IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 21, Issue 5, Ser. I (Sep - Oct 2019), PP 01-12
www.iosrjournals.org

Voice Recognition Door Access Control System

AdekolaOlubukola D.[1], AkinsanyaAdeoluwa[1], OlufowobiAbraham[2],BabajideOyetunde[3], SomefunOlawale M.[4],Oduroye Ayorinde[5]

[1, 2, 3, 4]*Computer Science Department, Babcock University, Ilishan Remo, Nigeria*
[5]*Computer Science Department, Caleb University, Imota, Lagos, Nigeria*

Abstract: *This study reviews how voice recognition can be used in making it easier for people with disabilities to access door systems and provide better security to lives and properties. Popular Biometric technology includes iris scan, fingerprint scan and facial recognition. These biometric identifiers are unique and distinctive based on features and characteristics used to identify different individuals for the safety and security of their lives and properties. Unfortunately, these biometrics can be hacked. An individual's finger can be cut off to perform fingerprint scan, an eye ball can be removed to perform an iris scan, a pin or password can be hacked, and a picture of the individual can be used to perform facial recognition. These setbacks can be averted with voice recognition biometrics technology. Voice biometrics technology is more accurate, faster and more convenient. The goal of this research study is to develop a door access control system that uses voice recognition algorithms to provide people with a quick way to unlock their doors and at the same time ensure their safety and security. The system consists of two phases which are the testing phase and the training phase. The training phase is when properties from a speech is extracted and stored in a database. During the testing phase, the intents from an individual's speech would be extracted using voice recognition algorithms and matched to voice models. If a match is found, then a user is granted access.*

Keywords:*Access Control, Biometrics, Security, Voice Recognition*

Date of Submission: 26-08-2019 Date of Acceptance: 10-09-2019

I. Introduction

The advent of fifth generation computers makes life easier for the whole world and changes the way daily activities are carried out. Fifth generation computer was an initiative by Japan's Ministry of International Trade and Industry which started in the 1980s [1] and is still currently in development till date. It aimed to create an "epoch-making computer" with supercomputer-like performance based on ultra-large-scale integration (ULSI), parallel processing hardware and to provide a platform for future developments of Artificial Intelligence (AI) software. AI is an emerging branch of computer science that tries to create means and method of making computers behave, think and learn like humans. The main features of the fifth generation are ULSI technology, development of AI systems, development of natural language processing (NLP), advancement in parallel processing, advancement in superconductor technology, more user-friendly interfaces with multimedia features and availability of very powerful and compact computers at cheaper rates. Some computers in this generation are Desktop, Laptop, Notebook, Ultrabook, Chromebook, Smartphones and Tablet. High-level languages such as C/C++, Java, .Net, Golang and so on are used in this generation. Examples of widely used fifth generation systems include artificial intelligent robots, neural networks, gaming systems, expert systems to make decisions in real-life situations, Natural language understanding and generation, voice recognition and so on.

Voice recognition also known as automatic speech recognition (ASR) or Speech to Text (STT) is a sub-field of computational linguistics that deals with decoding the human voice and identifying the speaker. Recently, voice recognition has found applications in; telephony, in-car system, education, access control systems and the likes. It is currently used in smartphones and different types of hardware in performing different activities or commands using virtual assistant software. The technology allows users complete their transactions using interactive voice response systems without dealing with bulky touchtone menu and also helps organizations to get rid of the burden of customer service agent costs. Voice recognition also contributes a lot in education to help students in their pronunciation skills and furthermore, speech to text application help students create their notes/documents by speaking without spending most of the time typing.

Voice recognition is one of many biometrics applications with lots of applications in access control systems. "According to a Unisys survey, consumer preference rank on biometric measures are: voice recognition (32%), fingerprints (27%), facial scan (20%), hand geometry (12%) and iris scan (10%)" [2]. Based on this survey, voice recognition biometric system is highly preferred by consumers. Voice recognition would

be used in unlocking different types of doors such as office doors, garage doors and gates by reading in the unlock phrase or password. The voice recognition system needs to pass through the training phase to understand and learn different voices from different individuals and then pass through the testing phase to ensure the system works properly in recognizing voices from different individuals. In this system, different individuals would read in phrases for unlocking a door system such as "open sesame", "unlock door", "hey door open up" and so on. The system analyses the voice and extract different properties and intents from the voice. These properties are saved to a database so that when next that voice is heard by the system, it is matched with the properties in the database and corresponding feedback is given.

II. Problem Statement

Security is one of the major concerns of any individual or organization and over the years with the advancement of technology, different approaches have been used to protect lives and properties through door access control systems. The traditional way of unlocking a door is through the use of a physical key to open the door or turning the door knob. Physical keys used to unlock doors are susceptible to duplication and can be misplaced by individuals. Also, the common biometric technologies and other technologies that are being applied are prone to various kinds of failures for instance an individual's finger can be cut off to perform a fingerprint scan, pin can be hacked using various tricks or permutations, an individual's picture can be used for facial recognition. Moreover, it is worse for people with physical disability for instance, it is difficult for a person in a wheel chair to unlock a door system without an extra aid or support from someone else. Hence, the need for a voice recognition access control system that can serve both abled-bodied and disabled individuals is inevitable.

III. Aim and Objectives

The aim of this study is to design and implement a door access control system with voice recognition capability to simplify the task of providing access to door systems and providing security to lives and properties of people.

The specific objectives of this research study are to:

i. Adoptnatural language processing (NLP) algorithm into the voice recognition system to enable the system understand the human language.
ii. Incorporate machine learning to enable the system learn and understand different speech models.
iii. Implement communication between the hardware installed on a door with the software.

IV. Significance of Study

The purpose of this study is to break the limitations of conventional door access control systems in ensuring safety of lives and properties. One limitation includes the inability of the current system to provide the best security due to different hacks on the system such as key duplication. It is also believed that it would serve as a stepping stone to the development of better voice recognition systems that would be aimed at providing better security and making life easier.

V. Research Questions

The research questions are:

i. Does voice recognition system provide a better usability and performance when compared with other biometric system such as iris and fingerprint scan?
ii. Would this study handle tones in an individual's voice with respect to moods? For instance, an individual's voice tone when just waking up is different from when the same individual is angry.

VI. Literature Review

Access control system is a system which provides a selective restriction of access to a place or resource. A door can serve as a physical means using a lock for restricting certain people who do not meet the particular access requirements such as a key, keycard, fingerprint, voice password, Radio Frequency Identification (RFID) card, security token or coin. The earliest known key and lock devices were discovered in the ruins of Nineveh, the capital of ancient Assyria [3]. Technology has evolved since then with the introduction of computers which provides access control using computer programs and software. Voice recognition, as one of the new forms of restricting access, deals with decoding the human voice and identifying the speaker. It is divided into speaker recognition and speech recognition. Speaker recognition is the identification of a person from properties or characteristics of voices. Speech recognition is the recognition of what is been said by the speaker. Speaker authentication is the act of verifying the identity ofa speaker in a system. There are two phases of a speaker recognition system which are enrollment (training phase) and verification (testing phase). During the enrollment phase, the voice of the speaker is recorded in form of input signals and features or properties are extracted to form

a template or model. In the verification phase, a sample speech utterance is compared against models already stored in the system to determine the best match(es).

6.1 Historical Background of Voice Recognition Door Access Control Systems

The first all-metal locks appeared between the years 870 and 900, and are attributed to the English craftsmen[4]. The key was claimed to be invented by Theodorus of Samos in the 6th century BC[5]. The majority of locks today are variants of the designs invented by Bramah, Chubb and Yale ([6];[7];[8]).

According to Lebovic, Galton's work "led to the application of mathematical models to fingerprints, phrenology, and facial characteristics", as part of "absolute identification" and "a key to both inclusion and exclusion" of populations [9].

Voice recognition started in the 1950s era and was limited to single-speaker systems with vocabularies of around ten words. In 1952, three Bell Labs researchers, Stephen. Balashek, R. Biddulph, and K.H Davis built an automatic digit recognizer called Audrey for single-speaker digit recognition. The spectral peaks of the sound spectrum of the human vocal tract (formants) was located in each utterance. In 1971, Defense Advanced Research Projects Agency (DARPA) through its speech understanding research program funded five years of speech recognition. They thought speech understanding would be a key to making progress in speech recognition but this turned out false. BBN, International Business Machines Corporation (IBM), Carnegie Mellon and Stanford Research Institute participated in this program.

The first successful speech recognition technologies were introduced in the 1990s era. The earliest products were Dragon Dictate released in 1990 and a recognizer from Kurzweil Applied Intelligence released in 1987. AT&T deployed a voice recognition call processing service in 1992 to route telephone calls without the use of a human operator. The technology was developed by Lawrence Rabiner and others at Bell Labs [10]. Lernout & Hauspie, a Belgium-based speech recognition company, acquired several companies, including Kurzweil Applied Intelligence in 1997 and Dragon Systems in 2000. The L&H speech technology company was ended in 2001 because of an accounting scandal. The speech technology from L&H was bought by ScanSoft which became Nuance in 2005. Apple originally licensed software from Nuance to provide speech recognition capability to its digital assistant [11].

Many aspects of speech recognition have been taken over by a deep learning method called Long short-term memory (LSTM), a recurrent neural network published by SeppHochreiterandJurgenSchmidhuber in 1997. Google speech recognition experienced a dramatic performance jump of 49% through Connectionist Temporal Classification (CTC) trained LSTM, which is now available through Google Voice to all smartphone users [12].

6.2 Application of Voice Recognition

Voice recognition applications generally fall into the following based on its functions:

i. In-car systems: Voice commands may be used to initiate phone calls, select radio stations or play music from a smartphone, MP3 player or a music loaded flash drive.

ii. Military: High-performance fighter aircraft use speech recognition in setting radio frequencies, commanding autopilot systems, setting steer point coordinates and weapon release parameters and controlling flight display.

iii. Telephony: speech recognition is mostly used as part of a user interface of mobile phones for predefined or custom speech commands

iv. Education; Speech recognition can be used to teach proper pronunciation. Blind students can use the technology to convey words and then hear the computer recite back to them. They can as well use a computer by commanding with their voice, instead of looking at the screen and keyboard.

v. People with disabilities (Handicaps): Speech recognition becomes useful for them in their day to day activities.

6.3 Innovations in Door Access Control Systems

Door access control systems are mainly to grant individuals access to certain resources. These systems have improved from the traditional way it was done. This door access control systems can now be equipped with different biometric technologies. Some of the biometric technologies that are currently being equipped into door access control systems are:

i. Voice recognition

Voice recognition is the ability of a door access control system to receive and interpret utterances from individuals and give the corresponding feedback. The system passes through the enrolment stage, during which the voice of the speaker is recorded in form of input signals and features or properties are extracted to form a template or model. In the verification phase, a sample speech utterance is compared against models already stored in the system to determine the best match(es) [13].

ii. Fingerprint scan

Fingerprint scan is a form of biometric identifier used in security systems. They are used to unlock doors, laptops, mobile phones and in other security applications. First step in using fingerprint scan in door access control systems is to register the individuals fingerprint by using an optical or thermal scanner to read and memorize the individual's fingerprint. To unlock the system, the individual would have to press the registered fingertip on the scanner and the device identifies the individual's unique characteristics to grant access [14].

iii. Facial Recognition

Facial recognition is a biometric artificial intelligence-based application that can uniquely identify a person by analyzing patterns based on the person's facial textures and shape. It works by comparing selected facial features from a given scan with faces within a database. Facial recognition also goes through two stages. The unique characteristics in the individual's face would be registered in the system in this stage. The system grants the individual access to the system when a face match is found in the database during the testing stage [15].

iv. Iris Recognition

Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques or video images of one or both of the irises of an individual's eyes, whose patterns are unique, stable and can be seen from some distance. Iris technology uses video camera technology with subtle near infrared illumination to acquire images of the detail-rich, intricate structures of the iris which are visible externally [16].

v. Hand Geometry

Hand geometry is a biometric identifier that identifies users based on the shape of their hands. Hand geometry readers measure a user's hand along many dimensions and compare those measurements to measurements stored in a file. It is the first and popular biometric identifier to find widespread computerized use. It remains the preferred technology for high security applications though it's not thought to be as unique as fingerprints, palm veins and iris recognition [17].

1.4 Voice Recognition Phases

The two major phases a voice recognition system must pass to ensure proper functioning are:

i. Enrollment: This phase is also called the training phase. This is when an individual speaker reads a text or phrase into the system. The system analyzes the person's specific voice characteristics and stores the characteristics in a database. Systems that do not pass through the training phase are called speaker independent systems whilst systems that pass-through training are called speaker dependent systems.

ii. Verification: This phase is also called the testing phase. In the verification phase, a sample speech utterance is compared against models already stored in the system to determine the best match(es) [18].

6.5 Review of Closely Related Work

Remarkable advances in voice recognition system is ongoing both in the industry and academia. The structural and functional designs of voice recognition door access control systems have changed over a long period of time and researches are continually being made to develop voice recognition algorithms that are agile and able to perform optimally in recognizing different individual's voice perfectly. The following are some notable advances in voice recognition door access control systems:

6.5.1 Intelligent Voice-Based Door Access Control System using Adaptive-Network-Based Fuzzy Inference Systems (ANFIS) for Building Security [19]

This study explained how secure buildings are currently being protected from unauthorized access by a variety of devices such as PIN pads, keys (both conventional and electronic), identity cards, cryptographic and dual control procedures. The ability to verify the identity of a speaker by analyzing speech, or speaker verification, is an attractive and relatively unobtrusive means of providing security for admission into an important or secured place. The research paper went further to explain that an individual's voice cannot be stolen, lost, forgotten, guessed, or impersonated with accuracy. Due to these advantages, the research paper described the designing and prototyping of a voice-based door access control system for building security. In the prototyped system, the access may be authorized simply by means of an enrolled user speaking into a microphone attached to the system. The prototyped system then will decide whether to accept or reject the user's identity claim or possibly to report insufficient confidence and request additional input before making the decision. Furthermore, intelligent system approach was used to develop authorized person models based on their voice. Particularly Adaptive-Network-based Fuzzy Inference Systems was used in the prototyped system to identify the authorized and unauthorized people. Experimental result confirmed the effectiveness of the proposed intelligent voice-based door access control system based on the false acceptance rate and false rejection rate.

6.5.2 Biometric Voice Recognition in Security System [20]

The objective of this study was to design and implement a voice recognition system to identify an administrator voice using MATLAB software. The input speech waveform was converted to a type of parametric representation for further analysis and processing. An existence of a wide range of possibilities to parametrically represent the speech signal for the voice recognition system such as Mel-Frequency Cepstrum Coefficients (MFCC) was discovered. The input voice signal was recorded and the computer compared the signal with the signal that was stored in the database by using MFCC method. The voice based biometric system was based on single word recognition. An administrator utters the password once in the training session so as to train and store the voice model. During the testing session the users can now utter the password again in order to achieve recognition if a match was found. A simulation of the rejection and recognition of a user's voice with MATLAB was done. From the result gotten from the testing phase, the system could successfully recognize a specific user's voice and reject another users' voice. The accuracy of the system depended on successfully training the system using the user's voice models.

6.5.3 Real Time Recognition based Building Automation System [21]

This research explained how technology was applied to homes to respond to the occupant's needs and commands to enhance the daily life at home. The main objective of this research paper was to design an embedded system to detect and recognize human voice commands, which was in turn used to toggle respective workloads. The design was accomplished using a speech recognition system along with an 8051-microcontroller kit and relays. The system's initial state was in standby mode waiting for an input from the user. Once an input was detected, it was analyzed by the speech recognition module. If a known command was detected, the speech recognition system sends respective digital representations to the microcontroller. The microcontroller then interprets these data signals, compares them with a database and thus identifies the referred load and its desired state. The processing results were then displayed on the Liquid Crystal Display (LCD) which was primarily used to display the system states. According to the load state identified, control signals are sent to respective relay circuits, thus actuating the appropriate loads. The goal of this research was to build a robust hardware design model to aid the control of home devices using speech recognition.

6.5.4 Door Automation System using Bluetooth-Based Android for Mobile Phone [22]

Smart Home was defined as a term commonly used to define a residence that uses a home controller to integrate the residence's various home automation systems.This study analyzed how android mobile phone Bluetooth can be used for automating the process of unlocking a door.The most popular home controllers are those that are connected to a Windows based PC. This research used a part of smart home technology, Bluetooth, in a mobile device, to make the process easier and more efficient to use. They used Arduino platform and android platform both of which are free open source platforms. A door lock automation system using Bluetooth-based android smartphone was proposed and prototyped during the process of the research. First the hardware design and software development were explained, then the design of a Bluetooth-based Smartphone application for lock/unlock the door were explained. The hardware design for door-lock system is a combination of android smart phone as the task master, Bluetooth module as command agent, Arduino microcontroller as controller center / data processing center, and solenoid as door lock output.

VII. Methodology

This is the construction of the proposed system with explanation of the various components.Unlike other biometric means of authentication such as fingerprint scan, voice recognition is still required to pass through lots of training phase to attain stabilization of the system. Stabilization is achieved by reading in different phrases from different individuals to better enable the system perform better. This study has been divided into five phases of project management, making the study a five-phase-cycle; project initiation, project planning, project execution, project monitoring and control, project closure. The division is necessary because of the kind of task involved.

The following are steps within the project planning, execution and monitoring and control:

1. Project Planning: Simulation and schematics of the intended solution was developed during the project planning stage. Research was conducted through the use of internet sites, papers and text that cover a wide range of areas relating but not limited to access control systems, voice recognition, artificial intelligence, machine learning and biometrics system.
2. Project Execution: Arduino and voice recognition algorithms were used in this project. Voice recognition algorithms was used in the software section whilst the Arduino was used in the hardware section of the research. Arduino hardware was used to control the light-emitting diode (LED) indicator switch, buzzer and the control of the magnetic lock. Natural language processing and machine learning was incorporated in the voice

recognition algorithm to enable the system process human language and learn from speech models to better improve its performance.

3. Monitoring and control: Various tests were carried out at post-execution to ensure that the door access control system is able to perform satisfactorily. The voice recognition testing consists of two stages which are the training stage and the testing stage. During the training stage, speech was inputted through the microphone. The features of the inputted speech were extracted using voice recognition algorithm and stored in the database. During the testing stage, speech was inputted through the microphone. The features from the inputted speech was extracted using voice recognition algorithms. This newly extracted features were matched with what was initially stored in the database during the training phase. If it matches with what is in the database, the door unlocks and if otherwise, the door remains locked.

7.1 Electronics and Component

Various electronic components were used to build the voice recognition door access control system. Some of them are Arduino, Wires and Electronic Magnetic locks:

1. Arduino

Arduino is an open-source electronics/software platform, project and user community that designs and manufactures easy to use single-board microcontrollers and microcontroller kits for building digital devices and interactive platforms that can sense and be controlled both physically and digitally. Its products are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), allowing the Arduino boards and software to be manufactured by anyone [23].

Arduino board designs use different variety or type of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (shields) and other circuits. The board feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. Arduino provides an integrated development environment (IDE) based on the Processing language projects.

Common applications of Arduino include:

a) Arduboy, a handheld game console based on Arduino
b) Arduinome, a MIDI controller device that mimics the Monome
c) Ardupilot, drone software and hardware
d) ArduSat, a cubesat based on Arduino.

The Arduino in this voice recognition system is responsible for opening and closing the magnetic lock.

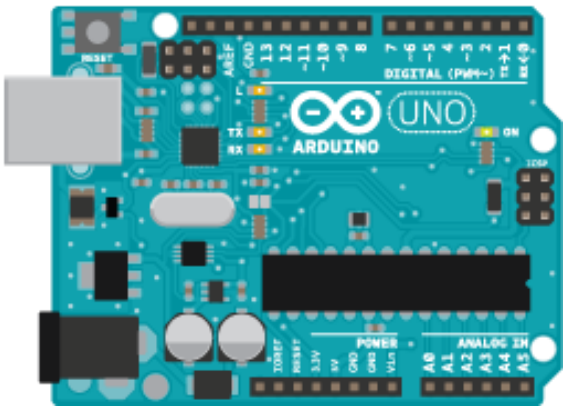

Figure 1: Arduino Board[23]

2. Wire

A wire is a single, usually cylindrical, flexible strand or metal drawn out into the form of a thin flexible thread or rod. Wires are used to carry mechanical loads or electric currents and telecommunications signals. Wire is commonly formed by drawing the metal through a hole in a die or draw plate. Wire gauges come in various standard sizes, as expressed in terms of a gauge number.

Wire comes in solid core, stranded, or braided forms. Although usually circular in cross-section, wire can be made in square, hexagonal, flattened rectangular, or other cross-sections, either for decorative purposes, or for technical purposes such as high-efficiency voice coils in loudspeakers.

Wires were used in connecting different components in the system to send/receive signals and also to pass electric currency to other components. Wires were used to connect the magnetic lock to a power pack to ensure the flow of electricity and also to the relay module to ensure sending/receiving of signal to/from the Arduino respectively.

3. Electronic Magnetic locks (Maglock)

An electronic magnetic lock also known as maglock is a locking device that consists of an electromagnet and an armature plate which securely prevents a door from opening without proper access credentials. Electric locking devices can either be "fail safe" or "fail secure". A fail-secure locking device remains locked when power is lost. Fail-safe locking devices are unlocked when power is lost. Direct pull electromagnetic locks are by default fail-safe. Maglocks can be paired with switches and/or credential tools to release the lock remotely to grant access. The electromagnet portion of the lock is attached to the door frame and a mating armature plate is attached to the door. The two components are in contact when the door is closed. When access is granted the electrical current connected to the lock is paused and immediately releases the lock. When the electromagnet is energized, a current passing through the electromagnet creates a magnetic flux that causes the armature plate to attract to the electromagnet, creating a locking action. Because the mating area of the electromagnet and armature is relatively large, the force created by the magnetic flux is strong enough to keep the door locked even under stress.

Using the Biot–Savart law (an equation describing the magnetic field generated by a constant electric current), it can be shown that the magnetic flux density, B induced by a solenoid of effective length, l with a current, I through N loops is given by the equation:

$$B = \frac{\mu_0 \mu_r IN}{l} \qquad (1)$$

The force, F between the electromagnet and the armature plate with surface area, S exposed to the electromagnet is given by the equation:

$$F = \frac{B^2 S}{2\mu_0} \qquad (2)$$

In both equations, μ_0 represents the permeability of free space and μ_r the relative permeability of the core.
The magnetic lock was attached to a door in the process of testing the system. The door unlocks whenever a user is authenticated and verified to have access to the system.

Figure 2, Electronic Magnetic Lock[24]

7.2 Voice Recognition Models, Methods and Algorithms

The main methodologies that made significant changes in the voice recognition field are explained below:

1. Acoustic Phonetic Approach

This approach investigates time domain features such as the mean squared amplitude of a waveform, it's duration, it's fundamental frequency or frequency domain features such as the frequency spectrum or combined Spectro temporal features and the relationship of these properties to other branches of phonetics and to abstract linguistic concepts such as phonemes, phrases, or utterances. The first step in the acoustic phonetic approach is a spectral analysis of the speech combined with a feature detection that converts the spectral measurements to a set of features that describe the broad acoustic properties of the different phonetic units. The next step is a segmentation and labeling phase in which the speech signal is segmented into stable acoustic regions, followed by attaching one or more phonetic labels to each segmented region, resulting in a phoneme lattice characterization of the speech. The last step in this approach attempts to determine a valid word from the phonetic label sequences produced by the segmentation to labeling.

2. Pattern Recognition Approach

The pattern-matching is the automated recognition of patterns and regularities in data and it involves two essential steps namely, pattern training and pattern comparison. In the pattern-comparison stage of the approach, a direct comparison is made between the unknown speeches with each possible pattern learned in the training stage in order to determine the identity of the unknown according to the accuracy of match of the patterns.

3. Template Based Approach

The term template is often used for two fundamentally different concepts: either for the representation of a single segment of speech with a known transcription, or for some sort of average of a number of different segments of speech. Both types of templates can be used in the Dynamic Time Warping (DTW) algorithm to compare them with a segment of input speech. It has a sequence of consecutive acoustic feature vectors, a transcription of the sounds or words it represents, knowledge of neighboring templates, a tag with meta-information. Template based approaches, in which unknown speech is compared against a set of prerecorded words (template) in order to find the best match. This has the advantage of using perfectly accurate word models; but its disadvantage is that; the prerecorded templates are fixed, so variations in speech can only be modeled by using many templates per word, which eventually becomes impractical. When considering the concrete implementation of template- based recognition, it quickly becomes apparent that the classical DTW algorithm with the Euclidean distance used as local distance metric, combined with a simple beam search will not do the job, neither from a performance nor from a computational point of view. Development of isolated word speech recognition system is based on a use of dynamic time warping (DTW) for speech pattern matching. The DTW process nonlinearly expands or contracts the time axis to match the same phoneme positions between the input speech and reference templates.

4. Support Vector Machine (SVM)

Support Vector Machines (SVMs) are a comparatively new and efficient pattern recognition tool with associated learning algorithms that analyze data used for classification and regression analysis. SVMs are fast in training and guarantee a global optimum if the kernel satisfies Mercer's condition but require an appropriate choice of kernel function. Most implementations of SVM algorithm require computing and storing in memory the complete kernel matrix of all the input samples.

5. Artificial Neural Network

Artificial Neural Networks are computing systems vaguely inspired by the biological neural networks that constitute the brain[25]. Recent work on neural networks raises the possibility of new approaches to the speech recognition problem. Their use of many processors operating in parallel may provide the computational power required for continuous-speech recognition. New neural network algorithms self-organize and build an internal speech model that maximizes performance. Auto Associative Neural Network (AANN) models for the task of speaker verification and speech recognition, which produce comparable performance with that of Gaussian Mixture Model (GMM) based speaker verification and speech recognition. There exists a relationship between principal component analysis and weights learned by a 3-layer AANN model. AANN model has been mostly used in applications involving dimensionality reduction. ANN approach was used in this research through Android Speech Recognizer.

6. Vector Quantization

Vector Quantization is a clustering technique that neglects the temporal information contained in a word in order to avoid the need for time alignment. The design of a vector quantization (VQ) is considered to be a challenging problem due to the need for multi-dimensional integration. Given a vector source with its statistical properties known, given a distortion measure and given the number of code vectors, find a codebook and a partition, which result in the smallest average distortion. During the recognition phase the feature vectors extracted from the test word are compared to all reference codebooks. The codebook that produces the minimum distortion determines the spoken word.

7. Hidden Morkov Model (HMM)[26].

HMM is a richmathematical structure that can be represented as the simplest dynamic Bayesian network. The Hidden Markov model can be considered a generalization of a mixture model where the hidden variables which control the mixture component to be selected for each observation, are related through a Markov process rather than independent of each other. The elements of HMM is characterized by following:

a. Number of state = N
b. Number of distinct observation symbol per state = T
c. State transition probability,

d. Observation symbol probability distribution in state
e. The initial state distribution

The Three Basic Problems for HMMs are;

Problem 1:

Evaluation Problem; Given the observation sequence O = O1 O2 · · · OT , and model λ = (A,B,π), how do we efficiently compute P(O| λ), the probability of observation sequence given the model.

Problem 2:

Hidden State Determination (Decoding Problem); Given the observation sequence O = O1 O2 · · · OT, and model λ = (A, B, π) how do we choose corresponding state sequence Q = q1 q2 · · · qT which is optimal in some meaningful sense.

Problem 3:

Learning Problem; How do we adjust the model parameter λ = (A, B, π), to maximize P(O| λ). Problem 3 is one in which we try to optimize model parameter so as to best describe as to how given observation sequence comes out.

Solution to the three problems of HMM are using Forward Algorithm for Evaluation Problem, Viterbi Algorithm for Decoding Hidden State Sequence P (Q, O| λ) and Baum-welch Algorithm for the Learning problem associated.

VIII. Implementation

The behavior of the system, tests carried out and errors encountered in the implementation of the voice recognition door access control system are explained in this section. System implementation defines the physical system design used in ensuring that such proposed system is fully operational and meets the necessary quality assurance standards. In this research, upon the completion of the modelling a check was made for precision and accuracy of the device to confirm if it conforms with the initial aim of the project. Testing and analysis were carried out vis-à-vis implementation to ensure that specific modules of the platform perform adequately.

8.1 Module Description

The modules are divided into the hardware and software module. The software module are the interfaces of the android app that accepts voice inputs. The Android app uses the Speech Recognizer class to access speech recognition service on the Android device. Speech recognizer supports multiple languages during speech recognition and provides Speech-To-Text recognition control, background services and intents. Speech recognition is done locally while complex recognition which is not found in the local dictionary is streamed to Google's Speech API service. Permission to record audio is required before the service can be used. A language model based on Google's free-form speech recognition is used to recognize speech. The result is gotten by classifying or filtering the array of response from the language model to find out the response with the best confidence based on the limited vocabulary on the device. Simple parsing is used to perform classification since the Android app is expecting only a few ranges of speech request.

The android app is used to send voice commands to the hardware module, speech recognition is done on the android app to recognize commands such as "lock door" or "unlock door". When the command is received, it is sent to the hardware which is connected to the phone through Wi-Fi. The ESP8266 in the hardware receives the signal which transmits it to the Arduino which is responsible for closing or opening the magnetic door lock.

1. Software Module

For the android app to run effectively there must be a provision of a smartphone that runs Android operating system such as Android 8.0 and 9.0. The smartphone should have a minimum screen resolution of 1280 x 800, a minimum internal memory of 2GB and a minimum Random-Access Memory (RAM) of 3GB.

a) Main Interface

This section provides an interface to accept input speech signals from an individual. It has a microphone icon button which request for permission to use the devices' microphone when clicked on.

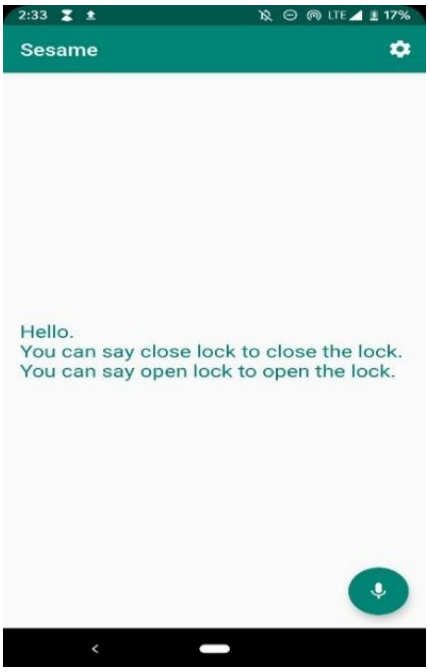

Figure 3, Main Interface

b) Settings interface

This section provides an interface to easily configure connections to the server. A user can change the Universal Resource Locator (URL) where speech signals are sent to the hardware.

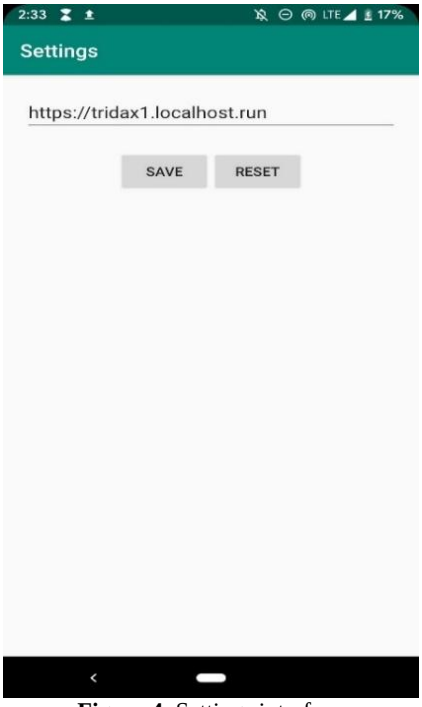

Figure 4, Settings interface

2. Hardware Module

The hardware components include an Arduino microcontroller, a relay module, and a magnetic lock.

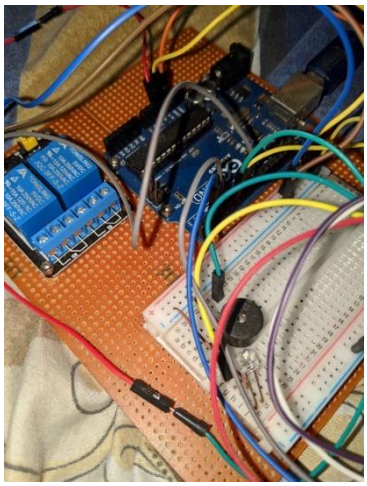

Figure 5, Project Hardware

8.2 Circuit Diagram

The circuit diagram shows the visual or graphical representation of the electrical circuit using either basic images of parts or industry standard symbols. Input signals are accepted through an android smartphone to the mobile app. Speech to text algorithms are used to extract text from the speech. The extracted text is sent to the server where the processing is done. If the text matches the predefined unlock phrase, the server sends an unlock signal to the Arduino which then sends the signal to the magnetic lock to unlock the door. The relay module provides electricity to the magnetic lock.

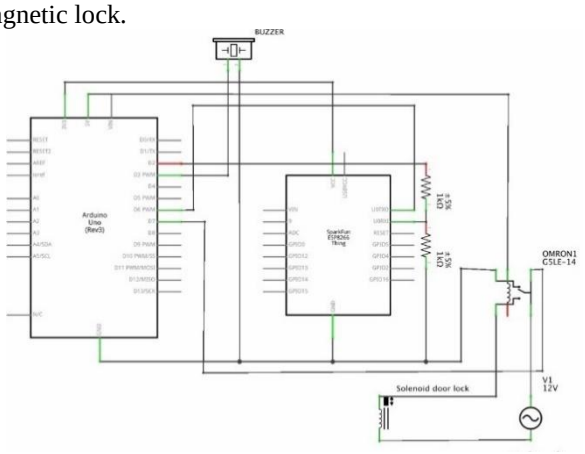

Figure 6, Circuit Diagram

IX. Summary

This research project provides an insight into voice recognition and door access control systems and techniques that can be used to ensure the security of lives and properties. It also explains how to curb the flaws in other forms of biometric authentications using voice recognition form of authentication.

From the reviewed literatures it is seen that there are several approaches or algorithms that can be employed in providing extra security to door systems but may not be capable of making it easier for people with disabilities to access door systems and provide the best security to lives and properties. It is also important to note that so many of the algorithms or approaches that are expressed in various research papers have not been implemented in practice because of the current limitation of voice recognition in terms of uniquely identifying different voices. Such papers only provide a theoretical representation of how an ideal voice recognition door access system would perform.

X. Recommendation

A lot of work has been put into place to ensure that the voice recognition system is able to recognize the owner's voice and grant access to the owner. There is still a lot of work that needs to be done to ensure that the voice recognition system is able to perform well and optimally. Some key areas that should be considered when making improvements on the voice recognition system include:

i. Native language: Major Nigerian native languages such as Igbo, Yoruba, and Hausa currently do not have speech to text engine. The ability of the voice recognition to recognize the native language of the user can be worked and improved upon by training speech models of those language.

ii. Security: The exchange of data between the various components of the hardware and the software should be encrypted to ensure that the system cannot be hacked and data integrity is maintained. The recommendation is further that a custom encryption algorithm should be implemented.

References

[1]. Ehud, Y. Shapiro, The fifth-generation project—a trip report, 1983, 637-641.
[2]. M. Cho, and J. Kang, "Voice Security On the Rise: Examining the Path to Secure Voice Automation,"Alticast Inc. Colorado, 2017.
[3]. de Vries, N. Cross, and D. P. Grant, Design Methodology and Relationships with Science: Introduction. Eindhoven: Kluwer Academic Publishers. p. 32. 1992, Archived from the original on 2016-10-24
[4]. Schlage's History of Locks. (n.d.). Retrieved from http://www.locks.ru/germ/informat/schlagehistory.htm.
[5]. Key Dimensions. (n.d.). Retrieved from http://www.dimensionsinfo.com/tabular-key-dimensions.
[6]. C. Locks, "History of Locks". Encyclopaedia of Locks and Builders Hardware, 1958, Archived from the original on 23 September 2006.
[7]. Massachusetts Institute of Technology. (n.d.). "Inventor of the Week Archive". Massachusetts Institute of Technology. Archived from the original on 2013-05-29. http://web.mit.edu/invent/iow/yale.html.
[8]. Wolverhampton City Council. (2005). "Lock Making: Chubb & Son's Lock & Safe Co Ltd". Retrieved 16 November 2006. http://www.wolverhamptonhistory.org.uk/work/ industry/lock_making2
[9]. NitzanLebovi, Biometrics or the Power of the Radical Center, 2015, 841–868.
[10]. B. H. Juang, L. R. Rabiner. Automatic Speech Recognition – A Brief History of the Technology Development. Georgia Institute of Technology, Atlanta. 2004. https://www.ece.ucsb.edu/ Faculty/Rabiner/ece259/Reprints/354_LALI-ASRHistory-final-10-8.pdf
[11]. S. Wildstrom, Nuance Exec on iPhone 4S, Siri, and the Future of Speech, http://tech.pinions, 2011.
[12]. HaşimSak, Andrew Senior, Kanishka Rao, Françoise Beaufays, Johan Schalkwyk (2015), Google voice search: faster and more accurate.
[13]. Macmillan, British English definition of voice recognition, Macmillan Publishers Limited, 2008.
[14]. D. Maltoni, D. Maio, K. Jain, and S. Prabhakar, Handbook of Fingerprint Recognition. Springer Science & Business Media, 2009.
[15]. R, Brunelli, and T, Poggio, "Face Recognition: Features versus Templates." *IEEE Trans. on PAMI, (15)*10, 1993, 1042-1052
[16]. Z. Kim, Reverse-Engineered Irises Look So Real, They Fool Eye-Scanners, 2012
[17]. M. Bača, G. Petra, and T. Fotak, Basic Principles and Trends in Hand Geometry and Hand Shape Biometrics, 2012.
[18]. P. Arnab, M, Sahidullah, and S, Goutam.. Speaker Verification with Short Utterances: A Review of Challenges, Trends and Opportunities, 2018.
[19]. Wahyudi, W. Astuti, and S. Mohamed, "Intelligent Voice-Based Door Access Control System Using Adaptive-Network-based Fuzzy Inference Systems (ANFIS) for Building Security*." Journal of Computer Science, Vol.3* (5), 2007, 274-280.
[20]. H.N.M. Shah, Ab Rashid, M.Z., Abdollah, MohdFairus, Kamarudin, Muhammad Nizam, C.K. Lin, and Z. Kamis, "Biometric Voice Recognition in Security System." *Indian Journal of Science and Technology, Vol.7*(2), 2014, 104-112.
[21]. G. Muthuselvi, and B. Saravanan, "Real time speech recognition based building automation system." *ARPN Journal of Engineering and Applied Sciences.* Vol.9, 2014, 2831-2839
[22]. L, Kamelia, A, S, R, Noorhassan, M, Sanjaya, and W. S. Edi Mulyana, "Door-automation system using bluetooth-based android for mobile phone." *Asian Research Publishing Network (ARPN) Journal of Engineering and Applied Sciences, Vol.9*(10), 2014, 1759-1762.
[23]. Arduino, (n.d.). Getting Started Retrieved from https://www.arduino.cc/en/guide/introduction
[24]. Magnetic Lock, https://www.indiamart.com
[25]. Y, Bengio, Artificial Neural Networks and their Application to Speech/Sequence Recognition. McGill University, Canada, 1991.
[26]. Hu, Hongbing, Zahorian, A. Stephen (2010), Dimensionality Reduction Methods for HMM Phonetic Recognition

AdekolaOlubukola D. " Voice Recognition Door Access Control System. " IOSR Journal of Computer Engineering (IOSR-JCE) 21.5 (2019): 01-12.