. Deep learning and computer vision methodologies were analyzed to come up with a solution to the problem that was identified.

Video Monitoring in Childcare Facilities [2]. This CCTV camera has been installed in the child area or child room. When accidents happen cameras can record them but could not be able to prevent or minimize the damage. parents can access the live footage through the web but then privacy issues can arise, and if parents are working, they could not able to more focus on a live video feed. So it is not possible to check their kids in real-time.

At present, Real-time object detection [3] is a viral topic when considering computer vision problems. And most of the solutions are based on real-time object detecting of surveillance video using OpenCV libraries and deep learning algorithms. Open CV libraries provide the facility to program for different results under various conditions and thereby assist in finding the optimal threshold and is providential to the edge of the image. Most researchers have been implemented real-time object detection using Raspberry Pi 3, Raspberry Camera, and OpenCV software. In most scenarios the canny edge detection [4], dilation, and erosion algorithms were used to detect objects.

Obtaining precise geometric features from objects is the hardest challenge in Object detection. Pattern description methods that are currently existing (Canny, Hough transform, Sobel, Prewitt, and chain codes) are not capable of having precise features for object recognition. When executing a project in real-time it is thorough that one frame should process within a time frame of 30-40 milliseconds which is very difficult. But these detection methodologies have some drawbacks. When we consider time, for canny detection algorithm consumes a lot of time because of complex computation

and algorithm do not provide a precise feature for object detection which affect to reach real-time response to prevent the danger.

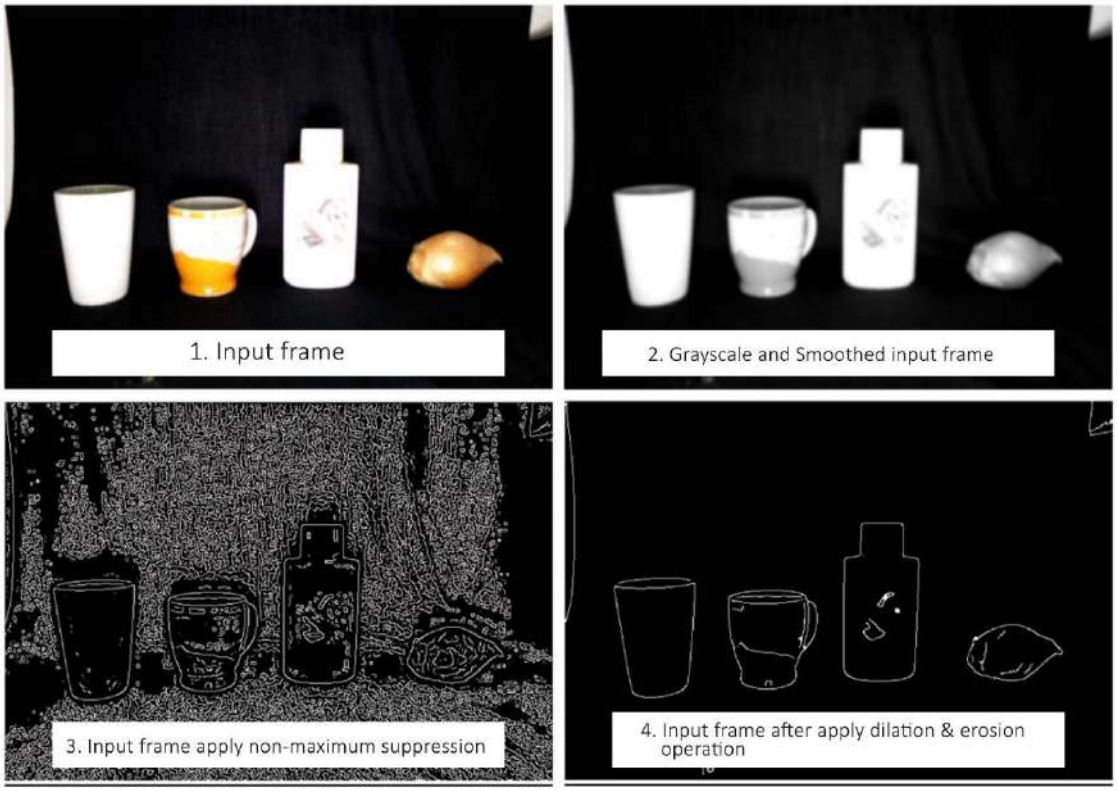


Figure 1.1 – Object Detection Using Canny Object Detection

Choosing the right algorithm [5] for detecting an object is very important since machines could not distinguish the hazardous objects in a video stream instantly like humans. Since it is required for the deep learning algorithms to be accurate as well as fast to detect an object in real-time [6]. Faster R-CNN, Tiny-YOLOv3, and YOLOv3 have been used for many approaches as the most efficient algorithms for detecting objects. Among all the better algorithms, YOLOv3 possesses the highest accuracy and F1 score followed by R-CNN. Therefore, using YOLOv3 to develop the solution can be of better advantage.

For computer vision applications, deep learning models are the most suitable [7]. During training and testing, found excellent object recognition accuracy. Recent image classification techniques which are based on CNN used, ResNet, VGG16 [8], Faster R-CNN, and Inception V3 models, which required high performing CUDA enabled GPU cards and large image dataset for training.

But these methodologies are not optimal for our solution as these methods require a high amount of processing time and computational resources. Detecting hazardous objects [9] is the most challenging and most important part of harmful child activity detection and prevention assistance application. Damage is depending on the time taken for identifying the object. So, most research suggesting deep learning models for detecting objects rather than Considering fast detection.

1.2 Research Gap

Conventional CCTV surveillance system installed in home primarily used for monitoring the children activity, tackle emergencies, ensure the safety and well-being of the children within the setting. But if some accident happened to a child from using the hazardous object, the damage cannot be recovered. As research empowered more influence in computer vision to be able to prevent that accident and damage can be minimized. Detecting objects and identify the danger level has been a challenging task as the objects were diverse. We suggest identifying objects based on sharp objects and hot liquid container objects. Following this way, I would be able to do a classification of what the object is and give an alert to the parent about the danger of this object. As we know, hot liquid container accident damages are high rather than sharp object accident damages. Only identifying the hazardous objects is not enough. My solution also proposes to classify whether a Child is in proximity to a hazardous object or not over the live surveillance footage.

Product	Research A [2]	Research B [8]	Research C [5]	Research D [3] [4] [5] [6]	**Proposed solution (AI Care)**
Child Surveillance System	✓	✗	✗	✗	✓
Real Time Object Detection	✗	✗	✓	✓	✓
Real Time Sharp Object Detection	✗	✗	✓	✗	✓
Classify the danger level	✗	✗	✗	✗	✓
Child detection	✓	✗	✗	✗	✓
Identify child is in proximity to hazardous object	✗	✗	✗	✗	✓
Prevent accidents before happening	✗	✓	✗	✗	✓

Table 2.1 - Comparison of Similar Research

1.3 Research Problem

Nowadays human lives have differed greatly comparing to present and past in many aspects of life, and this difference has raised the evolution of human civilization and the changing forms and patterns of life. In this generation, humans have been living with the pressure of engaging in numerous activities within a time frame of 24 hours narrowing down one's leisure time to a negligible figure. The role of a working mom is a no-brainer but an obvious victim of the explained situation as her life is sandwiched between the two roles: the role of a mom and a wife's role. Due to the pandemic situation, most of the corporates changed their rosters and working plans to work from home. It is given that with the current situation, safety plays a huge role but due to the current working arrangement followed by most offices, mothers are forced to balance office work along with balancing the two roles mentioned earlier which can be hectic.

Given the scenario is such, a babysitter sounds like a good idea but then again leaves us with a question mark on how safe it is?

Accidents are one of the biggest causes of death in the world. When thinking of accidents, traffic accidents, and outdoor activities-related accidents are the most significant. But accidents happening at home which is regarded as the safest place is less prominent. People spending less attention to the closest and the most prone accident variety for their lives is very despairing. Home can be a dangerous place for children is general in-house safety is neglected.

Most accidents are happened due to the curiosity of the children and lack of supervision. These days parents were busy with online workflow and tried to manage as two sides as possible. But It is not an easy task, being with a child and working. So, parents try to integrate CCTV surveillance and try to get rid of dangers out from children. But parents must watch them over the screen. Still, the danger is there. I propose a solution that can detect hazardous objects in an inhouse space monitored by a surveillance camera and also classify them under sharp objects or hot liquid container objects and give an alert to parent based on a Child is in proximity to a hazardous object or not. This solution work as a child activity detection and prevention assistance.

2 OBJECTIVES

2.1 Main Objectives

The main objective is to ensure that child is in the early development stage are safe from accidents using hazardous objects by using surveillance cameras integrated with computer vision. The proposed solution will be implemented for capturing harmful events (child hazardous events) and objects (dangerous objects) effectively and accurately and taking prompt responsive actions to avoid the danger.

2.2 Specific Objectives

Following specific objectives needs to be attained to archive the main objective.

- Hazardous object localization
- Identifying the hazardous object whether sharp or ho liquid container objects
- Identify the danger level.
- Classify whether the Child is in proximity to a hazardous object or not.
- Trigger warnings to the child to distract or give alerts to parents to minimize or prevent danger. [10] [11]

3 OBJECTIVES

3.1 Requirement Gathering

In requirement gathering, the research domain and background study was analyzed. After analyzing the requirement, understanding the current processes and the similar implemented systems was also done. define the project scope and understanding the domain which I would be covering was a challenge.

In the case of application, interviews were conducted with the parents and caregivers of children to find out the most appropriate features for this.

Key steps :

- Collecting related research papers
- Feasibility study
- Background and literature survey
- Reading and analyzing collected research papers
- Financial viability.
- Collecting data from users and analyzing their perspective about this system
- Filtering out the most appropriate components and finalized the project scope.

3.2 System Architecture

The system architecture is shown in the figure.

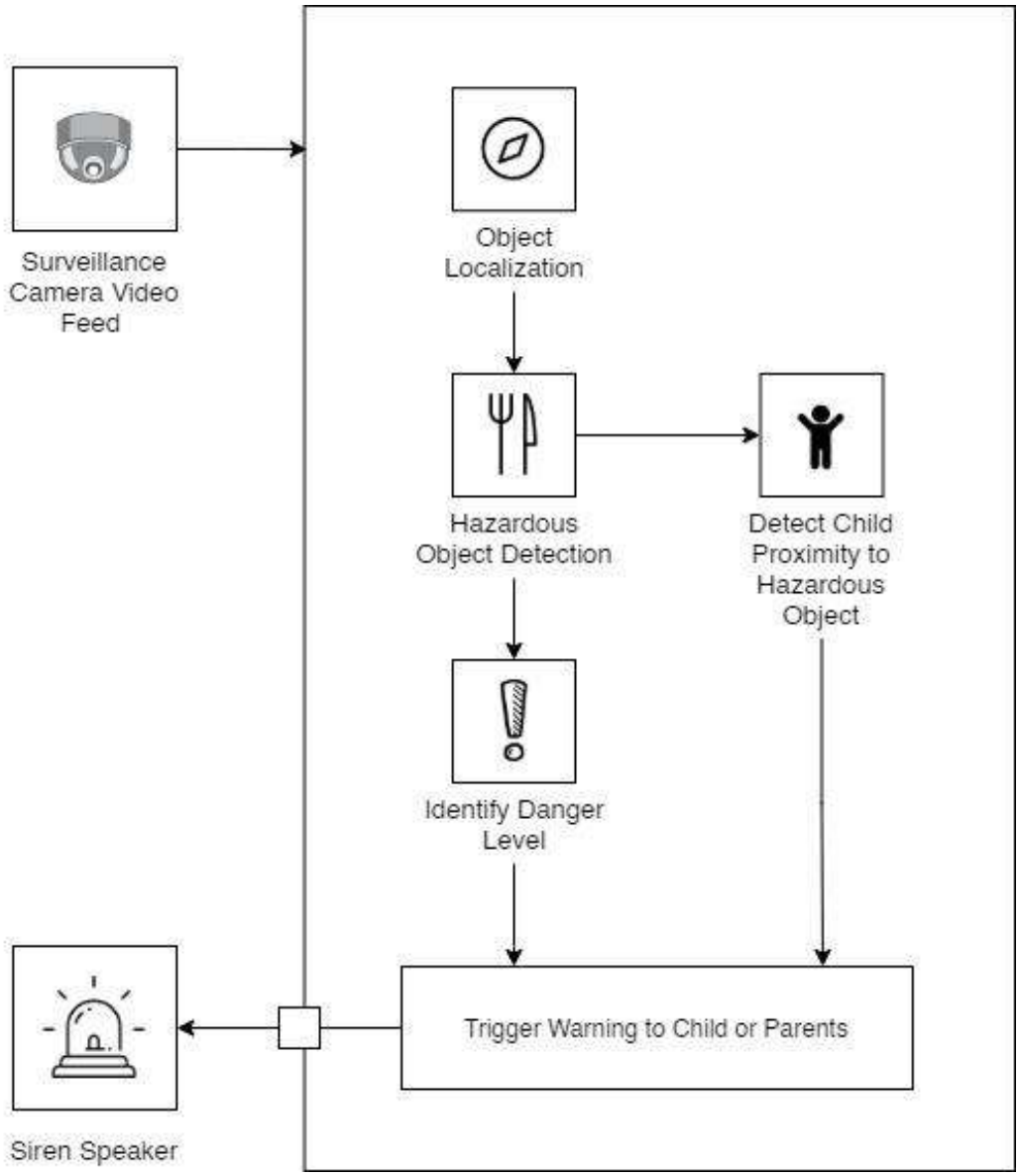


Figure 3.1 – System Architecture Diagram

3.3 System Implementation

According to the proposed system design, I have breakdown the system into four criteria. Each criterion is working for satisfying the core component which is capturing harmful child events and dangerous objects effectively and accurately, taking prompt responsive actions to avoid danger.

The purposed solution has the capability of,

- Detect the hazardous objects using a live video feed.
- Identify the child is in proximity to a hazardous object or not.
- Identify the danger level of the hazardous object.
- Trigger the appropriate warnings to the parents or child based on a danger level.

3.3.1 Detect the hazardous objects.

Using computer vision for detecting objects that involve recognizing the presence, location, and type of one or more objects in each video feed. This proposed function, mainly focus on hazardous object detection and it is divided into two as,

1. Sharp objects
2. Hot liquid container objects

The reason for dividing hazardous objects into two is when considering the hot liquid containers, is danger level is high compared to sharp objects and the child accidents injuries are very serious and when comes to the alerting section, it is easily triggered proper warnings to prevent accidents efficient way.

Building upon function, some key steps which I followed are given below.

1. Object recognition (Where the objects are)
2. Object localization (Extent of objects)
3. Object classification (What are the objects)

To perform the above segregation, YOLO, a family of CNN (Convolutional Neural Network) would be utilized to capture real-time video frames and attain near state-of

the-art results with a single end-to-end model. The system will be trained using COCO and ImageNet datasets.

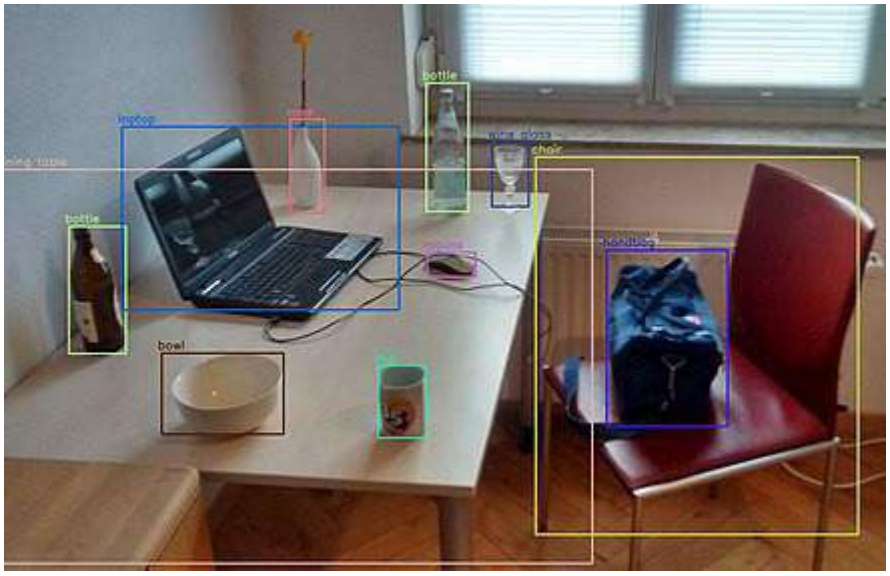


Figure 3.2 – Object Detection Using YOLO

3.3.2 Identify the child is in proximity to a hazardous object.

As a second step, the system will be checked whether the child is in proximity to a hazardous object or not. To perform this function, the system is split into two criteria.

1. Identify only the child (Not a parent or caregiver)
2. Identify child is in proximity to a hazardous object or not.

The system would be triggered warnings only for the child's dangerous activities, not the parents or caregiver activates. Using a classification algorithm, identify whether the actions were caused by a child in the given video feed.

As a second criterion of this function, the system would check whether the child is in proximity to the hazardous object or not. To perform this, SORT (Simple Online Realtime Tracking) [12] algorithm will be used which is a pragmatic approach to track an object with a focus on simple and effective algorithms.

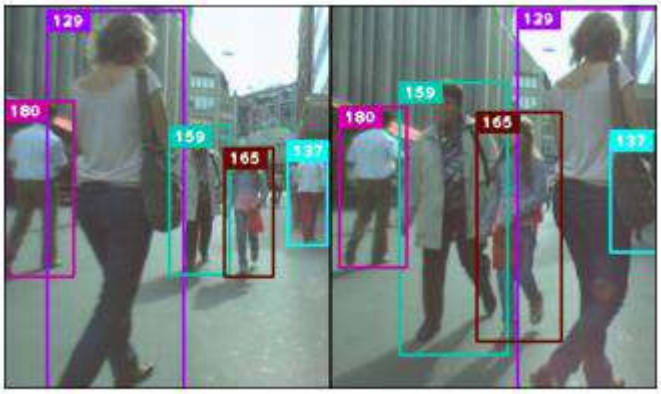


Figure 3.3 – Object Tracking Using SORT Algorithm

3.3.3 Identify the danger level

The system will be assigned a score based on step 1 (detect the hazardous object) and step 2 (Identify the child is in proximity to a hazardous object or not) of the danger level. Under hotpots, kettles, similar hot liquid container objects and child is in proximity to that object would be classified as high potential dangers and the system will be giving a high score for that kind of scenario.

When considering sharp objects, the risk is high accidents using blades, scissors, and knives comparing to forks and screwdriver accidents. That way, the system classified the danger level, and based on the danger level, appropriate warnings are triggered.

3.3.4 Trigger appropriate warnings

To the triggering warnings, there are two speakers are located, one in the child room and another one is in the parent or caregiver area. In an instance, the system identifies the high danger level, the parent would be notified, and the system gives alerts to distract the child's danger activity. Also, if the system notified a low danger level, a child is distracted from his / her action by the system, using customizable recordings which facilitate the parents to give warning in their voice. But a child tries to reach the same danger over and over, the parent would be notified regarding the child's actions.

3.4 Tools and Technologies

To implement the purposed solution, the required tools and technologies are listed below.

- Python
- TensorFlow
- Yolo
- OpenCV
- Keras
- JavaScript / HTML / Boostrap4

3.5 System Requirement

3.5.1 Functional Requirements

- Should have a method to localize the hazardous objects in child area.
- Should have a method to classify the hazardous object danger level (Hot liquid container has high risk)
- Should have a method to detect child's actions without identifying parents' actions.
- Should have a method to classify whether Child is in proximity to a hazardous object.
- Should have a method to distract child activity or alert to the parents or caregiver about the danger.

3.5.2 Non-Functional Requirements

- System efficiency and performance
- Availability
- Accuracy

3.5.3 Personal Requirements

- Parent/Guardian should be available.
- A child should listen to the warnings.
- Parent/Guardian should react to the alerts.

3.5.4 Hardware Requirements

- There should be a way to configure the speaker to the system.
- There should be a way to configure the camera to the system.

3.6 Work Breakdown Structure

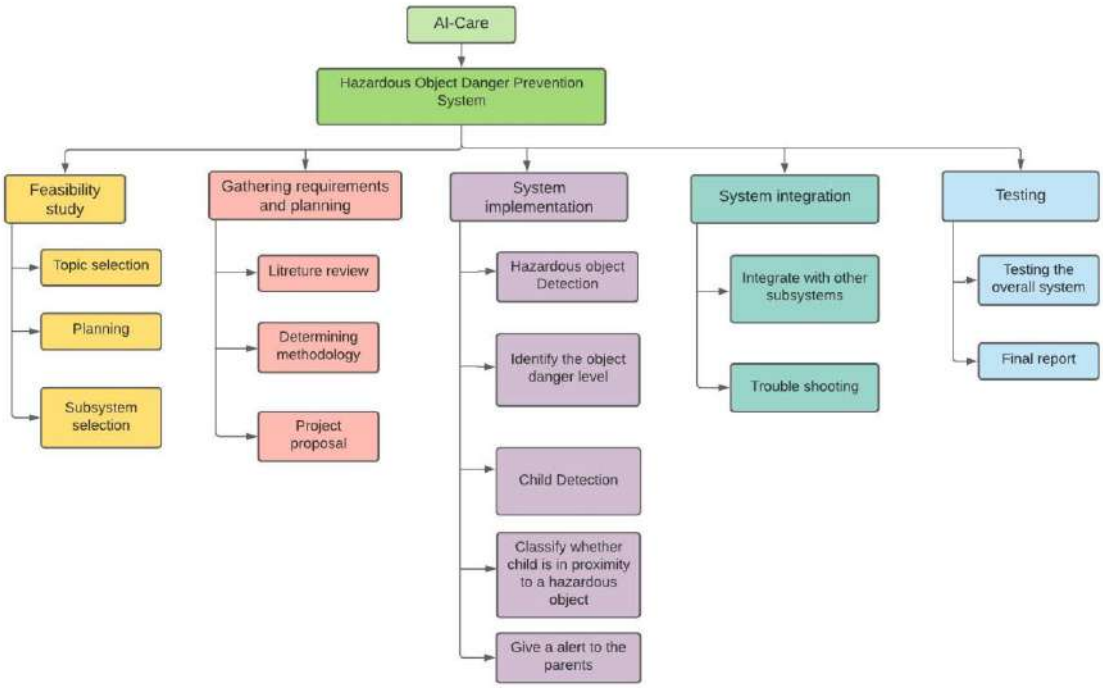


Figure 3.3 – Work Breakout Structure

4 COMMERCIALIZATION

In public society, kids' safety is the biggest concern in the contemporary world due to the raise of kids' accidents in the home. The main reason would be the current world competitive lifecycle and parents engaging in numerous activities within a time frame of 24 hours to earn more and make their lifestyle more comparable. As a result, most home injuries happen due to the lack of supervision and parents stressed in working. To address these issues, the proposed solution takes place at home or in immediate surroundings as an automated child activity detection and prevention assistance.

As mentioned earlier, the system has the capability of,

- Identify the hazardous objects (Share objects or Hot liquid containers)
- Identify a child is in proximity to the hazardous object or not
- Identify the danger level
- Alerting proper warnings (To the child or parent)

As a product, we can straightforwardly commercialize this solution as there is no product available in the present market, focusing on kids' safety as automated assistance using a surveillance environment. As our research, this product can be highly commercialization initiating for potential entrepreneurs.

5 BUDGET AND BUDGET JUSTIFICATION

Hardware Resource	Quantity	Estimated Price
Surveillance Camera	2	Rs 7000 *2
Speaker	2	Rs 1000 *2
Touch Sensor	1	Rs 300
Total	5	Rs 16300 /=

Figure 5.1 – Expected Budget

6 GANTT CHART

Figure 6.1 – Gantt Chart

7 REFERENCES

[1] G. Sreenu and M. A. Saleem Durai, "Intelligent video surveillance: a review through deep learning techniques for crowd analysis," *J. Big Data*, vol. 6, no. 1, pp. 1–27, 2019, doi: 10.1186/s40537-019-0212-5.

[2] "Video Monitoring in Childcare Facilities."

[3] N. A. Othman, M. U. Salur, M. Karakose, and I. Aydin, "An Embedded Real-Time Object Detection and Measurement of its Size," *2018 Int. Conf. Artif. Intell. Data Process. IDAP 2018*, pp. 16–19, 2019, doi: 10.1109/IDAP.2018.8620812.

[4] Z. Xu, X. Baojie, and W. Guoxin, "Canny edge detection based on Open CV," *ICEMI 2017 - Proc. IEEE 13th Int. Conf. Electron. Meas. Instruments*, vol. 2018-Janua, no. 1, pp. 53–56, 2017, doi: 10.1109/ICEMI.2017.8265710.

[5] S. L. Kuna, "Real Time Object Detection and Tracking using Deep Learning," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 8, no. 6, pp. 58–64, 2020, doi: 10.22214/ijraset.2020.6010.

[6] J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, "You only look once: Unified, real-time object detection," *Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit.*, vol. 2016-Decem, pp. 779–788, 2016, doi: 10.1109/CVPR.2016.91.

[7] "SHIP DETECTION BASED ON DEEP CONVOLUTIONAL NEURAL NETWORKS FOR POLSAR IMAGES (1) Key Laboratory of Electronic Information Counter Measure and Simulation Technology of Ministry," no. 1, pp. 681–684, 2018.

[8] J. Lai and S. Maples, "Developing a Real-Time Gun Detection Classifier," 2017.

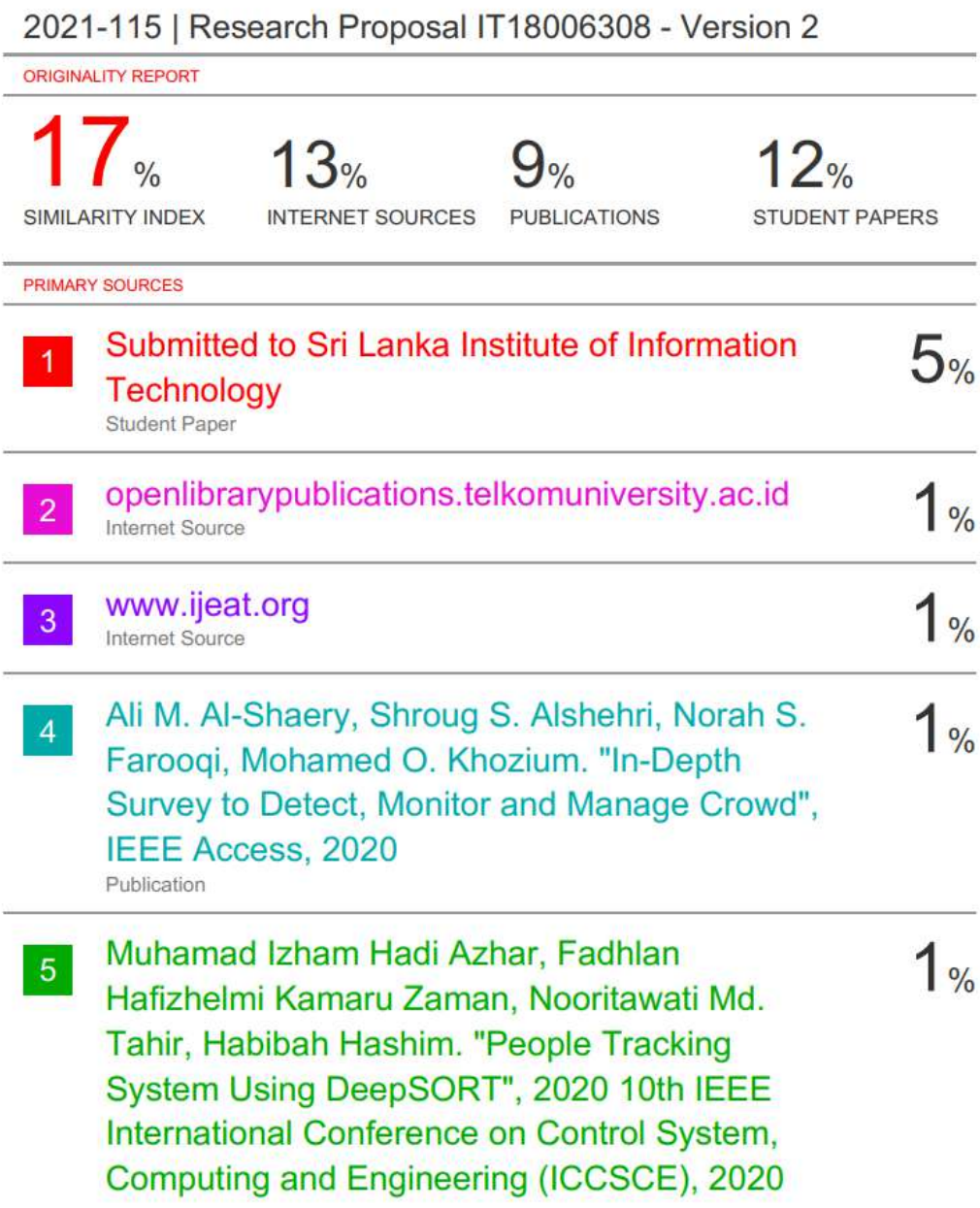
[9] N. Ramakrishnan, A. Kamalakannan, B. J. Chelliah, and G. Rajamanickam, "Computer vision framework for visual sharp object detection using deep learning model," *Int. J. Eng. Adv. Technol.*, vol. 8, no. 4, pp. 477–481, 2019.

[10] R. Kayalvizhi, S. Malarvizhi, S. D. Choudhury, A. Topkar, and P. Vijayakumar, "Detection of sharp objects using deep neural network based object detection algorithm," *4th Int. Conf. Comput. Commun. Signal Process. ICCCSP 2020*, pp. 0–4, 2020, doi: 10.1109/ICCCSP49186.2020.9315272.

[11] "Accident Statistics."

[12] N. Wojke, A. Bewley, and D. Paulus, "Simple online and realtime tracking with a deep association metric," *Proc. - Int. Conf. Image Process. ICIP*, vol. 2017-September, pp. 3645–3649, 2018, doi: 10.1109/ICIP.2017.8296962.

8 APPENDIX



2021-115 | Research Proposal IT18006308 - Version 2

ORIGINALITY REPORT

17%	13%	9%	12%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Sri Lanka Institute of Information Technology Student Paper	5%
2	openlibrarypublications.telkomuniversity.ac.id Internet Source	1%
3	www.ijeat.org Internet Source	1%
4	Ali M. Al-Shaery, Shroug S. Alshehri, Norah S. Farooqi, Mohamed O. Khozium. "In-Depth Survey to Detect, Monitor and Manage Crowd", IEEE Access, 2020 Publication	1%
5	Muhamad Izham Hadi Azhar, Fadhlan Hafizhelmi Kamaru Zaman, Nooritawati Md. Tahir, Habibah Hashim. "People Tracking System Using DeepSORT", 2020 10th IEEE International Conference on Control System, Computing and Engineering (ICCSCE), 2020	1%

6	Chang. "Development of a Child Detection System with Artificial Intelligence Using Object Detection Method", Journal of Electrical Engineering & Technology, 2019 Publication	1%
7	Evgeniy Y. Omelchenko, Evgeniy V. Voronov, Sergey S. Enin. "Development of Machine Vision System for Tracking Crane Mechanisms", 2019 International Russian Automation Conference (RusAutoCon), 2019 Publication	1%
8	machinelearningmastery.com Internet Source	1%
9	Nashwan Adnan OTHMAN, Mehmet Umut SALUR, Mehmet KARAKOSE, Ilhan AYDIN. "An Embedded Real-Time Object Detection and Measurement of its Size", 2018 International Conference on Artificial Intelligence and Data Processing (IDAP), 2018 Publication	1%
10	jurnal.polines.ac.id Internet Source	1%
11	Submitted to University of Northumbria at Newcastle Student Paper	<1%

13	Jacob Rose, Thirimachos Bourlai, James A. Loudermilk. "Assessment of Data Augmentation Techniques for Firearm Detection in Surveillance Videos", 2020 IEEE International Conference on Big Data (Big Data), 2020 Publication	<1%
14	Nicolai Wojke, Alex Bewley, Dietrich Paulus. "Simple online and realtime tracking with a deep association metric", 2017 IEEE International Conference on Image Processing (ICIP), 2017 Publication	<1%
15	Submitted to University of Colombo Student Paper	<1%
16	ieeexplore.ieee.org Internet Source	<1%
17	www.environment.gov.za Internet Source	<1%
18	ir.uz.ac.zw Internet Source	<1%
19	tailieu.vn Internet Source	<1%
20	www.eskom.co.za Internet Source	<1%

22	"Intelligent Data Engineering and Automated Learning – IDEAL 2020", Springer Science and Business Media LLC, 2020 Publication	<1%
23	www.ijitee.org Internet Source	<1%
24	www.physics.mun.ca Internet Source	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		