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Alarm System Designed to Protect Children from the Risk of Ovens in Smart Homes

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***Abstract*– Stoves produce fire for the purpose of cooking food. However, at the same time, ovens in the kitchens of houses represent a source of risk. The level of protection and safety associated with ovens should be extremely high to protect people against any danger. Children usually cannot use stoves properly, like adult people. Therefore, the target of this research is to produce an alarm system based on a camera, which is attached to ovens, detects when a child is very close to stoves, then sounds an alarm voice to warn parents and other people in the house regarding the situation. Thus, the presented alarm device is able to detect any person who may be using the stove, although it can sound the alarm only when the detected person is a child.**

***Index Terms*– Smart Home, Pattern Recognition, People Detection and Context Awareness**

I. INTRODUCTION

THE main purpose of this research is to propose an alarm system, which warns people in the house if a child comes very close to a stove. Thus, the proposed system is able to distinguish between adults and children, and it does not sound the alarm when, for example, the parent is using stove. As shown in Fig. 1, the system aims to release an alarm in regard to the child only, not the adult. Therefore, the proposed system is able to recognize children who come very close to the oven based on two parameters. Firstly, the camera range can only cover the height of the oven. Secondly, in the case of a camera detecting an adult, he/she will be ignored due to the height of that detected adult. Thus, the system sounds an alarm only regarding children and ignores adults.

Advantages of the proposed system:

- Able to detect a person who is in front of stove from any angle.
- Very high “detection of people” rate achieved, based on using the well-known people detection algorithm.
- The system is smart, because it ignores people who are not at risk of ovens, like adults or children who are still crawling. Sounding an alarm about any person inside the kitchen could make the system annoying. In contrast, the proposed system intelligently recognizes the child only and consequently sound an alarm only about children who can touch the surface of the stove.

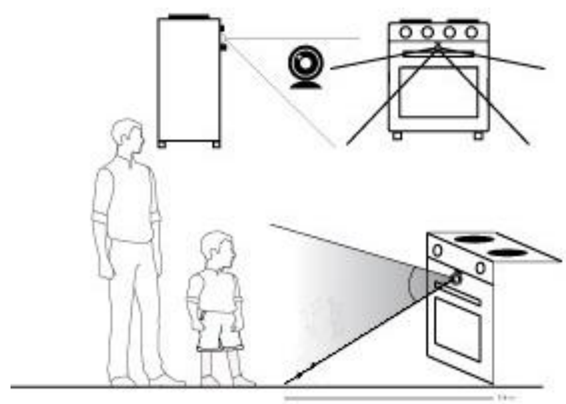

Fig. 1. Descriptive image of an alarm device

II. LITERATURE REVIEW

The development of technologies is reflected in many research areas, including the smart home field. In research on smart home infrastructure, we found that many researchers proposed their publications to assist elderly people [1]–[5]. Other researchers have focused on healthcare services, like [6]–[10], and monitoring children, like [11]. The aim of this research is to monitor the activities of children to manage television viewing, video gaming, and activity on PCs, mobile phones and tablets, as well as all activities that consume children’s time. A wearable device was proposed by [12], designed to monitor the heath conditions of an autistic child and send notifications to parents when, for example, the temperature and pulses of their child are above normal. [13] Proposes a system that aims to protect children by reporting to parents and teachers about a child’s activities, based on technologies, like RFID and GPS/GSM. [14] Produced a system, the purpose of which is to monitor infants and detect their cries. The Computer Vision System Toolbox in MATLAB version R2018b is used in experiments in this research. In particular, the function of detecting people using aggregate channel features (ACF) is selected to be used in the proposed system [15]–[17].

III. EXPERIMENTS AND TEST FUNCTION OF PEOPLE DETECTION

Exploratory experiments are conducted on the function "detectPeopleACF" to evaluate the people detection rate of that function in order to examine the efficiency usage in our system. The camera has been fixed at a height of 2 m from the floor. Then, 20 images containing people had been taken. The function, "detectPeopleACF," was successful in detecting people in 17 images out of the 20 samples, and its failed attempts to detect people in 3 cases. Thus, that function obtained a successful detection rate of around 85%. The samples from number 1 to 10 in Table I contain the child, and those from number 11 to 20 contain an adult. The third column in Table I represents successful/failed detection cases, and the fourth column represents the height of the detected people. Additionally, Fig. 2 shows the height of the detected people in the 17 samples. By observation of the height of the detected children, we found that the maximum height of a child is 2500 pixel, and we designed the system to sound an alarm for only detected person whose height is equal or less than that measurement. The detected person whose height is greater than 2500 is more likely to be an adult, so he has been ignored, and the alarm does not sound when he is close to the oven. Based on that assumption, we found that the system sounded the alarm correctly in 7 cases and mistakenly in only 2 cases, appearing in No 15 and 16 in Table I. Additionally, the alarm did not sound when an adult person was detected in 8 samples, as shown in Table I.

Table I. Detection of people using the "detectPeopleACF" function

No	File Name	Detect People ACF	Length	Detected as Child	Detected as Adult
1	J_1	×			
2	J_2	✓	2500	✓	
3	J_3	×			
4	J_4	✓	2500	✓	
5	J_5	×			
6	J_6	✓	1584	✓	
7	J_7	✓	1584	✓	
8	J_8	✓	1461	✓	
9	J_9	✓	1744	✓	
10	J_10	✓	2255	✓	
11	S_1	✓	3242		✓
12	S_2	✓	3705		✓
13	S_3	✓	3242		✓
14	S_4	✓	3242		✓
15	S_5	✓	2500	✓	
16	S_9	✓	2500	✓	
17	S_10	✓	3242		✓
18	S_11	✓	3242		✓
19	S_12	✓	3242		✓
20	S_13	✓	3705		✓

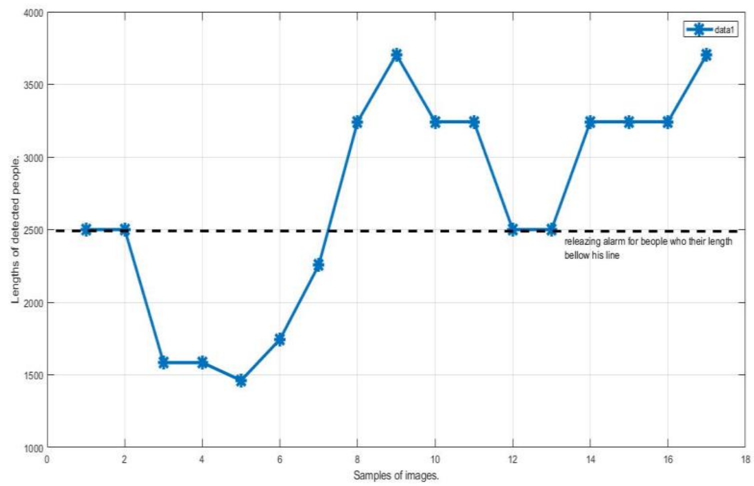

Fig. 2. Length of the detected people

Improvement of an Alarm Detection System

This research aims to produce an alarm device attached to an oven, so the images that the system will consider should be taken from the height of the oven, which is almost 1 m. One of the main benefits of the analysis images that are taken at the height of the oven is that they will reduce the detection of adult people in order to make the system avoid sounding an alarm about adult people as much as possible. Because of that, adult people are out of the range of the camera, and they are more likely to be ignored when the camera is attached to the oven. Therefore, other sets of images were taken from beside the oven, and valuable results were achieved, which appear in Table II and Fig. 3. The system was able to detect people in all 12 samples and recognize that there are children close to the oven based on their heights. Consequently, an alarm was successfully released in all 12 samples, without any child being missed or any mistaken alarm.

Table II. Images that were taken beside the oven at a height of around 1 m

No	File Name	Detect People ACF	Length	Detected as Child
1	Kit1	✓	439	Yes
2	Kit2	✓	168	Yes
3	Kit3	✓	725	Yes
4	Kit4	✓	515	Yes
5	Kit5	✓	943	Yes
6	Kit6	✓	480	Yes
7	Kit7	✓	168	Yes
8	Kit8	✓	400	Yes
9	Kit9	✓	431	Yes
10	Kit10	✓	423	Yes
11	Kit11	✓	168	Yes
12	Kit12	✓	515	yes

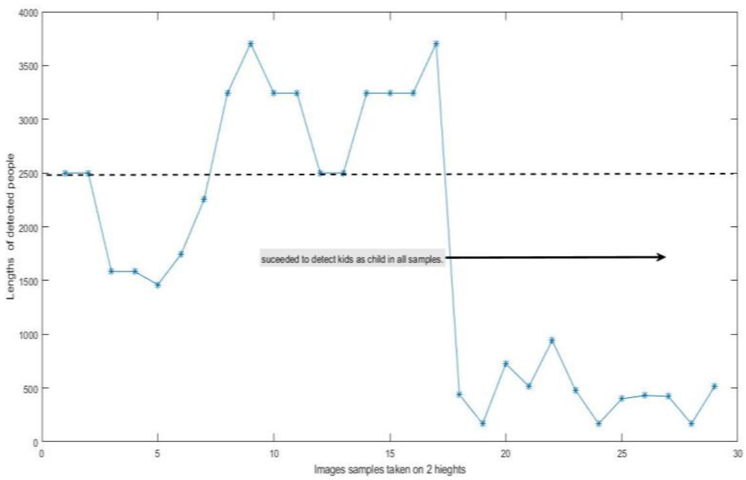

Fig. 3. Releasing an alarm concerning the children in all samples

IV. CONCLUSIONS AND FUTURE WORKS

The author has tried, through this research, to contribute to the safety level in smart home environments. An alarm system has been proposed via a protection device that contains a camera that is attached to an oven, detecting when children—child only not adult people—come very close to the stove and releasing an alarm about such children. A flow chart of the proposed system is shown in Fig. 4. A high achievement rate of child detection has been achieved. In the near future, the author plans to evaluate the capacity of the system to detect children in real time frames to examine the usability of that protection alarm device.

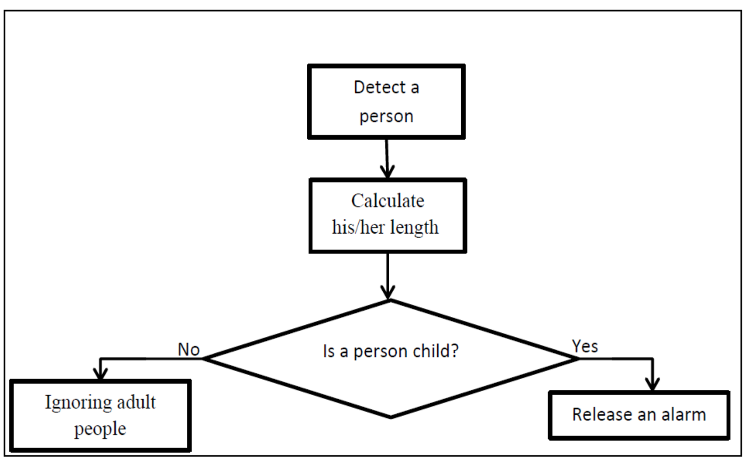

Fig. 4. Flow chart of the detection of people and releasing an alarm about children

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