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Advanced smart lock

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Abstract
With all the more devices being added to the internet of things and every aspect of life getting digitilized, the need for high security is becoming all more important. The earlier password protection methods aren't considered effective anymore since they could be shared between individuals or can be obtained by using some sophisticated permutation techniques. And the keypad technology which was very popular in recent years has its set of drawbacks. There are research which have found that hackers could decipher the acoustic sound produced while typing keys and hence crack the password. These setbacks can be forestalled using biometric technology. The popular biometric technology includes face recognition, iris scan, fingerprint and voice recognition. In this paper we will focus on fingerprint and voice recognition.

Keywords: Voice recognition, fingerprint sensor, authentication

Introduction
Security is the most important aspect of everyone's life. And the means of Security has changed a lot over the years. In the recent years, use of biometrics for the purpose of security is gaining popularity because of many advantages. On main thing is, its unique to every individual. There is no way 2 persons on earth could have same fingerprint or voice or same pattern on iris scan. We are taking advantage this uniqueness in the technology.

Problem statement
The physical way of opening and closing the door using lock and key is not so effective since it could be broken or a duplicate key could be made. There are also chances of individual misplacing the key. As we have discussed earlier keypad pins can be deciphered using the sounds they make. Moreover all the above methods aren't convenient for especially abled people.There comes the need for the security method which is easy to use but won't compromise with the purpose. And voice recognition and fingerprint technology can be the solution.

Evolution of fingerprint and voice recognitin technology
It all started with the basic lock and key. First with wood and then using metals. Roman civilization somewhere in 300 AD is believed to develop this lock and key technology. But for all the needs of today lock and key won't be efficient. We need something better than it. Because the keys can be easily duplicated and used by the intruder. That is when we use Speech recognition and fingerprint technology.

Natural language processing (NLP)
It all started with the basic lock and key. First with wood and then using metals. Roman civilization somewhere in 300 AD is believed to develop this lock and key technology. But for all the needs of today lock and key won't be efficient. We need something better than it. Because the keys can be easily duplicated and used by the intruder. That is when we use Speech recognition and fingerprint technology.
We use natural language processing techniques in Automatic speech recognition technology. It is the approach through which computers are made to learn, read and produce information in the form of human languages. There are 2 important fields in NLP are: language processing and language generation [1]. Language processing has the word suggests is the analysis of language and generation is producing a suitable reply for the above processed language. In the process of language generation, we also need to planning capability so that there won't be ambiguity in the generated language.

Its been century since the research on NLP began but we haven't been able to obtain the proper machine that could do the job. The earliest research was conducted several decades in 1940's.Machine translation is the process of automatically converting the message from one natural language to another, without the change in context and meaning. And Weaver and Booth were the first ones to work on Machine translation related projects in the 1940's.But it was Weaver's Memorandum in 1946 which set a milestone in machine translation and this made him to be called as one of the pioneers of Machine translation. These Memorandum which had 4 proposals suggested more effective ideas rather than just word-word translation, which failed miserably due to its limitations. Earlier Machine translations just referred dictionary and reordered the words after completing the process of translation, but this didn't solve the problem of lexical ambiguity, hence led to poor results. And the Memorandum addressed this problem. The other major step in this field was when Chomsky published Syntactic structures which introduced the idea of generative grammar. And it is at this point of time other fields of NLP such as speech and voice recognition began to emerge.

Voice Recognition

Thomas Edison's phonograph in 1877 became the first device to record and reproduce sound. Though the accuracy was very low it's a major step in the field of speech recognition. It was again in 1936, voder (simplified term for voice encoder) was developed by Bell labs. It's speech synthesizer that could produce speech just like humans. It's a machine which produces sound with variations instead of monotone. But this machine was not able to recognize human speech.

In 1952 the first machine capable of recognizing human speech was invented by Bell laboratories. It was named "Audrey". It was able to recognize numbers from 1 to 9 with pauses in between. Back then Audrey occupied 6 foot rack and was expensive. As it was designed using vacuum tube circuitry, it consumed a lot of power and was difficult to maintain. Its application in the real world was limited because it couldn't understand anything other than numbers and the accuracy was pretty low. Also in most situations, time taken for manual dialing of a number is equally fast as voice dialing. So at the most it could have been used for voice dialing in customer service sectors.

The "Shoebox" demonstrated by IBM In1962, could understand 16 spoken languages. There were efforts all over the world in the field of voice recognition and soviet scientists came up with the machine that could recognize 200 words in English.

The major breakthrough in this field was when Defense Advanced Research Projects Agency

(DARPA) funded 5 years of speech recognition research and this program to the creation of Harpy, machine capable of recognizing 1,011 words. In the next coming years, the approach for voice recognition changed. Scientists started using hidden Markov model instead of earlier models such as Acoustic Phonetic approach, Pattern recognition approach and template based approach. These change made a significant difference in the field of speech recognition.

And this led to the development of Tangora by IBM, which is a machine having capability to recognize 20k words. Then with the invention of Doll Julie in which we can train the toy to respond to particular voice, voice recognition technology entered homes and became accessible to public instead of something that seems very distant technology.

It is in 1990 Dragon launched Dragon dictate, which could recognize continuous speech at the rate of 100 words per minute. There is no going back ever since. By 2002, Microsoft integrated voice recognition with its products Windows Vista is the first version of windows to have speech recognition technique. With the introduction of Siri by apple, voice recognition entered the field of home automation.

Fingerprint Technology

Fingerprint identification is the one of the most accurate and reliable technology to identify an individual. The history of this technology dates back to various centuries. It mainly works on the basis examining the distance between ridges and loops in finger. These ridges and loops were first observed by Marcello Malpighi in 1686.And Sir Francis Galton was the first person to prove that these fingerprint pattern are unique and can be used to identify individuals. He is also the person to discover that fingerprint of every individual remains constant in their lifetime. He said there are 3 common types of fingerprints - loop, whorl and arch. And this classification holds true till this date [2, 3].

Methodology

Both voice recognition and fingerprint technology has 2 phases

1. Enrollment
2. Verification

In the enrollment phase, the user will register their fingerprint or the voice and that is stored in the database. During verification, the input obtained is compared with the existing data (fingerprint or voice) and if it matches with any of previously stored data, then the user will be given access to open the door.

We will be using the Hidden Markov Model (HMM) for voice recognition technique [4, 5]. It is a way to model sequential data. It this model, we won't know the underlying data. In simple terms, we will just know the observational states not the states that led to it. In voice recognition technology, data refers to the voice input. This is the model used in Google assistant [7]. And we use Google assistant to convert our speech to texts. So it happens in following steps

1. Google first records the speech as interpreting parallelly would take a lot of computational power.
2. It breaks the speech into individual sounds. Then the sound is interpreted and converted to text.
3. If the text message is "Open door" and the voice is enrolled, the person will be given access.

During enrollment, every user has to place their finger on the sensor twice, upon which an image is formed and stored. During verification, the image generated by placing a finger on the sensor by the user is compared to all the existing templates [6, 7]. Below is the pictorial representation of fingerprint sensing process.

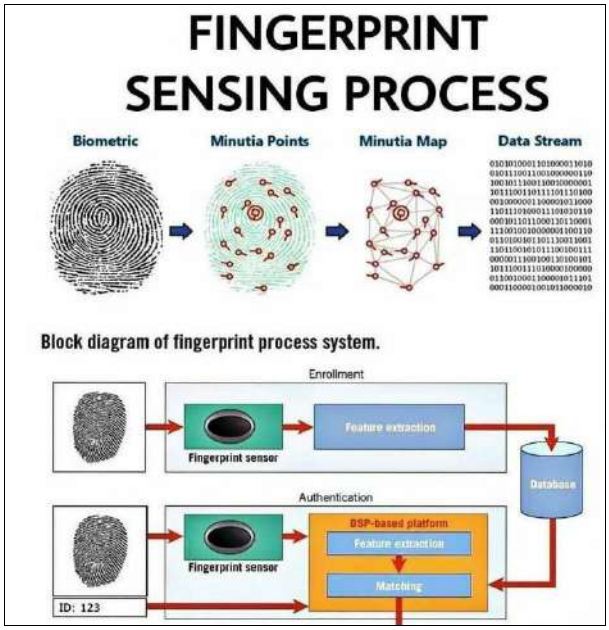

Fig 1: Visualization of Fingerprint sensing process

Electronics and components

Arduino

It is an open source platform used for projects related to electronics. It consists of a microcontroller and IDE (Integrated Development Environment) on which we can write our code and then later upload to the physical board. i.e, microcontroller. The board has various input/output pins that can be interfaced with other circuits and breadboards. It also has an interface for Universal serial bus (USB) on some models which makes is stand out of other programmable circuit boards. Earlier programmable circuit boards need a separate piece of hardware called programmer to load new code onto the board. But Arduino needs just USB connection. The simplified version of C++ used by Arduino makes it easier to program. It has lots of peripheral support including third party libraries.

Fig 2: Image of Arduino

Fingerprint Sensor

This is used to enroll the fingerprints and its verification. During enrollment, every user has to place their finger on the sensor twice, upon which an image is formed and stored. S During verification, the image generated by placing finger on the sensor by the user is compared to all the existing templates

Fig 3: Image of fingerprint sensor

Adafruit IO and IFTTT

IFTTT which is short form of "If this then that", is an automation tool that helps to connect different apps and devices. It is available as a website and app for both ios and android which makes it even more convenient.

Ada fruit is the cloud service which displays the data in real time. It supports various hardware such as Arduino, Raspberry pi, Esp2866. It provides libraries for a wide range of programming languages. The data is visually represented in various charts and graphs which makes it user friendly and stand out from other IoT cloud service providers.

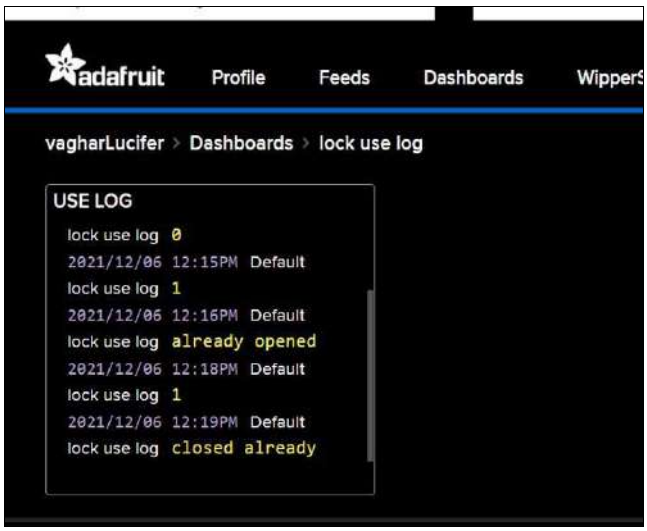

Fig 4: Image of Ada fruit screen which is running some program

Implementation

We have 2 modules-hardware and software.

Software module

In the software module, we have an app which acts as an interface that accepts the inputs i.e, voice commands and fingerprint. The android app uses Google assistant to convert the speech to text. The app should be allowed to record the voices prior to using the app. The app runs effectively on the smartphones with operating system Android 8.0 and above

Main interface

D. Relay module

Fig 5: Image of Relay module

It is a device which is electrically operated and can be used to control the flow of current. They can work with low voltages (3.3V) like ESP32 or high voltages (5V) like Arduino.

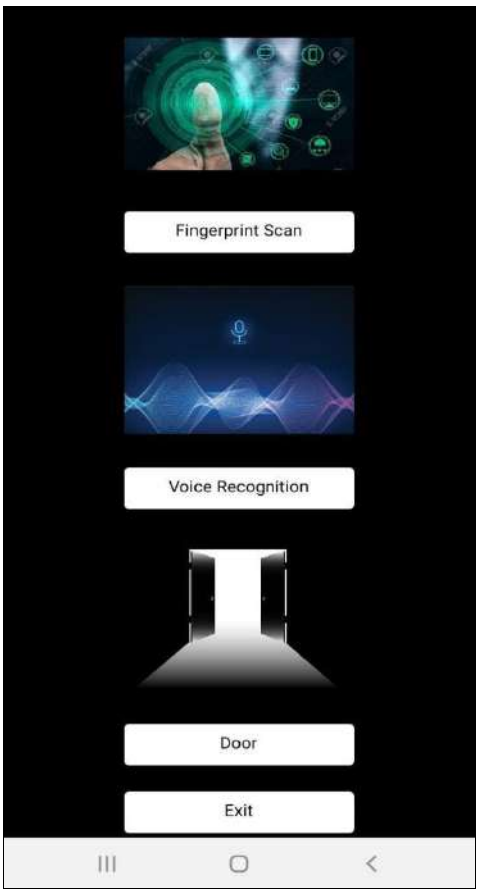

Fig 6: Main interface of our App

Here we provide an interface, where a user can choose to use a fingerprint method or voice recognition to open the door. If in case both are not convenient, they can directly open the door using the third option.

If they click opt for fingerprint verification option, we will have below interface which asks the user to place the finger on the sensor. Additionally, it also displays whether the android has fingerprint scanner, app has permissions to access it and are there fingerprints already enrolled in it.

Fig 7: Fingerprint Scanning Interface

If the user chooses to use the voice recognition option, we will have the below screen. When they click on the microphone option, it requests permission to use the microphone and the voice starts to get recognized and conversion to text starts.

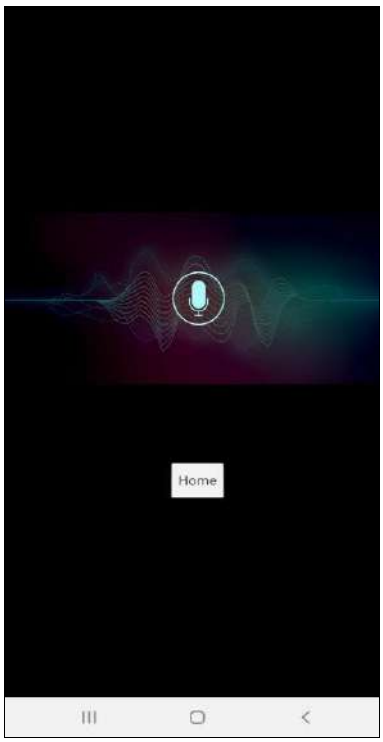

Fig 8: Voice Recognition Interface

If the user chooses to go for the third option, we will have the below screen.

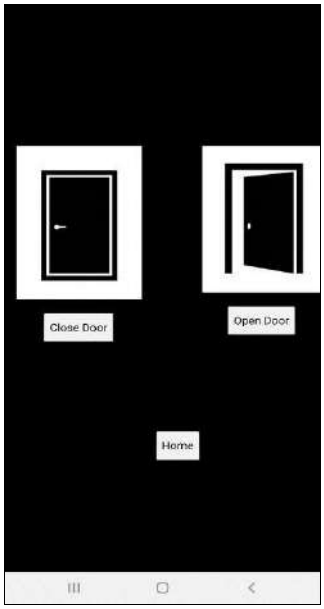

Fig 9: Interface where you can directly open and close door

Hardware Module

The hardware components used are Fingerprint module, Arduino UNO, magnetic lock, Bluetooth module, relay module

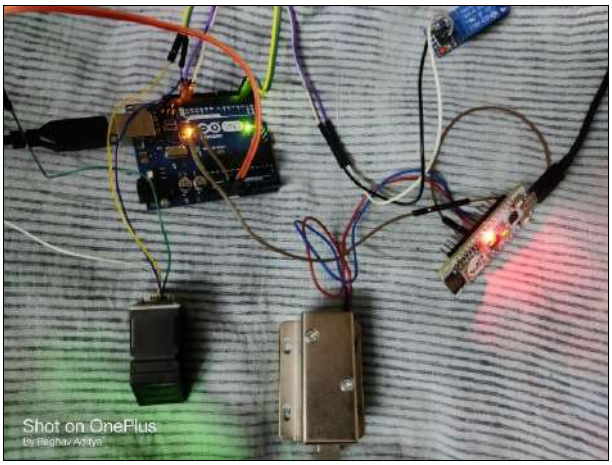

Fig 10: Project Hardware

Circuit Diagram for fingerprint Technology

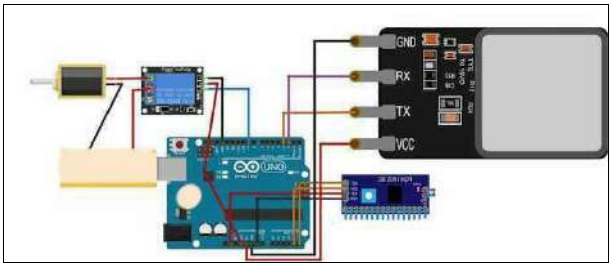

Fig 11: Circuit Diagram for fingerprint technology

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