HARMFUL CHILD ACTIVITY DETECTION AND PREVENTION ASSISTANCE

Project ID: 2021-115

Project Proposal Report

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DECLARATION

I do hereby declare that this is my own work, and this proposal does not incorporate without acknowledgement 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 acknowledgement is made in the text.

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The supervisor/s should certify the proposal report with the following declaration.
The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

…… ……..

Signature of the supervisor: Date

ABSTRACT

The issue of children household accidents, kidnapping, and getting injured due to harmful child activities have come into significant notice of public interest. 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.

A real-time harmful child activity Detection and Prevention Assistance system that consists of surveillance cameras as the input medium, a classification methodology to detect the presence of a child and a triggering system in the audio form is a perfect utilized tool that aids in child protection. Monitoring systems on children's behavior in closed spaces is possible to recognize their activity by the cameras in the environment, collect data, and then using learning algorithms. A deep learning algorithm to recognize and classify children's activity in smart homes is proposed with data collected from cameras in a smart environment, as the overall group research.

This research paper is based on "Child Kidnap detection and prevention" to identify susceptible child kidnap by unauthorized persons. The intelligent surveillance system proposed for this is known as 'AICare'. Purpose behind developing a proper kidnap detection methodology is to enhance and strengthen the existing child security systems. The key is to identify the main characteristics of a kidnapper in real time which follows skin detection, speed detection and hand detection theories. Skin detection is used to identify whether the outlined individual has covered his body specially face in a way of hiding the true identity, or else the person's face is directly processed to face recognition for authorization. Speed detection is useful in calculating the average speed of movement of the targeted individual. Finally, the stranger is subjected to hand detection to classify whether he/she is empty handed or not. The captured classification classes' average percentage outcome is compared with minimum threshold values to take the person as a kidnapper suspect.

Keywords: intelligent surveillance system, kidnap detection, video processing, real-time

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1. INTRODUCTION

Kidnap detection has many applications such as security, area localizing, internet communication, and pose detection. The problem of kidnap detection is still unsolved and offers a great challenge to researchers because none of these researches address the main problem of abduction in human children. There are researches which depicts kidnap detection and prevention aid centralizing a robot's pose and in a limited area space[1]. In this situation kidnap detections for real-time abductions have come into need.

Skin detection is mostly used as a primary step in various human concerned image processing applications. Skin detection is a method if discriminating human skin pixel from non-skin pixels in an image or video. It is one of the prominent researches are in human and computer interaction, face detection, face tracking, gesture recognition, computational health informatics, web content filtering and many more[2]. Here it depicts the significant landmark of skin detection in face detection and analysis for the recent years.

A kidnapper is a person of quick movements and is anxious on making the abduction quickly and smoothly as possible. Thereby, capturing these quick movements before the danger happens is something that is vital to be done in a kidnap detection system. The system should be capable to capture the speed of motion of the suspect to proceed with conclusions. For fulfil this requirement speed detection methodologies are used. Though speed detection work in vehicles are visibly abundant, motion speed detectors for humans are sparse. [3] suggests speed detection in humans via a radar technology.

An individual being hold of suspicious objects in hand can lead him to be a kidnapper suspect or more. Hand detection accurizes the goal of identifying a kidnapper suspect in real time as quickly and accurate as possible before any danger occurs. Hand detection locate the position of the hands and make it further implementable to identify gesturers and movements[4].

To confirm the final outcome, face of the external individual is compared with the authorized people's faces. For this face detection can be used to identify faces present

in images and videos frames in real-time. It operates for the two modes of face verification and face authentication. Face verification involves capturing the face of the image through comparison with previously identified template face. Face authentication involves is comparing a query face with a collection of template face images in the database whose identities are claimed [5].

The biggest concern of a parent is their children's safety. Even in the presence of better safety measure, children are prone to life endangering situations as children does not possess the skill to protecting themselves. This paper focuses on the risk associated to household kidnapping when children are allowed to wander in their room alone. There have been previous incidents where children have been abducted from their foster home forcibly [6]. To improve child safety most of the parents tend to employ a nanny to take care of their children inside the house. Nonetheless, absence of human oversight can lead to heartbreaking incidents as in the previous cited story. This paper presents a Realtime Multiple Face Recognition system to monitor the presence of unauthorized person/people in the room with the child to enhance overall safety to the child from a possible kidnap.

Contributions

This paper provides the following contribution to the research community:

1. Provides a procedure to detect occupied and empty hands.
2. Provides a mode of operation to detect speed of motion in humans.
3. Provides a methodology to detect suspiciously covered faces.
4. Provides a framework for kidnap detection in children abduction.
5. Provides baseline to detect kidnap and techniques to prevent kidnap before it occurs.
6. Provides methodology to detect kidnapper suspect using a sequence of classification results based on kidnapper characteristics.

Tools and technology

The technologies that would be used for the implementation of the system are mentioned below.

- Python3
- Deep Learning
- Tensor Flow
- OpenCV
- JavaScript/HTML/Bootstrap4

1.1 Background and Literature Survey

Here I presents the most related work to the solution proposed in this paper. [7] proposes a tracking system for children where a child module is used, and it transmit tracking information to a mobile device and a database. The disadvantage of using this system is that it is heavily expensive when deploying and also the module is not convenient for children.

[8] explains a tracking system. This system consists of android terminals that from clusters through Bluetooth technology to support communication within themselves. Relevant information among the clusters is communicated via WLAN. Very high deployment cost is the biggest disadvantage of this system.

Child wearable Bluetooth tracking devices are also commercialized [9]. These devices are designed to be worn as a necklace or a bracelet. These devices can detect when the child moves out of an area specified by the parents as safe zone. Then an alert will be sent to the parents giving the location of the child in a geographical map with the help of a mobile application. Major drawback of this system is that it notifies only when the child moves out of the safety zone, in which the danger might have already happen.

There are some other applications that use biometric features such as Fingerprint Recognition for children in which the children's scanned fingerprints are obtained using an acquisition device[10]. It uses image processing to enhance the information on the image and feature extraction to encode the found information. Then, the images are sent to compare with a secure database which contains the previously registered users' patterns. Based on implementing this, it is possible to administer the entrance and leave times of a child from a particular place. A huge flaw of this approach is that it is not child friendly, thereby is difficult for young children to use the acquisition device and correctly place their fingers on it. This may lead to inaccurate identifications and verifications.

Intelligent security camera concept is an area that is widely subjected to research and knowledge. [11] has developed an intelligent security camera system for kidnap detection. This study has proposed a system that can detect kidnapping cases by vehicles and send a prompt alert message to emergency services. This paper introduces

a methodology of using human monitoring-based system to capture criminal behaviors automatically. This function effectively uses security cameras and image recordings for crime prevention through immediate action. The main disadvantage of this system is that it only detects kidnappings that take place from vehicles.

[12] is a paper that explains the use of human pose estimation for kidnap detection. This scheme accurately classifies kidnapping cases from normal cases. Human's 10 joint information obtained from Open Pose library is used to estimate human poses from the input video. These estimated poses of human joints are what classify kidnapping situations from normal accompanying ones distinguishably. The study that is proposed in this paper does not appear to be reliable for child abduction. As small children of the preschool age do not have to be forced taken for a kidnap to occur. These kids may follow the instructions of the kidnapper as small children tend to listen to whatever an adult instructs. The methodology proposed by this paper is unable of capturing such situations.

Same as the above mentioned study [13] also proposes an intelligent video surveillance system which is able differentiate kidnapping and normal accompanying situations using frame-based classification. INHA-VAT a semi-automatic video annotation tool is used here to create the training data from the video. Same as this, another frame-based event classification system was also developed using Bayesian network model which can distinguish kidnapping situations from accompanying ones. Nonetheless child kidnapping situations by accompanying cannot be prevented using this method. [14] says that children are very open and trusting and therefore they are prone to kidnappers who disguise as trustworthy.

According to [1] kidnapping is a location based problem that take place when the target was subjected to an unexpected movement upon the interaction with its surroundings. This result of incorrect pose estimation. This study proposes a method to solve this problem in robots which are in a previous known-map area. The developers assume that the robot is delocalized successfully after being kidnapped to the explored area during SLAM. Kidnap detections built centralizing robots consider different features

than of when detecting child kidnap. Therefore, this methodology cannot be implemented in detecting child abduction.

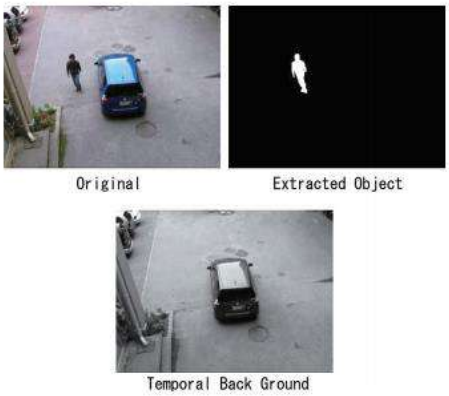

Figure 1 – Kidnap using vehicles

Figure 2 – Kidnap detection using human pose estimation

1.2 Research Gap

There are many facts that can be considered when determining a kidnap is taking place. Popular researches on kidnap detection has considered the following facts to identify an ongoing kidnap.

- Kidnap by vehicles
- Abnormal poses when being kidnapped.
- Frame-based classification for kidnap and normal accompanying.
- Unexpected movements for the target during kidnap

Most of the researches conducted consider abnormal poses as a fact when detecting a kidnap.

All of these available research papers [11] [12] [13] [1] detect kidnaps on activities that happened during the kidnap is happening and then after proceed to alert or notify the responsible authorities. This does not mitigate the risk of danger of kidnap. [15] states that children face critical mental and physical breakdowns after suffering a kidnap. In such a background allowing a person to be kidnapped for at least a least amount of time cannot be afforded for a child life. Therefore, a common insight these research studies lack is acting upon preventing kidnap.

Child kidnap and overall human or adult kidnap differs in some important aspects. Adult kidnapping involves force and might include physical activities like fighting and running. Adults have more knowledge on self-defense than a child. But a child is a mere kid who tends to trust whatever adults say to them [16]. For example, a stranger offering sweets and candies for a child can manipulate the child to follow his instructions and thereby will not have to take the kid by force. These serious situations were not considered in the previous researches on kidnap detection. This is noticed as vital gap that should be filled in the future research on child kidnap.

The table 1.1 depicts the tabular format of the explanation.

Research	Detect child kidnaps	Consider common characteristics of a kidnapper for the research	Prevent kidnap before happening	Give alert or notification on detecting a kidnap
[1]	NO	NO	NO	YES
[11]	NO	YES	NO	YES
[12]	NO	NO	NO	YES
[13]	NO	NO	NO	YES
AICare	YES	YES	YES	YES

Table 1 – Comparison of Former Researches

The AICare concept, which is proposed, is designed with many more functionalities beyond the currently prevailing researches. By the proposed solution, the intelligent surveillance system will alert of a possible kidnap if a kidnap suspect is identified within the given criteria and thus prevent the kidnap from happening.

1.3 Research Problem

Nowadays human lives accelerate at an unbelievable speed forcing everyone living in this generation to live 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 no brainer but an obvious victim of the explained situation as her life is sandwiched between the two roles: 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. Even a babysitter can make mistakes. Humans are prone to mistakes [17]. Not every person is good at multitasking and it is proved that multitasking is subjected to inefficiency and more mistakes [6]. There arises the problem of safety of children.

According to USA statistics an average of 350 children are abducted every year in USA. Therefore, every day at least one child has been abducted in the world. A child's main responsibility falls on the parents. As per the current evolution of the world not many parents are free enough to pay their hundred percent attention to their child. Children in the preschool age are at the greater risk due to this reason.

In an era where technology develops and families disperse and children solitudes, technology is the only aspect that can bring solutions for these problems.

2. OBJECTIVES

2.1 Main Objective

The main objective is to ensure that children in the early development stages are safe from kidnappings. This safety is achieved by an intelligent surveillance system that is placed in the area where the child is present. The proposed solution will be implemented with the explained motive by indicating the caretakers or parents of such incidents and to prevent or diminish harm to minors as the solution makes sure to notify the relevant parties subsequent to detecting kidnapper suspect.

1.2 Specific Objectives

To reach the main objectives, the specific objectives that needs to be attained is as follows,

1. To identify whether the face is covered in a suspicious way or not.

   Use skin detection to get the amount of area which is covered in the face. Face should be uncovered as of per normal ethic. Face covered in a suspicious way is identified as a kidnapper suspect and will proceed simultaneously with the other detections.

2. Face recognition and authorization.

   Fully uncovered face is subjected to face recognition to feature select and compare with the face images of the authorized people to identify whether the given face has authority to enter the area where the child is present.

3. Detect motion speed of entering persons.

   Find the speed the person in the room move towards the child or move into the room. Moving at high pace in a room with a child is accepted as a dangerous and suspicious activity as it appears that the person is in a hurry. And thus, will be a suspect of kidnap.

4. To identify objects in hand

   Hand detection is used to detect if the hands of a person are empty or occupied and is it suspicious or dangerous. As even a minor danger cannot be given to a child, a person holding a suspicious object is identified as a suspect kidnapper at that point.

3. METHODOLOGY

System overview diagram

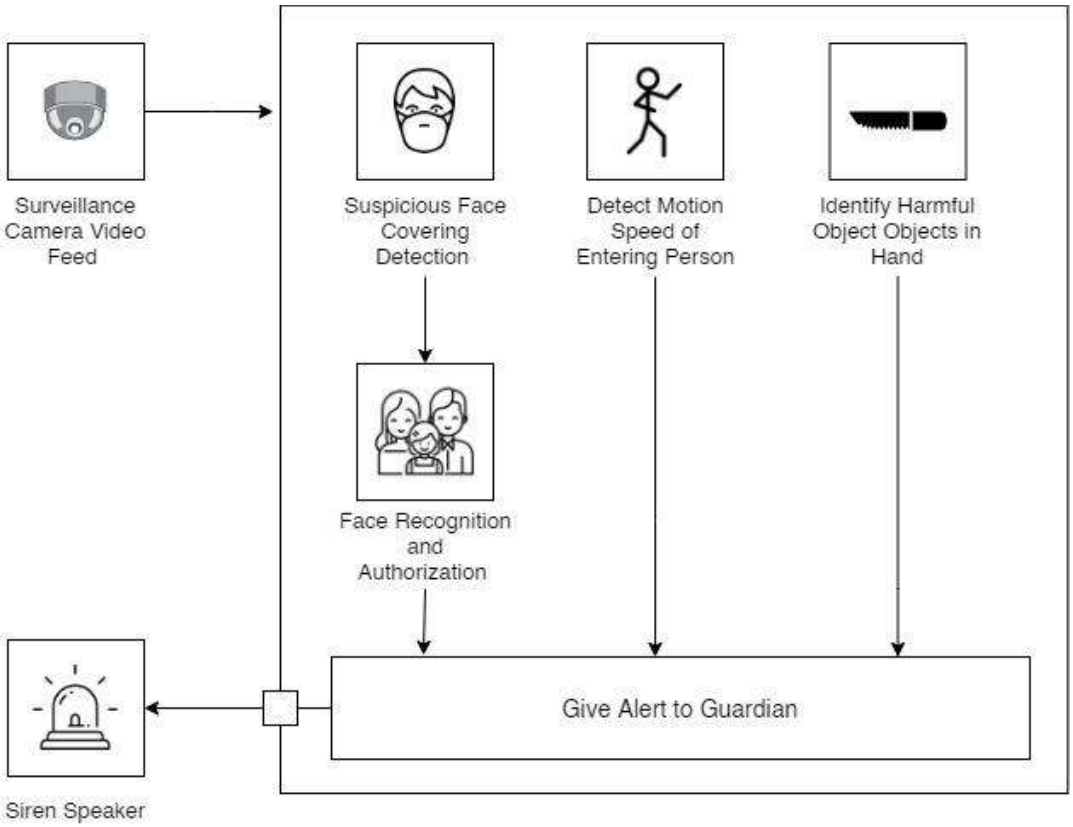

Figure 3 – System Overview Diagram

The system considers four criteria to identify a potential kidnapper or a possible kidnap.

1. Suspicious face covering
2. Face Authorization
3. Suspicious motion speed
4. Harmful objects in hand.

The flow wise manner how these criteria are considered is depicted the above system diagram. The entering person's entering motion speed is detected at the door itself using the camera placed front of the door. Meanwhile the face is detected and identified whether it is suspiciously covered, revealing only an insignificant percentage of skin.

At the same time hand is detected and use object detection (object detection is implemented as a separate subsystem by another team member) to identify harmful objects in hand. Uncovered faces will be compared with the images in the database to recognize whether authorized to enter. Unauthorized entrance is objected to prompt alert. Else the top mentioned three criteria are contemplated collectively to conclude for alerting process.

Suspicious face covering detection

- Algorithm: Skin Detection
- Technology: OpenCV

Image input from camera is taken and used for the detection. Face area of the image is captures to perform the skin detection. Skin colored pixels of the face is identified and given a percentage value to the amount of skin detected. This is then classified using Convolutional Neural Networks classifier to classy to one of the suspicious or non-suspicious categories.

Figure 4 – Skin Detection

Face recognition and authorization

- Algorithm: Face Recognition
- Technology: OpenCV

Image input from camera is taken and used for the authorization. Face area of the image is captured using face detection. The face image is subjected to comparison with the images in database. Upon finding suitable match the person is granted authorized status.

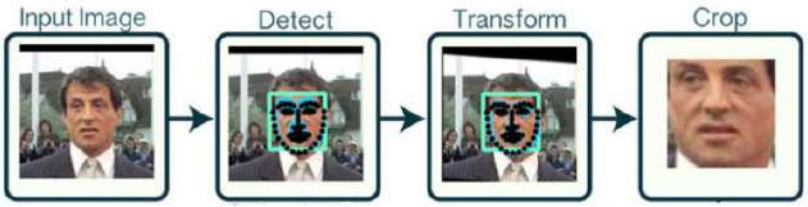

Figure 5 – Face Recognition

Motion speed detection

- Algorithm: Speed Detection
- Technology: OpenCV

Video input from camera is taken and used for the detection. Moving person is capture and converted to binary form. The person is tracked throughout frames until he moves out if camera scope. Get the velocity of the person moving between two frames.

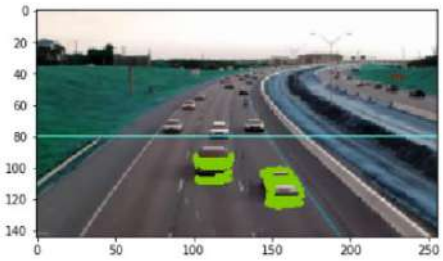

Figure 6 – Speed Detection

Harmful objects in hand

- Algorithm: Hand Detection
- Technology: OpenCV

Image input from camera is taken and used for the detection. Hand region is captured and confirm hand by hand shape. Use object detection (object detection is implemented as a separate subsystem by another team member) to further recognize harmful objects in hand.

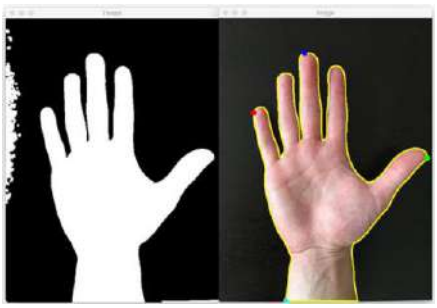

Figure 7 – Hand Detection

Work breakdown structure

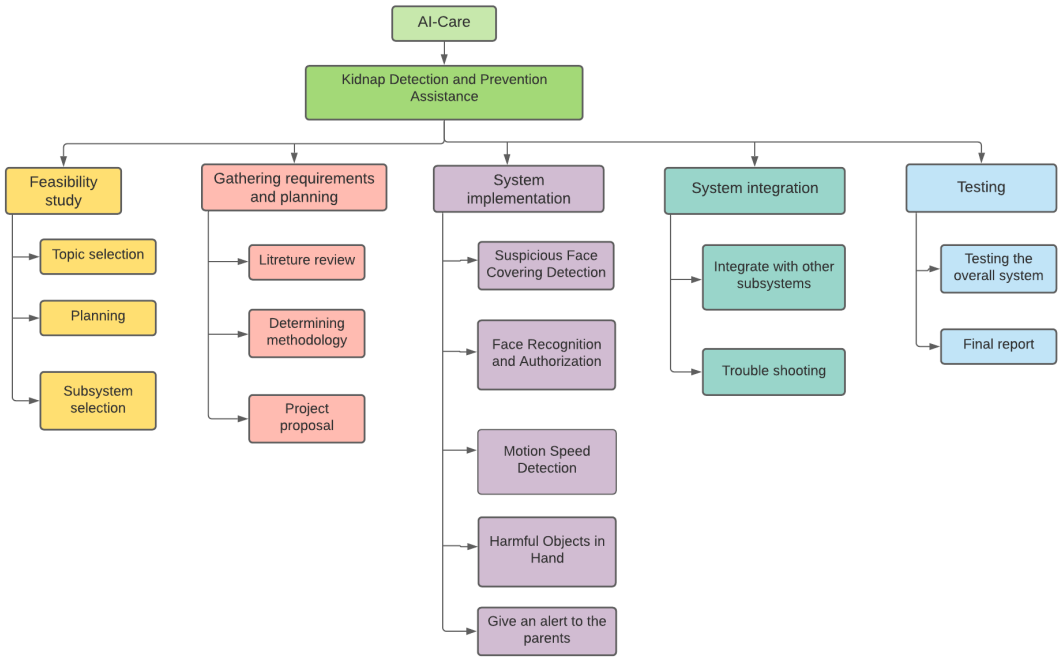

Figure 8 – Work Breakdown Structure

Gantt chart

Figure 9 – Gantt Chart

4. PROJECT REQUIREMENTS

4.1 Functional Requirements

- Integration should be allowed between subsystems.
- There should be a way to capture the persons face.
- There should be a way to identify child separately.

4.2 Non-Functional Requirements

- Response time and net processing time.
- Efficiency.
- Availability.

4.3 User Requirements

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

1.4 System 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.

4.5 Expected Test Cases

Test Scenario ID	Face Cover -1	**Test Case ID**	Face Cover -1A
Test Case Description	Face Cover – Positive test case	**Test Priority**	High
Pre-Requisite	NA	**Post-Requisite**	NA

Test Execution Steps:

S. No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Wear Balaclava and face the Web Cam from different directions	Image frames of the face	Highlight the skin areas on the screen. Give output as suspicious face covering	Highlight the skin areas on the screen. Give output as suspicious face covering	Pass	Detect Suspicious Face Covering successful

Table 2 – Test Case Face Cover 1A

Test Scenario ID	Face Authorization -1	**Test Case ID**	Face Authorization -1A
Test Case Description	Face Authorization – Positive test case	**Test Priority**	High
Pre-Requisite	NA	**Post-Requisite**	NA

Test Execution Steps:

S. No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Pose naked face of a family member in front of the Web Cam from different directions	Image frames of the face	Highlight face on screen and state as authorized.	Highlight face on screen and state as authorized.	Pass	Face authorization successful

Table 3 – Test Case Face Authorization 1A

Test Scenario ID	Face Authorization -1	**Test Case ID**	Face Authorization -1B
Test Case Description	Face Authorization – Negative test case	**Test Priority**	High
Pre-Requisite	NA	**Post-Requisite**	NA

Test Execution Steps:

S. No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Pose naked face of a stranger in front of the Web Cam from different directions	Image frames of the face	Highlight face on screen and state as unauthorized. Wail siren.	Highlight face on screen and state as unauthorized. Wail siren.	Pass	Face authorization successful

Table 4 – Test Case Face Authorization 1B

Test Scenario ID	Motion Speed -1	**Test Case ID**	Motion Speed -1A
Test Case Description	Motion Speed – Positive test case	**Test Priority**	High
Pre-Requisite	NA	**Post-Requisite**	NA

Test Execution Steps:

S. No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Run through the entrance in front of the web camera	Video frames of the motion	Display the speed of motion. Highlight in red as suspicious	Display the speed of motion. Highlight in red as suspicious	Pass	Detect motion speed successful

Table 5 – Test Case Motion Speed 1A

Test Scenario ID	Motion Speed -1	**Test Case ID**	Motion Speed -1B
Test Case Description	Motion Speed – Negative test case	**Test Priority**	High
Pre-Requisite	NA	**Post-Requisite**	NA

Test Execution Steps:

S. No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Slowly walk through the entrance in front of the web camera	Video frames of the motion	Display the speed of motion. Does not highlight as suspicious.	Display the speed of motion. Does not highlight as suspicious.	Pass	Detect motion speed successful

Table 6 – Test Case Motion Speed 1B

Test Scenario ID	Harmful Object -1	**Test Case ID**	Harmful Object -1A
Test Case Description	Harmful Object – Positive test case	**Test Priority**	High
Pre-Requisite	NA	**Post-Requisite**	NA

Test Execution Steps:

S. No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Hold a knife in hand and show Knife at the Web Cam	Image frames of the Knife	Detect and Highlight the Knife on screen	Detect and Highlight the Knife on screen	Pass	Detect Harmful Object successful

Table 7 – Test Case Harmful Object 1A

Test Scenario ID	Harmful Object -1			**Test Case ID**	Harmful Object -1B	
Test Case Description	Harmful Object – Negative test case			**Test Priority**	High	
Pre-Requisite	NA			**Post-Requisite**	NA	
Test Execution Steps:						
S. No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Hold an Iron Rod in hand and show at the Web Cam	Image frames of the Iron Rod	Does not Detect or Highlight the Iron Rod on screen	Does not Detect or Highlight the Iron Rod on screen	Pass	Does not Detect non-harmful Object successful

Table 8 – Test Case Harmful Object 1B

5. BUDGET AND BUDGET JUSTIFICATION

Two surveillance cameras are placed within the area. One at the entrance to capture entering people and one inside the room to surveil the child's activities. Two speakers are stationed for the purpose of warning the child and alerting the parent. The speakers are placed within the room and outside the room, respectively.

Hardware Resource	**Quantity**	**Estimated Price**
Surveillance Camera	2	Rs 7000 *2
Speaker	2	Rs 1000 *2
Total	5	Rs 16000 /=

Table 9 – Budget and Budget Justification

6. COMMERCIALIZATION

In a society where families with both parents working have become a common norm, children have left to grow up by themselves. Children between the age 1 year and 5 year is the most crucial period where a child need a lot of parental attention.

AICare has the potential to be the latest trend in childcare in the coming decade. Being able to give real time protection assistance to a child when parents are attending to work increase the average working time of an employee. Being able to work from home reduces the number of leaves an employee might take. We anticipate that AICare is going to be a top solution companies will invest on providing for their employees because of the high return of investment AICare provides.

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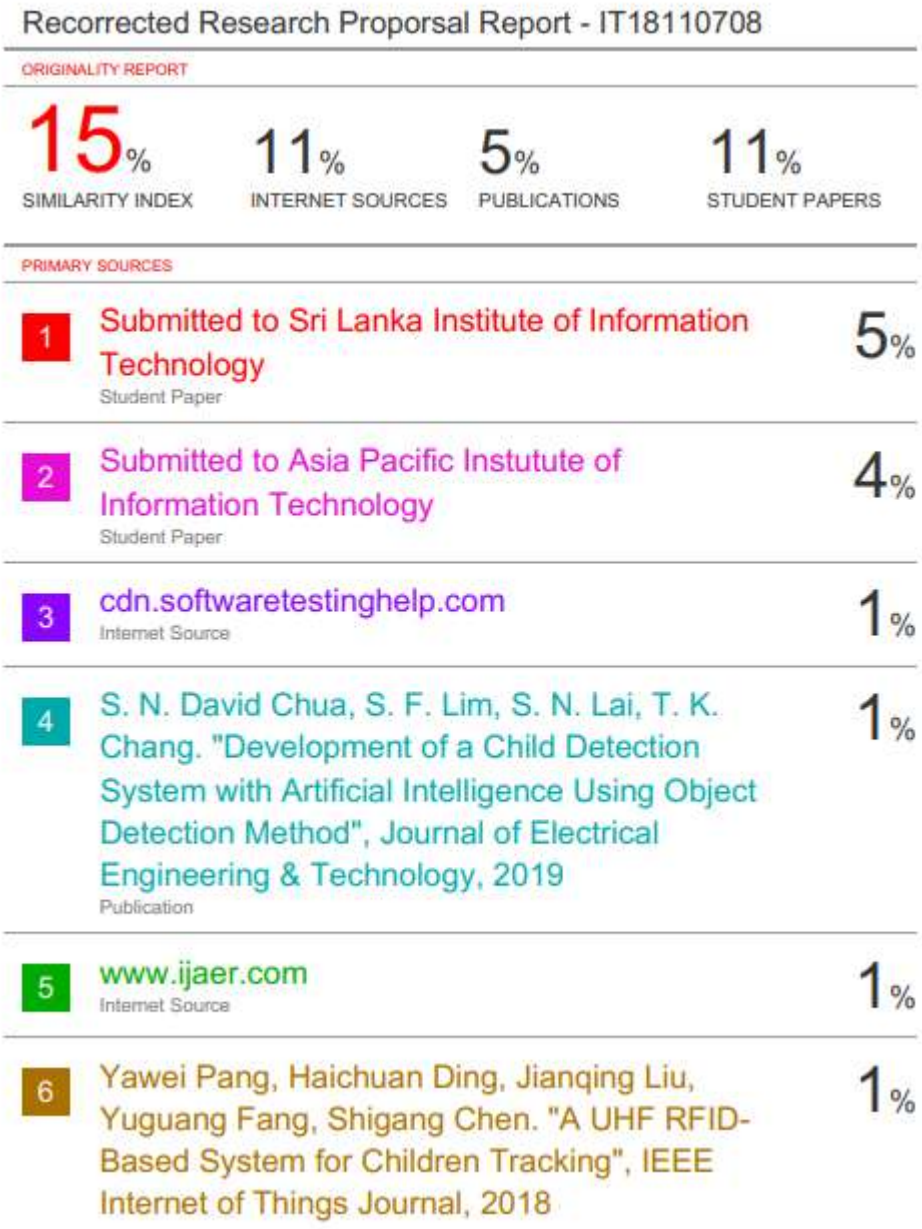
8. APPENDICES

Appendix A - Turnitin Report



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