TWO FACTOR LOCK FOR VISUALLY DISABLED

Capstone Project Proposal

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Mentor Consent Form

I hereby agree to be the mentor of the following Capstone Project Team

Project Title: TWO FACTOR LOCK FOR VISUALLY DISABLED		
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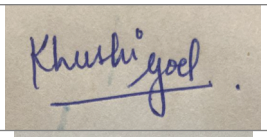
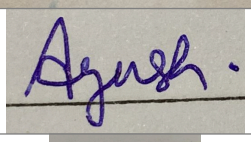
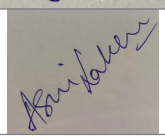
102017112	Khushi Goel	
102016100	Ayush Nagpure	
102016041	Asmi Lakhani	
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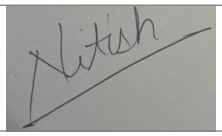
102196010	Nitish Kumar	

NAME of Mentor: **Dr. Sushma Jain**

SIGNATURE of Mentor: . . . . . .

Project Overview

Visually impaired people face limitations to carry out movements and their daily activities without assistance. So this project aims to build a two-factor secure lock that can be used independently by visually disabled people without any assistance. This 2-factor lock would first use face detection and then hand gestures to unlock the door. The image data from the camera will be fed to face recognition code and processing will be executed. This module will consist of a database of allowed faces with a blind person being the master with the ability to enter the gesture sequence. If the person is a master user then the system will generate a prompt along with an activation sound to enter the hand gestures. The hand gesture module will be able to recognize the hands of the person in front and a deep learning model will be trained to recognize gestures in sequence. Once the hand gestures match, a trigger signal will be sent to the latch module. The latch module upon receiving the trigger signal will open the latch and it closes automatically when the person enters the facility.

Problem Statement

The conventional lock and key method cannot be used by a visually disabled person. Also, there exist other automated systems like the fingerprint scanner, retina scan but all of these are not very useful for such people.These all solutions mentioned above cannot be used independently by visually disabled people ,they need someone's support to use them.Also these systems are not very secure so a locking system is needed which is both secure and convenient to use.

Need Analysis

Visually impaired people face a lot of problems in their day to day activities. They face limitations to carry out movements and their daily activities without assistance. Thus special considerations are required to make the systems utilizable for them. There is no such secure lock that exists for blind people.The current locking system available in the market cannot be used by visually disabled person on their own.Also these locking system are also not very safe.We are trying to build a lock which can be used independently by them and has two factor authentication i.e. face recognition and hand gesture.This lock ensures safety which is one of the biggest concerns faced by them and also convenience.

- **Accessibility**: Ensure that the authentication method is accessible for visually disabled individuals by providing alternative methods such as audio instructions or tactile feedback.
- **Usability**: The authentication method should be easy to use and navigate, regardless of the user's level of visual impairment. Consider user testing and feedback to refine the user experience.
- **Compatibility**: Ensure that the authentication method is compatible with a range of devices and platforms, to accommodate a variety of assistive technologies and operating systems.
- **Support:** Provide adequate support and documentation for visually disabled individuals, including instructions for setting up and troubleshooting the authentication method.

Literature Survey

Theory Associated With Problem Area

A report by the World Health Organization (WHO) and International Agency for Prevention of Blindness (IAPB) stated that there are approximately 285 million people around the world who are visually impaired. Visually impaired people face limitations to carry out movements and their daily activities without assistance. Moreover, almost 90% of them have to depend on others to ensure their safety. Thus special considerations are required to make the systems utilizable for them. There is no such secure lock that exists for blind people. So this project aims to build a two-factor secure lock that can be used independently by visually disabled people without any assistance. They can check and control who is at the door. This helps them to move freely in the house without any fear that someone can enter without their knowledge or permission.

Existing Systems and Solutions

The literature survey showed that a limited number of studies were conducted focusing on assistive systems for visually impaired users, and even fewer automatic door authentication systems exist for the visually impaired. The existing systems do not address all the needs of the visually impaired but have certain features that we seek to inculcate in our research, like face recognition, voice command control, and gesture control. Some of the existing devices and systems are the Swing Door Lock [1], a flexible door handle that has numbers on a circular Numpad, and with the help of upward or downward movements of the handle, the number combination set by the user can be entered. Another device in place is the YALE ENTR Smart Door Lock [2], which features a keyless lock that can be unlocked using a smartphone or a Bluetooth-enabled device, fingerprint reader, or touchpad reader.

Research Findings for Existing Literature

Table 1: Research findings for existing literature

S. No	Author	Paper Title	Tools/ Technology	Findings	Citation
1	Nitesh Saxena and James H. Watt	Authentication Technologies for the Blind or Visually Impaired.	Computer Vision	Usable Security research aimed at disabled user population becomes extremely challenging is that disabled human subjects are not easily accessible to perform usability studies.	[3]
2	Khan *et. al.*	Secure biometric template generation for multi-factor authentication	Image Processing, Biometric sensors.	It involves using a secure sketch-based approach to generate a binary template from the original biometric data. The binary template is then hashed using a secret key to create a secure and encrypted version.	[4]
3	Yugashini *et. al.*	Design and Implementation of Automated Door Accessing System with Face Recognition	Computer Vision, GSM module	Facial recognition gives good results and is highly secure as the face is matched with database, alerting users via SMS.	[5]

4	Shah *et. al.*	Biometric Voice Recognition in Security System	Signal processing	The system successfully recognizes the user's voice, by feature extraction and comparing it with that stored in the database, instructing Arduino to open the door, and rejects all the other impostor's voices.	[6]
5	Daniella Briotto Faustino and Audrey Girouard	Understanding Authentication Method Use on Mobile Devices by People with Vision Impairment	Computer Vision,Image Processing	It showed that majority consider fingerprints to be the most secure and most accessible user authentication methods.Survey showed that blind people considered patterns the least accessible methods.	[7]

- Nitesh Saxena and James H. Watt [3] have majorly found from their research that one main reason Usable Security research aimed at disabled user population becomes extremely challenging is that disabled human subjects are not easily accessible to perform usability studies.
- Khan *et. al.* [4] have used a secure sketch-based approach to generate a binary template from the original biometric data. The binary template is then hashed using a secret key to create a secure and encrypted version.

- Yugashini *et. al.* [5] found that facial recognition gives good results and is highly secure as the face is matched with database , alerting users via SMS.

- Shah *et. al.* [6] have developed a system that successfully recognizes the user's voice, by feature extraction and comparing it with that stored in the database, instructing Arduino to open the door, and rejects all the other impostor's voices.
- Daniella Briotto Faustino and Audrey Girouard [7] have conducted a survey that showed that majority consider fingerprints to be the most secure and most accessible user authentication methods.Survey showed that blind people considered patterns the least accessible methods.

Problem Identified

Table 2: Problem Identified

Exciting Approaches	**Limitations**	**References**
Improved accuracy in face recognition	It is difficult to achieve very high accuracy with most existing algorithms, owing to hardware limitations.Cost is more.	[8] and [9]
Cost structure	The current research is mostly funded by R&D departments of big startups/companies, where the priority is not to cut down prices, making it expensive.	Many open pieces of research
Speed and efficiency	Decreasing false positives, as well as acting as fast as possible. This isn't possible with the equipment being used currently.	[2]

Objectives

The proposed system seeks to meet the following proposed objectives:

- To study about the problems and the needs associated with visually impaired people.
- To develop a 2-factor authentication lock using 2 modules - face recognition and hand gesture recognition which will independently run on raspberry pi.
- To apply an algorithm to minimize the effect of background on face recognition and hand gesture recognition.

Methodology

The following methodology will be followed while working on the proposed system:

1. A proximity sensor will be used to detect the presence of a person in front of the lock. It will trigger a sound on the buzzer and activate the camera module.
2. A Face recognition module will be developed. The image data from the camera will be fed to face recognition code which will be deployed on either a raspberry pi or on AWS where the processing will be executed. This module will consist of a database of allowed faces with the blind person being the master user with the ability to enter the gesture lock. The master would be able to maintain a record of known faces on the database. Local storage or AWS s3 bucket shall be used. Depending on the person in front of the camera ,the following possibilities will be incorporated:-

- If the person is the master user then the system will generate a prompt along with an activation sound to enter the hand gesture sequence as saved by the master .
- If the person has his/her face registered into the system, the module will identify the person and give a speech output recognizing the person.
- If the person falls into neither category, the sound module will generate a normal alarm.

3. A hand gesture recognition module will be developed. The module will store a passkey corresponding to the sequence of hand gestures as demonstrated by the master user. The passkey can be changed at will only by the master user. This module will consist of the following features:-

- The module will be able to recognize the hands of the person in front and apply background reduction on the images captured. Series of image processing techniques like erosion, dilation, and thresholding will be applied for this purpose.
- A deep learning model will be trained to recognize the gesture in the input image. The model will recognize gestures in a sequence.
- The system will maintain a stack of the gestures entered and convert it into a passkey. If the passkey matches with the accepted key, a trigger signal is sent to the latch module.

4. The latch module upon receiving the trigger signal will open the latch for 10s when the person can enter the facility and the latch will close automatically after that.
5. The device will also allow storing face images of some known faces to the master user. The face images will be stored in a database hosted on cloud services and facial recognition techniques will be used accordingly.
6. A graphical user interface (GUI) will be developed to execute the set, reset and register facilities provided by the lock.
7. The following framework will be followed during the development procedure of the proposed system:

- Front End - A GUI needs to be developed as mentioned above.
- Backend - Python will be used for this purpose as it has proven to be very dynamic for developing applications in a short period using a plethora of
  open source libraries that come with it.
- Database - Since most of the processing is proposed to be done on the cloud servers, AWS S3 Bucket will be useful and fast. Moreover, it also uses a NoSQL database which is a cheap and fast storage method nowadays.
- Model Building - Python provides two of the most versatile libraries, namely Tensorflow and Keras, for developing deep learning models. Therefore it proves to be the best language for developing hand gesture recognition and facial recognition modules.

- Deployment – Naturally the models developed will be deployed on AWS using the EC2 instances services. EC2 provides a variety of tools that a developer can play around with that includes using network protocols and Linux operating system services.

Project Outcomes & Individual Roles

The major outcome of our project will be a two-factor lock which will be first of all easy and convenient to use for visually disabled people. Secondly, it will be safe to use because safety is one of the biggest concerns of these people. We will ensure a well authenticated secure locking system which will use two modules-face recognition and hand gesture recognition.

Table 4: Individual Roles

S.No	**Task**	**Individuals involved**
1.	Circuit Design	Nitish Kumar, Khushi Goel
2.	Raspberry Pi Code	Ayush Nagpure, Khushi Goel
3.	Face Detection Module	Nimit Gupta, Nitish Kumar
4.	Hand gesture Module	Asmi Lakhani, Nitish Kumar
5.	Latch Module	Asmi Lakhani, Nimit Gupta
6.	Voice Triggering	Ayush Nagpure
7.	Integration b/w hardware and web services	Ayush Nagpure, Nimit Gupta
8.	Documentation	Khushi Goel, Asmi Lakhani

Work Plan

The following plan will be followed to complete the project:

Table 3: Work plan

Sr. No.	Activity	Month	Feb Apr		May-Jun				Jul-Aug				Sep-Oct				Nov-Dec			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Project planning and study of hardware, software requirements	Plan																		
		Actual																		
2	Face recognition module development	Plan																		
		Actual																		
3	Gesture module development	Plan																		
		Actual																		
4	Design Optimisation and Modifications	Plan																		
		Actual																		
5	Circuit design and raspberry pi coding	Plan																		
		Actual																		
6	Integration between hardware and web services	Plan																		
		Actual																		
7	Testing and Modification	Plan																		
		Actual																		
8	Final Report	Plan																		
		Actual																		

Course Subjects

The following course subject's knowledge will be used in the development of the proposed system:

Subject code	Subject name	Description
UCS503	Software engineering	The methodology of agile will be used throughout the process of making the software for this project. As taught in this subject, all the well-suited diagrams and other different kinds of methods will be implemented like SDLC, scrum, UML diagrams, etc. Different kinds of testing strategies will be implemented which we learned in the practical implementation throughout this course.
UCS310	Database Management Systems	All the logical and physical database designs will be implemented as taught during this subject. Analysis of database design using E-R data model will be used as implemented during the project for this course. All the conceptual and practical knowledge regarding the database management gathered during this course will be implemented in this project.

UML501 and UCS411	Machine Learning and AI	By virtue of these two concepts, different ML models will be used to perform hand gesture and face recognition as it is a subfield of AI which aims to teach computers the ability to do tasks with data, without explicit programming. The concept of training ML models to perform computational tasks is used here during the development of the device. All the conceptual and practical knowledge regarding the ML and AI gathered during this course will be implemented in this project.

References

[1] Homecrux (2017). Swing Door Lock comes with blind-friendly mechanism – homecrux.com [Online]. Available: https:// www. homecrux.com/swing-door-lock- comes-blind-friendly-mechanism/61902/

[2] Yale smart Living (2016). ENTR Smart Door Lock [Online]. Available: https:// www.yalelock.it/en/ yale/yale-italy/smart-living/ smart-door-locks/

[3] Nitesh Saxena and James H. Watt "Authentication Technologies for the Blind or Visually Impaired", 2010.

[4] Salman H. Khan, M. Ali Akbar, Farrukh Shahzad, Mudassar Farooq, Zeashan Khan, "Secure biometric template generation for multi-factor authentication", Volume 48, Issue-2, pp. 458-472, February 2015.

[5] I.Yugashini, S. Vidhyasri, K.Gayathri Devi, "Design And Implementation Of Automated Door Accessing System With Face Recognition", International Journal of Science and Modern Engineering(IJISME), Volume-1, Issue-12, November 2013.

[6] H.N. Mohd. Shah, Mohd. Z.A Rashid, Mohd. F. Abdollah, M.N. Kamarudin, C.K. Lin, Z. Kamis, "Biometric Voice Recognition in Security System", Indian Journal of Science and Technology(IJST), Volume. 7(2), pp. 104–112, February 2014.

[7]Daniella Briotto Faustino and Audrey Girouard, "Understanding Authentication Method Use on Mobile Devices by People with Vision Impairment", the 20th International ACM SIGACCESS Conference, pp. 217–228, October 2018.

[8] O. M. Parkhi, A. Vedaldi, A. Zisserman Deep Face Recognition British Machine Vision Conference, 2015.

[9] D. King, "High Quality Face Recognition with Deep Metric Learning," blog.dlib.net [Feb 12, 2017] [Online]. Available: https://blog.dlib.net/2017/02/high-quality- facerecognition-with-deep.html [Accessed Feb 27, 2021]