CSCE 462 - Project Proposal

Fall Detection

Member 1: [redacted]

Member 2 : [redacted]

Member 3: [redacted]

Summary

In this project proposal, we will talk about the fall detection system. This system provides a way to detect if an elderly family member or friend has fallen and requires immediate assistance. As an introduction, we will talk about why the fall detection system is required and describe the environment and constraints of the device in order to justify why the fall detection device is a critical component.

Within the later sections of this project proposal, we will detail the system design of the fall detection system including the concepts driving our design and a detailed description of how the concepts will be implemented into a prototype. Furthermore, a bill of materials, reimbursement request, tentative work schedule, and team coordination agreement will be discussed as well.

Introduction

Many elderly people are left helpless due to falling in their private residence without any immediate assistance. This problem is made worse whenever there is serious injury involved. Currently, there are products on the market that try to prevent this issue such as LifeAlert, a portable medical alert system. However, these types of services require monthly subscriptions. There may also be times when the elder falls unconscious. Automated and accurate detection of falling is still a necessary tool in order for protecting the elderly.

The fall detection system is a fully automated camera system that can detect if an elderly man or woman has fallen based on two cameras and a green article of clothing. The system will also utilize a buzzer in order to detect nearby family members or friends. As a hopeful goal, we hope to implement software that allows for automated calls to external people informing them about the fall.

The fall detection system will be placed in a controlled environment where the first, main camera will be placed on a desk and the second camera will be placed on the floor, a more complex overview of the system will be provided in the section below. Furthermore, the constraints of the fall detection system would be that accuracy could be greatly affected if the target elder is too far from the main camera. Another constraint would be that the system cannot work without two cameras and a green article of clothing.

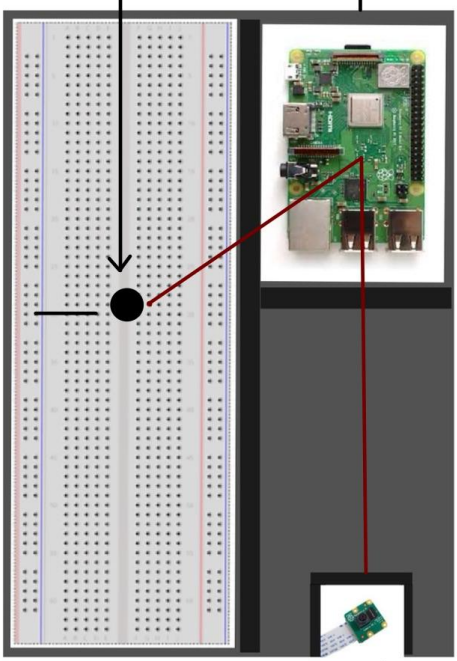
System Design

In our fall detection system, the function is primarily driven by two cameras, one buzzer, and a green article of clothing. The reason we need a green article of clothing is because this will be the main point of body/human detection for our tool. However, before diving into the details let us give a very high overview of how the fall detection detects a fall.

There will be a camera sitting on a table or platform which has an optimized software threshold that should always be detecting the green article above the threshold. If the green piece of clothing is under the threshold, the system will wait thirty seconds until the buzzer is sounded. For the second camera, the camera is on the complete floor directly below the first camera, this camera has a very narrow height threshold. If the second camera detects the green article of clothing at any time, it will sound the buzzer.

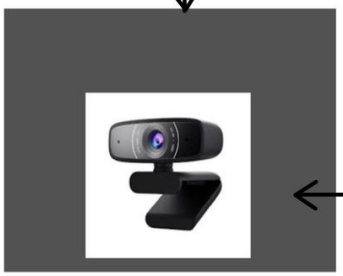
Now that we have discussed the fall detection system at a high-level, we will begin to dive deeper. The green piece of clothing (or any other bright, uncommon color) is a necessary part for our system to work. Furthermore, the camera that is sitting on the desk or high platform is our first layer of detection. We as a team have understood that there are multiple different types of falling which need to be detected. The second camera detects the most aggressive type of falling which is falling straight to the floor, this can be detected by the second camera detecting the green band on the floor. The first camera will catch all other types of falling by waiting for a presence below the height threshold for 30 seconds.

The software we code for this project would be able to detect the elderly through the use of the green band or article of clothing which was described above. The green band will be placed on the upper portion of the body. Also, OpenCV will be utilized for body detection purposes. With both the green band and OpenCV, we can detect if the green band is actually on the person in question and not some other color present within the environment. This will allow us to focus on detecting if the elderly person has fallen or not and not some other arbitrary object in the environment. Furthermore, similarly to the Lane Detection software, we will be analyzing the RGB values of the image in order to detect where the green band is assuming a body is detected as well. With the pixels, we will compute our functions on an optimized number of rows, our height threshold, and determine if the person in question is below that defined threshold. If the person is below the threshold for over 30 seconds based on the first camera, a buzzer will activate. If the person has been detected in the second camera, which is placed on the floor, the buzzer will automatically sound without a wait period.



3D printed Box 1

*gaps show room for error from the 3D printer however all parts should fit snug. A cap will also be created.

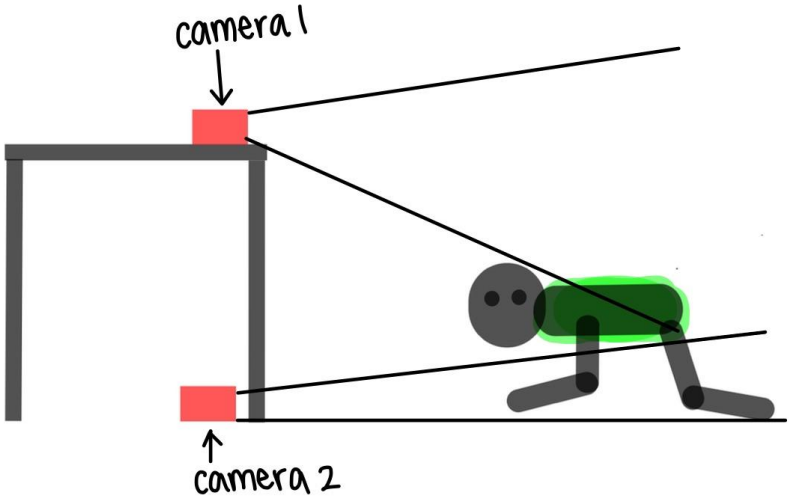


3D printed Box 2

*the USB camera is required since the CSI (camera serial interface) will be occupied due to the first camera.

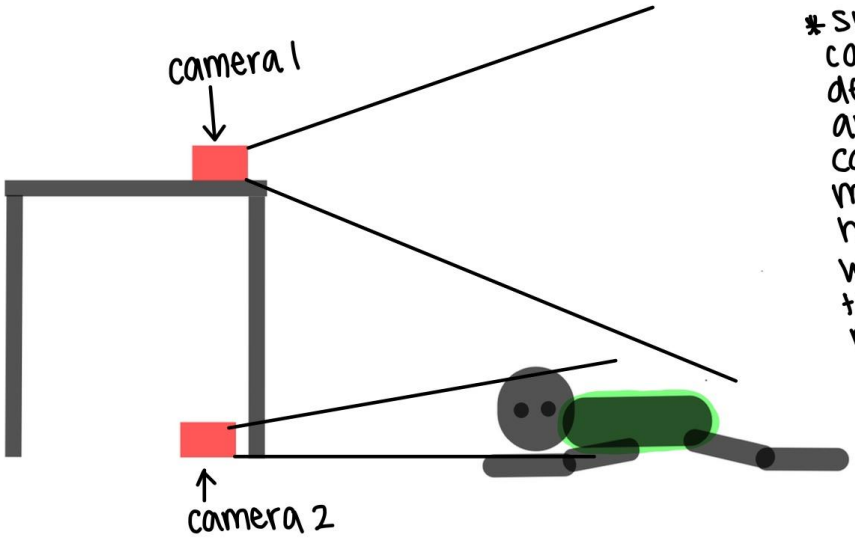
*Also all components will be held down using 3M tape

Detecting Falling on Hands



* From the camera, the second camera is unable to detect the body and the green article of clothing. Also, since it is below our theorized height threshold, the system will wait 30 seconds before alarming.

Detecting Full Falling



* since the first camera does not detect the green article but the 2nd camera does, this means the elder has fully fallen which will sound the buzzer automatically.

The two pictures above show rough examples of how some of our first prototypes will turn out from the 3D printer. In the images above, there are two boxes, "Box 1" is the main container which holds the raspberry pi, breadboard, buzzer, and CSI camera module. The components should fit snug within the box and 3M tape will be utilized in order to keep the components in place. Furthermore, as more iterations of the 3D printed box are created, the components will fit better and a redesign may occur. "Box 2" is the second 3D printed box which will hold the USB camera. The USB camera must be contained within a box since it will be placed on a floor and since the camera is expensive. Also, a USB camera is required since the main CSI module on the RPI will be taken from the first camera and the only other option is a USB camera. Furthermore, both boxes will have the required input and output holes which will allow wires to pass through. At this moment the holes in box 1 will be for power and the usb and box 2 will allow power and wire out. As the project develops, a more detailed and in-depth model will be created in the software which prints the 3D boxes.

A majority of how the fall detection system works is based on software and the cameras. In addition to the buzzer, which informs nearby family members or friends, we are considering creating a telegram bot or an SMS service which will alert pre-selected members of the falling event. The description and explanation of the system above is our first potential solution to the fall detection problem and is subject to many changes throughout the project development lifecycle. We as a team believe that this concept can produce a viable and working prototype.

Explanation of 3 Members

Our team has 3 members which is relatively large in comparison to other final projects for this class. In technical terms, the reason why we require 3 members for this project is because this is the first time any of the team members have worked with computer vision. Neither of the team members are aware of how to begin taking images, analyzing them for specific key features, body detection utilizing OpenCV, and optimizing other features. Some of these features may be optimizing the number of frames taken per second and efficiently analyzing the pictures that are taken/recorded. Also, actually detecting falling within software may be far harder than we expect, the methods that we have described above may be too elementary of a way to accurately detect falling in comparison to other actions an elderly person may perform. Lastly, the briefly introduced telegram bot or SMS service will be difficult to implement as well due to having to connect to external APIs which may or may not require another programming language to use, if the latter is correct, the complexity and difficulty will increase. Due to all these potential considerations which increase

complexity for this project, 3 members are required to accurately and effectively complete this project.

Bill of Materials

Item	Price	Shipping Time	Manufacturer	Link
Raspberry Pi 4	$0.00	None	Owned	N/A
Camera 1	$9.99	3 days	Arducam	Arducam Camera
Camera 2 (USB)	$22.99	3 days	Hrayzan	Hrayzan Webcam
Buzzer	$5.99	3 days	RuiLing (Ships from Amazon)	RuiLing
Breadboard	$0.00	None	TAMU	N/A
Jumper Cables	$0.00	None	TAMU	N/A
3D-printed Prototype Box 1 (Camera and RPI)	$0.00	None	N/A	N/A
3D-printed Prototype Box 2 (Camera 2)	$0.00	None	N/A	N/A

Reimbursement Request

The team WILL request for a reimbursement. No one in the team plans to keep the prototype once completed. However, the Raspberry Pi is personally owned and will not be returned at the end of the project cycle.

Tentative Work Schedule

- Week 1 (10.25-10.29)
    - Complete One Pager

    - Get Ideas Approved
    - Begin Project Proposal
- Week 2 (11.1 - 11.5)
    - Receive Feedback for Project Proposal
    - Make refinements on design and ideas
    - Order all required materials
- Week 3 (11.8 - 11.12)
    - Begin initial software implementation
    - Calculate initial threshold estimates
- Week 4 (11.15 - 11.19)
    - Continue building prototype
    - Make software refinements
    - Brainstorm possible test cases to ensure success of prototype
    - Begin initial testing phase
- Week 5 (11.22 - 11.26)
    - Complete Testing
    - Begin Final Presentation Prep
- Week 6 (11.29 - 12.3)
    - Final Presentation Completion

Team Work Coordination and Cooperation Agreement

The team agrees to have equal technical contribution throughout the project. We will also ensure to be good communicators, and have daily meetings, so we don't fall behind on the completion of the project. Our main platform for communication will be slack, as well as messages for a backup. We will constantly ask for feedback, and make immediate refinements as a team to achieve our week.