A Project Report On

Developing an on-air hand doodle system to secure Aadhar biometric scheme for aging society

Submitted in partial fulfillment of the requirement for the 8^{th} semester

Bachelor of Engineering

in

Computer Science and Engineering

DAYANANDA SAGAR COLLEGE OF ENGINEERING

(An Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE & ISO 9001:2008 Certified)

Accredited by National Assessment & Accreditation Council (NAAC) with ‘A’ grade

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CERTIFICATE

This is to certify that the project entitled **Developing an on-air hand doodle system to secure Aadhar biometric scheme for aging society** is a bonafide work carried out by **Srividya Adiga [1DS19CS168]**, **Srujana [1DS19CS171], Chaithra V [1DS20CS405]** and **Priyanka M [1DS20CS417]** in partial fulfillment of 8th semester, Bachelor of Engineering in Computer Science and Engineering under Visvesvaraya Technological University, Belagavi during the year 2022-23.

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1..........................	....
2...........................	....

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Abstract

In computer-based communication, authentication is a crucial component of system control. Like fingerprint, iris, retina, and voice modulation, human face recognition is a crucial component of biometric verification. A person's identity is thus represented through their face. Since the development of image processing technology, there has been a significant change in the ways that this physical property is used. Air-drawing for authentication or gesture recognition has been thoroughly explored in order to develop new techniques for character identification that are more accurate and independent of any gear, such as gloves that can detect fingertip movement, wearable sensors, or the use of an external pen. In this study, we'll examine the practise of air-writing. One of them involves using the fingertips as a pen and comparing it to a trained media pipe model using DNST and Bi-LSTM for regression and hand gesture identification and classification. Additionally, we employ the three motions of Draw, Save, and Erase for gesture recognition.Two risks to IoT devices were used as the basis for the security assessment: guessing and physical observation. The findings indicate that the suggested authentication method's password strength is greater than that of the conventional 4-digit PIN password. The information will be secured by the aforementioned methods of verification, but classic based passwords have a combination of text, numeric, and alphanumeric characters that are challenging to remember. The on-air hand doodling system is simple to remember and may be used without any sensors. Any application can employ iris and voice-based methods for second factor authentication. As a secondary authentication factor, we employ voice-based technology, that gets around third party authorisation.In order to develop new techniques for the identification of the drawn character with greater precision and independence from any hardware components, such as gloves to detect fingertip movement, any wearable sensor, or utilising any external pen, extensive research is being done on air-drawing for authentication or gesture recognition.

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List of Abbreviations

1. **OAHDS** On-air Hand Doodle System
2. **CNN** Convolutional Neural Network
3. **LMP** Leap Motion Controller
4. **SDR** Software Defined Radios.
5. **RF** Radio Frequency.
6. **3D** Three Dimensional.
7. **GD** Gaussion Distribution.
8. **Open CV** Opensource Computer Vision.
9. **HTML** Hypertext Markup Language.
10. **CSS** Cascading Style Sheet.
11. **API** Application Programming Interface.
12. **ASR** Automatic Speech Recognition.
13. **OTP** One Time Password.
14. **HAT** Hand in Air Trapping.
15. **SPDN** Self-paced Dense Convolution Network.
16. **COTS** Commercial off the self.
17. **IR-UWB** Ultra Wide Band.
18. **CODP** Clicked on object to Draw an pattern.
19. **GMM** Gaussion Mixture Model.
20. **MFCC** Mel-frequency Cepstral co-efficients.
21. **COSS** Clicked on an model object to select secrets.

22. **IoT** Internet of Things.

23. **EEG** Electroncephalography.

24. **TTL-USB** Transistor Transistor Logic - Universally Asynchronous Recevier/Transmitter.

25. **DTW** Dynamic Time Wraping.

26. **IMU** Intertial Measurement Unit.

Chapter 1

Introduction

In the modern world, everything is becoming intelligent enough to communicate with one another. Traditional techniques for communicating with smart devices, such as computers, smart watches, and other gadgets that rely on a graphical user interface, are not very effective. Therefore, in order to communicate with intelligent objects, a new form of natural human interaction is needed. The most crucial stage of the interaction process between IoT devices and people is authentication. One of the key components of security operations and systems is authentication.

With no need for a touch-pad or touchscreen type surface, on-air writing can take the place of the conventional technique of using the typewriter. While handwriting and gesture recognition techniques are frequently developed and studied, the majority of them require the use of hardware components such as cameras, sensors that record fingertip movement, hardware that has restricted movements, etc., so new approaches are investigated to make the task easier. Although the domain has been investigated, it still presents a number of difficulties. Nevertheless, it has the potential to protect users' private information and serve as an authentication method similar to a graphical password.

And there is a chance including multi-factor techniques for security purpose, and these multi-factor can irritate users as they require extra-interaction with the system. Additionally, due to the size and unfamiliarity of the screen, some groups of individuals, such as the elderly, may find it challenging to utilise touch displays on smartphones or input the characters on the screen. Systems that allow users to type characters on screens while only using the camera on their smartphones without any additional hardware or sensors.

1.1 The Problem Statement

Since everyone is reliant on smart devices today and there is a chance to tamper their information, so there are numerous authentication techniques that can be quite tricky for using. Therefore, we are presenting a new technique based on gestures and movements called the on-air hand doodle system. Drawing is used as one form of password since graphical passwords are easier for humans to remember than typing passwords. Passwords are a form of authentication that provides the platform for security but there can be cases where these are vulnerabilities and multi-factor authentication is preferred. In addition to drawing, on-air writing or drawing needs commands to govern the process, such as drawing, erasing, and saving.

1.2 Real World Application

The project was designed to improves the usage of this system by overcoming the existing loopholes. And by leveraging existing frame work and we are going to improve by reducing the hardware compatibility. And mainly used by elderly community, kids and by all organizational sectors.

1. Public Distribution System: The main application that was utilised in significant public sector areas. Biometric authentication is primarily utilised in ration distribution, and updating Aadhar information requires both biometric and iris verification. If we take into account biometrics, elderly people's fingerprints will deteriorate. Iris verification is possible and secure, but background light will make it difficult to use in rural locations.

2. Organization where instead of passwords employees can draw: If any private businesses or IT industries are to be considered, technology is advancing at the same time. If we use this way for authentication, it will be a quick and convenient method, saving the organisations' time. Instead of employing numerous algorithms and strategies in various ways, coming to information security will also be accomplished by using this technique.

3. E-Commerce websites: Each and every product in the modern AI world is integrating new features and developing a website application. Users must log into the application for each product, and as part of this procedure, they must think about creating secure passwords to protect their personal data. This authentication method, which is simple to memorise and draw in the air, can be used to prevent the combination of numbers, characters, special characters, and alpha numeric characters.

4. Shopping accounts and Banking sector: Regarding banking and retail applications, each branch has a unique method for collecting login information. Once more, we must use strong passwords to protect private information, but they are incredibly tough to remember, therefore we can utilise the doodling approach to authenticate.

The on-air hand doodle system can be used to replace the standard password approach in any mobile applications that require registration and login processes.

1.3 Organisation of Project Report

Chapter(2) We go over the problem description and suggested solution in Chapter 2. We also examine the present-day systems and the problems they encounter.

Chapter(3) With a review of the existing literature, Chapter 3 delves deeper into the various hardware and software-based solutions that are available.

Chapter(4) Specifies the software and hardware requiements used for the execution on system. Chapter(5) examines the proposed solution's architecture together with a system design overview, making use of system block diagrams and data flow diagrams.

Chapter(6) describes the hardware and software requirements, dataset definitions, and implementation specifics before delving into the solution's implementation.

Chapter(7) describes our testing process.

Chapter(8) examine our experimenting methodology and the outcomes.

Chapter(9) outlines our conclusions and ends the paper.

1.4 Summary

This chapter describes about replacing text passwords and bio-metrics by on-air hand drawn doodles which are more easy to remember.Free hand-drawn symbols passwords without being restricted to the size, grid, or orientation as it is on-air drawn.It is difficult to remember multiple passwords for applications. Human neurotic system tends to forget when it is not used regularly. Elderly people tend to degrade fingerprints bio-metrics with age. Elderly People may not be comfortable with touch screens as it is fixed size. Regularly changing passwords for bank applications can be tedious to remember. Where OAHDs will use the basic doodle as passwords, how it is helpful in real world applications and how this method will help for authentication.

Chapter 2

Problem Statement and Proposed Solution

2.1 Problem Statement

The on-air hand doodle system is a revolutionary method of authentication that does away with the conventional password-based technique. The hardware equipment attached to the user for the painting in the air will track hand gestures and will be expensive. Therefore, we developed a new technique named "Developing an on-air hand doodle system for succeeding secure bio-metric scheme for ageing society," which doesn't involve any additional hardware devices, and we also introduced "second factor authentication" along with "doodle authentication." This method executes by some of libraries called media pipe, opencv, and the pyaudio library which is used for speech recognition, as well as for hand gesture comparison and doodle comparison.

2.2 Existing Systems

This authentication approach has been utilised with a variety of solutions. where as IoT devices and other external devices with additional sensors and hardware equipment connected to the hand and used like a pen and The other additional device utilised to display the doodles produced in the air is touch pads. Doodles can also be displayed in 3D using an AR environment and a graphic doodle password technique. The solution is to put into place a system that allows the older community to submit a safe encrypted password in the form of a hand-drawn doodle that will outperform both a textual and a bio-metric method.

2.2.1 On-Air Writing Technique

The on-air writing difficulty can be handled using four basic strategies, each of which is discussed below. The principles behind these methods are computer vision, wearable sensors, radio waves, and electronics. Recent studies on each approach are included in the subsections that follow.

2.2.2 Radio Waves-Based Technique

Uysal and Filik proposed the use of radio frequency (RF) waves for human-machine interaction, such as air writing. They proposed a device-free system based on a machine-learning air-writing recognition framework called RF-Wri, which can effectively distinguish 26 capital letters. Two-channel low-cost software-defined radios (SDR) and oppositely polarized antennas are used to provide polarization diversity, which makes the classification accuracy superior. It is verified with various real measurements that the proposed framework, RF-Wri, achieves 95.15 percent accuracy in the classification of all 26 air-written letters and outperforms the fairly new WiFi-based air-writing recognition approaches.

According to Chen et al.presented a three-dimensional (3D) pen-like positioning system based on a high-precision 3D ultrasonic positioning method[3]. The high-precision 3D ultrasonic positioning method can achieve millimeter-level accuracy in 3D positioning within a working area of 2 m ×1.5 m ×1.5 m.

2.2.3 Devices-Based Technique

In this method David et al.proposed a leap motion controller to detect the position of the user's finger, which acts as the "pen" in air-writing English capital letters, and dynamic time warping to recognize air-drawn letters[12]. They evaluated the overall reliability of the system by allowing users to test the system by air-writing each of the 26 letters numerous times. This is a section. I have used the section tab which you can view in the source file.

In order to solve the challenge of air-writing recognition, in which text is freely written in three dimensions, Bastas et al. presented a deep learning architecture. They concentrate on handwritten numbers, namely the numbers 0 through 9, which are organised as multidimensional time-series and obtained from a leap motion controller (LMC) sensor.

2.2.4 Drawing Password for Authentication

A method for real-time size and coordinate matching of doodles in an AR environment for user verification was put out by Wazir et al.[1] On a smartphone, touch gesture recognition creates doodle passwords in an AR environment.

Through the addition of biometric data as a second level of user authentication, Tolosana et al. proposed enhancing conventional authentication systems based on personal identification numbers (PINs) and one-time passwords (OTPs). Instead of inputting the password as usual, users in the proposed method sketch each digit on the device's touchscreen. Every handwritten digit in our proposed bio-metric system is thoroughly analysed, as well as its robustness when the length of the password and the number of enrollment samples are increased.

2.3 Proposed Solution

By studying all techniques and algorithms, we are introducing our new method for authentication by construction of a virtual pen and hand detection were both accomplished using a computer vision technique. When the hand is in front of the camera, the hand automatically picks up the virtual pen. Second, three-hand motions were classified using a media pipe for dynamic hand gesture detection. The sketch was made with an open index finger gesture. The erasing was done with an open palm gesture. The gesture to save was a closed hand gesture. Thirdly, the Kalman filter is a straightforward and portable algorithm. On the broadcast, handwritten symbols were smudge-free thanks to our technique. Fourth, there are three phases to login authentication and verification. The login is drawn to the authentication key symbols first. Keys were then extracted. The following subsections provide an in-depth explanation for each part.

The architecture design consists of two main components of the proposed work.

(i) Hand gesture component which uses computer vision for hand detection using media pipe technique and classify gesture.

(ii)Media pipeline is used for detection of hand.

(iii)For voice recognition we are going to use the method called Gaussion mixture.

2.3.1 Object Detection using Media pipeline

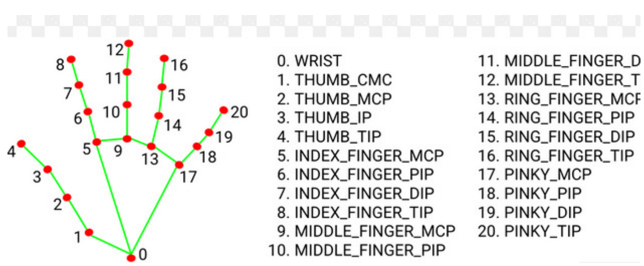

Figure 2.1: Hand landmarks of media pipeline

Above figure depletes the initial part of the approach which entails the recognition of hand gestures in this case, we make use of the media pipeline library to identify hand landmarks. A foundation for creating computer vision interfaces over sensory input like audio and video will be provided by the media pipeline. Here, time series will be used to process audio and visual data using the cv2 library. The media pipeline uses data from the camera module to operate in real-time applications; initially, it receives a stream of images as input and outputs hand landmarks for placement. The finger positions and position numbers are provided by these landmarks. We shall learn several hand movements thanks to this. Hand detection and virtual pen production are done using computer vision. The hand picks up the virtual pen while it is in front of the camera.

Figure 2.2: Working of media pipe

The Figure 2.3.2 shows how media pipe will use computer vision to recognise the hand landmarks.The computer vision component teaches computers to extract and analyse data from images and videos. Utilise information from digital photos, videos, and other visual inputs to influence decisions and recommendations.The hand will be identified by computer vision to generate a virtual pen for drawing. Accessing data from image and video processing is done through open CV method.

2.3.2 Kalman filter algorithm

Kalman filter is the algorithms which was used in existing methods for the estimation of the state of a system based on observations or measurements. We also make of this kalman filter algorithm for hand recognition and positioning.

Figure 2.3: Positioning of kalman filter

Kalman filtering is an algorithm that provides estimates of some unknown variables given the measurements observed over time. Kalman filters have relatively simple form and require small computational power.This algorithm will be used for statistics and control theory in filtering. It is a valuable tool for various applications, such as object tracking, autonomous navigation systems, and economic prediction.The fundamental concept behind the Kalman filter is that it forecasts the state of the future by using the prior knowledge of the current state. Utilising the linear stochastic difference equation, the Kalman Filter is designed to estimate the state of a system at time k. It is based on the supposition that a system's state at time k evolved from its previous state at time k-1.

By locating the closest accurate location of the virtual pen tip in the air, this work suggests a Kalman filter to correct the drawn line course on the air. In two dimensions, it has been applied once for the X coordinate and once for the Y coordinate. The Gaussian distribution (GD) is the foundation of the Kalman filter. This holds true in a real-world setting when there is no pure sensor signal. Any sensor's readout is not accurate, but it does have an error rate that varies with the sensor's accuracy.A Gaussian distribution is a continuous probability distribution that is completely described by two parameters: the mean and variance.

A priori and a posteriori estimations are two concepts utilised in the Kalman filter equations. Based on the system dynamics and the previously determined state, the a priori estimates provide the projected state and error covariance. The updated state and error covariance, which the a posteriori estimates represent, is the state and error covariance following the addition of the new measurement.Which we represented in our project to define the exact position hand movements.This was displayed in the above figure.

2.3.3 Feature Extraction hand detecting function and Classification

After getting the camera initialization, we have used the Media pipe Library tool to configure pre-built processing pipelines to get immediate, engaging, and output for image with various hand gestures functions.

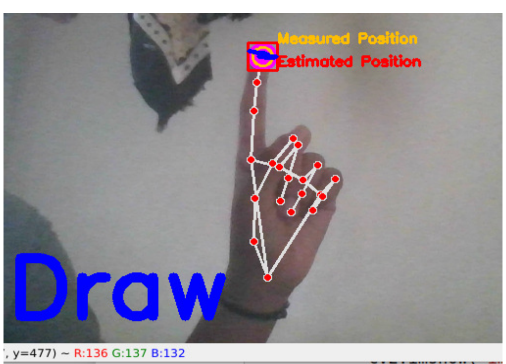

Figure 2.4: Index finger identification

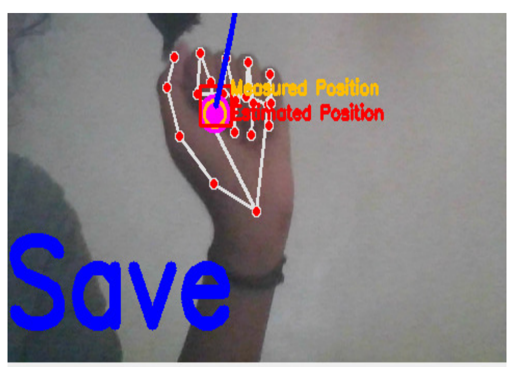

Figure 2.5: Closed hand recognition

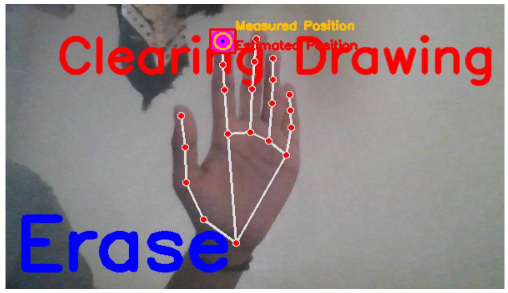

Figure 2.6: Open hand Function

The above figures will defines the three functionalities used for authentication purpose. The Recognition of index finger will be done by media pipe with the help of top most position of the hand will indicates the user to draw the doodle in air.

After completion of draw function the doodle should be save and compared with existing image stored in database/system storage, for this we are using the closed hand gesture which has been above figure 2.3.5.

The Erase function will be done by open hand gesture recognition. This will help when user draws wrong doodle or if there is a any mismatch in doodle. This function will also be used after completion of drawing doodle before we go through save function.

These functions will be executed with the help of media pipe library which provides the accuracy of images and high picture quality extraction from web cam.The media pipe model was trained using an artificial picture dataset that was constructed and then tweaked. The trained media pipe doodle model was applied to the prediction step to forecast the hand movements.

2.4 Feature extraction of hand gestures using CNN model

A typical Deep Learning neural network architecture in computer vision is the convolutional neural network (CNN). A computer can comprehend and analyse visual data or images to the field of artificial intelligence known as computer vision. CNN consists of multiple layers like the input layer, Convolutional layer, Pooling layer, and fully connected layers. These layers applies filters to the input image to extract features,, the image is down sampled by the Pooling layer to minimise computation, and the final prediction is made by the fully connected layer. With the help of gradient descent and back propagation, the network learns the best filters.

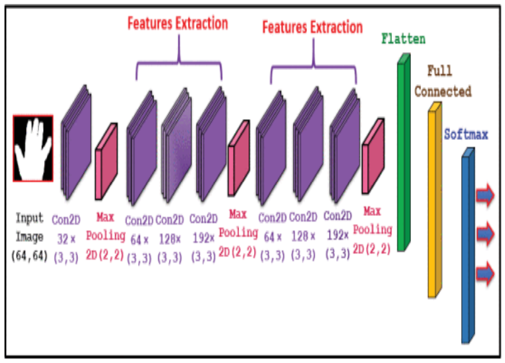

Figure 2.7: Hand gesture recognition

The CNN model has better recognition, so this method was represented in proposed system for recognition of gestures.Convolution, pooling, and activation layers are only a few of the hidden layers that make up the input and output layers of the CNN network. An image of 6464 dimensions made up the input layer. Three layers with 64, 128 and 192 channels each made up the two convolution stages for feature extraction. With the exception of the output layer, all situations utilised the ReLU activation function. In real time, after a camera snaps a picture of a hand gesture. The image is then processed to make its dimensions and black background colour more like those of the training images. Finally, depending on the model's training parameters, the trained model predicts and categorises the image as one of the three hand motions.

2.5 Speaker Recognition

Speaker recognition is a technique for automatically identifying or recognising a person from their distinctive voice. The system can work independently of the text (without being constrained by the content) or depend on the text (trained and tested for a specific word or phrase). Depending on the machine's final task or choice, the speaker identification or verification are categorised. Easy-to-use, affordable microphones are employed for data collection in order to carry out the process of particular applications that are related to speech recognition. According to the claim, speaker tracking can be used to find a specific talker's section in an audio clip or during an automatic teleconference segmentation for speaker identification in multi-user systems. Additionally, it found it helpful in assisting the court's discussion and application.This includes two methods for implementing techniques.

2.5.1 Gaussion Mixture Model

A probabilistic model for modelling regularly distributed subpopulations within a larger population is the Gaussian mixture model. In general, mixture models don't need to know which subpopulation a data point belongs to; instead, the model can learn the subpopulations on its own. This is a type of unsupervised learning because the subpopulation assignment is unknown.They are employed to divide data into various groups in accordance with the probability distribution. Gaussian mixture models can be used to a variety of fields, including marketing, finance, and many more.
While more flexible than K-means, Gaussian mixture models might be more challenging to train. When runtime is a key factor, K-means may be favoured because it tends to converge more quickly.It is feasible to mark data points that are noticeably different from the rest of the data (i.e. outliers) by using Gaussian mixture models to fit a model to a dataset and then rating fresh data points. This might be helpful for spotting fraud or data collecting mistakes.

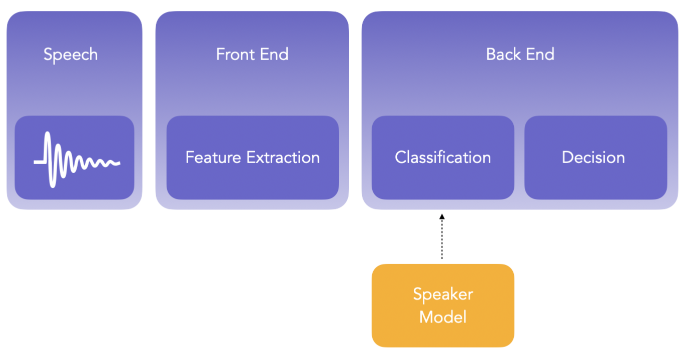

Figure 2.8: Clustering by using GMM's method

For model training, we used the Gaussian Mixture Model (GMM) method. The GMM is a probabilistic model that makes the assumption that all of the data points were produced by combining a limited number of Gaussian distributions with unidentified parameters. Mixture models can be thought of as generalising k-means clustering to include details on the covariance structure of the data as well as the locations of the latent Gaussian centres.
A clustering approach known as a "Gaussian mixture model" makes the assumption that each data point was produced by a combination of Gaussian distributions with unknown characteristics. The algorithm's objective is to calculate the Gaussian distributions' parameters as well as the percentage of data points that each distribution accounts for. K-means, on the other hand, is a clustering algorithm that does not rely on any presumptions regarding how the data points are distributed in general. The

data points are simply divided into K clusters, each of which is identified by its centroid.

2.5.2 Mel Frequency Cepstral Coefficients (MFCC's)

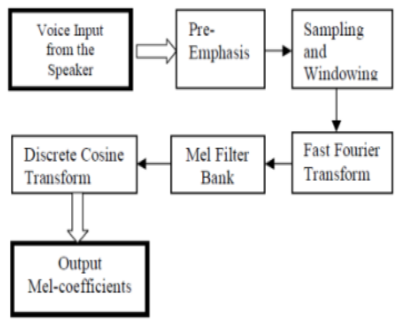

Figure 2.9: Extraction of spectral features for speech using MFCC

The step by step computation of MFCC is described by the above block diagram

- Pre-Emphasis- The speech signal x(n) has to be sent through high-pass filter: y(n)=x(n)-a*x(n-1) where y(n) is the output signal and the value of a is usually between 0.9 and 1.0.The processing of signal is done by passing it through a filter which would emphasize its higher frequency. The energy of the signal is increased at higher frequency.

- Frame Blocking: The spoken signal is broken up into frames, which are 20–30 ms long. Each frame that is next to the other frame may be separated by M(MN) if there are N numbers of frames. M and N are commonly employed with values of 100 and 256, respectively.

- Windowing: It is a signal processing technique that divides a voice stream into discrete temporal segments. The signal's repeating bounds have no connection to the signal in the outside world. A smooth function called a windowing function has an extreme value of zero. The goal is to conceal the border discontinuity. The signal changes after the window function is applied, but the impact on the signal statistics is minimised.The Hamming Window function is the window function that MFCC often employs. It keeps the first and last points in the frame connected. The equation below defines the hamming window function, where W (n) is the window function. y(N)=x(n)*w(n)

- Fast Fourier Transform-It is a signal analytic approach used to extract and compress specific speech signal characteristics while preserving all pertinent data, making speech processing simpler. It displays the signal in the given frequency domain. Only the signal's representation is altered; all pertinent information from the original signal is kept. The frequency domain signal is created from the time-domain signal.

- The primary goal of MFCC is to replicate how human ears behave. Based on perception, MFCCs are coefficients that represent sounds. It is derived from the audio clip's discrete cosine transform or Fourier transform. The MFCCs frequency bands are positioned logarithmically , which approximates the response of the human auditory system more precisely than the linearly spaced frequency bands of FFT or DCT. This is the fundamental distinction between the FFT/DCT and the MFC. Better data processing is made possible by this, for instance in audio compression. The MFCC processor's primary function is to simulate the action of human hearing.

2.6 Drawbacks of Existing System

(i) Shoulder Sniffing Attack.
(ii) Background Lightening.
(iii) Text based passwords and Bio metric.

2.7 Summary

Here we have defined the problem statement of our proposed system and existing system,and to over come these drawbacks, we have used different technologies such as media pipe for object detection and detecting hand land marks, Kalman Filter for smoothing the drawing and for voice recognition we have used two different algorithms such as MFCC and Gaussion Mixture Model.To overcome above drawbacks we have included second factor authentication as voice.

Chapter 3

Literature Survey

There are several ways to write in the air. They fall primarily into different categories:

- Method uses device-based/Hardware technique
- Method uses Software Components.
- Some of the related methods involves computer vision technique

IoT-enabled hardware solutions are used to control the writing in the air. software solutions analyze video feeds to decide doodles and provide a solutions to employ brain signals.

3.1 Method uses device-based/Hardware Components

YAN et al., described new research on Conscious Interactive Angle of Pen in 3D Contactless Air-Drawing and Writing[32]. Pen-based communication is increasingly employed as a means of communication. In this study, words are written and drawn using three-dimensional pen interaction based on the penrole angle. The idea of the aware interactive angle is presented. Angles may alter while we are writing normally; this is known as an unconscious angle. Regardless of how the pen is used to convey instructions in this instance, manipulation of the pen is intentional, and a change in angle is referred to as a conscious angle. In this, the two studies to examine the utilisation of the pitch, yaw, and row angles of pens are taken into consideration. In experiment 1, the 3D pen rotates generally unconsciously, but the user must rotate the pen consciously for each pitch, yaw, and rolling interaction approach.

GUIRGUIS et al., described new mthod which is based on Adaptive Thresholds of EEG Brain Signals for IoT Devices Authentication[23]. In this paper, a distinct authentication method for Internet of Things (IoT) devices is suggested.Electroencephalography EEG signals and hand movements are used to accomplish this. A cheap NeuroSky MindWave headset is used for this EEG signal authentication.They used TensorFlow to create the CNN deep learning model for classifying hand motions, and after converting it to TensorFlow Lite, they eventually installed it on the Raspberry Pi board.With regard to usability factors like efficacy and efficiency, the results obtained by the EEG signals authentication method are remarkable.The accuracy and efficacy of the EEG signals used for authentication were 92 percent and 93 percent, respectively.

Wearable Air-writing Recognition System employing Dynamic Time Warping is other technique described by Luo et al.,[18]. This research introduces a wearable air-writing technology that enables users to write the English alphabet in three dimensions freely. The Inertial Measurement Unit (IMU) is the system's foundation. Jumper wires and a TTL-USB converter interface will be used to communicate the data generated by the IMU sensor to the computer. DTW is a traditional approach based on dynamic programming for determining how similar two temporal sequences are, even if they may differ in length and speed. We show some novel optimisation to the IMU and DTW algorithms in order to increase the recognition accuracy and benefits.The outcomes demonstrate that the suggested air-writing system performs well and is highly accurate, particularly when time and sample size are constraints.The potential of this air-writing device is enormous.

Pal introduced doodle based technique that is MicaPen: A Pen to Write in Air Using Mica Motes[20]. The MicaPen application, which is low-cost and suitable for disabled people without fingers or limbs, is described in this study. Using Micaz motes, we can write in the air. Patients can move their hand in accordance with the characters they want to write by using the micaz mote as a wristwatch. Characters are displayed on the screen after movement is sensed by the accelerometer on the MTS310 sensor board. TinyMotion, which employs image processing to detect motions, uses the camera to capture images for vision-based gesture detection. To detect hand motions and interpret them for English character and number recognition, a MICAz sensor node is mounted to the user's hand. This uses RF-based gesture recognition.

Hand in Air Tapping: a Wearable Input Technology to Type Wireless technology introduced by Meli1 et al.,in this study, Hand in Air Tapping (HAT), a wearable input device that enables finger tapping interactions, is suggested. It is made up of Bluetooth Low Energy rings. Using any compatible device, wireless connectivity.Two user studies on text input using this technology were examined. The user's learning curve for writing speed is the subject of the first study, and the rate of text entry between the suggested interface and numpad-style keyboards is the subject of the second study. The keystroke is connected to a group of letters or symbols, and two methods—one based on the T9 technique and the other on the multi-tap input method—are contrasted.The findings reveal an intriguing learning curve, and a study of curve fitting suggests that a typing speed of at least 60 CPM is possible.

3.2 Some related work methods involves(Signal-Based) Software Components

WiWrite: An Accurate Device-Free Handwriting Recognition System with COTS WiFi based technique introduced by wang et al.,[4] which is on Accurate Device-Free Handwriting Recognition System with COTS WiFi is the following method that has been suggested.This eliminates the need for keyboards and offers a convenient method of handwriting recognition.The method being discussed is wi-write, a reliable device-free handwriting recognition system.This will primarily help persons with neurological problems and blurred vision avoid handwriting.Without the need for the user to be attached to any device, it will enable writing across the air.The software utilised is self-paced dense convolution network (SPDCN), which is based on CNN, and the next technique is commercial off-the-shelf (COTS) wifi that achieves fine-grained finger tracking for automatic retention of low noise data.The noisy raw wifi channel is processed using the CSI division algorithm.The SPLS function is solved using the MM (majorization Minimization), CNN, DenseNet, and neural network algorithms.Finally, this article describes precise free.

Radar Trajectory-based Air-Writing Recognition using Temporal Convolutional Network is the new method developed by Arsalan et al.,[5].Includes the classification of digits written in the air using gestures is described in this study.It takes into account the data collection using three Impulse radio ultra-wideband (IR-UWB) radar sensors.The triangle geometry contains the radar sensors. In this, CNN-based gesture categorization using traditional radar-based gesture detection is introduced.For categorization, this approach makes use of enormous data matrices.The hand trajectory is used to provide simple and reliable hand orientation and classification, and the CNN classifier is utilised to obtain a strong gesture recognition.The trajectory matrix was subjected to an image-transforming method in order to obtain picture data that is suitable for CNN input. The algorithms will monitor for the lowest amount of time necessary for a gesture motion.To get rid of the noise line, an outlier rejection method is employed.

Speech Processing: MFCC Based Feature Extraction Technique generated by D.Prabakaran et al.,[33]. Details about Biometric authentication and speech recognition which are two widely used methods. Recognition is preferable because it gives the user a convenient route to take and only needs the user's voice to do it. This paper describes the technque called Mel Frequency Cepstrum Coefficient

(MFCC), a recognition method, is also having trouble with background noise. Automatic Speaker Recognition (ASR) continues to act as the physical defence against any assault. The voice-based absolute authentication system outperforms other biometric strategies with a minimal amount of duplication. Numerous feature extraction techniques are available with their careful benefits and drawbacks while keeping coordination and accuracy in mind. The overall concert characteristics of each feature extraction strategy based entirely on MFCC are discussed in this study, and a strong argument is made for combining feature extraction techniques rather than using them alone. Combining feature extraction techniques results in the cancellation of potential pitfalls and a decrease in operation delay.

A Captcha-Based Graphical Password With Strong Password Space and Usability Study is a method which reduces the hardware usage introduced by A.Khan et al.,[21]. The author describes how graphic password scheme and user authentication, was used in this system and how the system is suggested users work and personal data was secure.Humans are better at remembering visual information than text, thus graphic passwords are simple to remember.The CaRP, Pass-Go, and BDAS graphical password scheme, which is divided into two sub-schemes such as "Clicked on Object to Draw a Pattern (CODP)" and "Clicked on an Object to Select Secrets (COSS)", were integrated using graphical schemes.The CSAV algorithm is used to create the image.This system features two new graphical password schemes, CODP and COSS, that can thwart shoulder surfing assaults and offer a secure password space in addition to unlocking the smartphone's pattern.

3.3 Research Gaps

The above mentioned research's were developed for on-air hand gestures recognition, but some of the methods includes a wearable input devices which are fixed to finger, some other will use EEG based NeuroSky MindWave headset and other techniques which are based on CNN , use of WiFi based signals for recognition of fingertips. So we are introduced a new technique which uses open source libraries for hand gestures recognition and which eliminates the use of large hardware equipment's. The proposed system includes double authentication method so that it is simple and secure for the related application.

3.4 Summary

Here, we have described about different techniques were used for writing in air.Some of them were having iot devices and some of them were signal based.So here different methods were introduced by different researchers for writing in air and how the proposed system was accurate than other methods.

Chapter 4

System Requirement Specification

Software Requirements Specifications (SRS), often known as requirements documents, are created during the requirements stage of the development of software. This report establishes the groundwork for software engineering activities and is created after all requirements have been elicited and examined. SRS is a formal report that serves as a representation of software to allow customers to assess whether it (SRS) is in line with their needs. Additionally, it contains both specific descriptions of the system needs and user requirements for the system. A software product, programme, or collection of applications that carry out particular tasks in a particular setting are specified by the SRS. Depending on who is writing it, it can achieve a number of objectives. The client of a system could, in the beginning, write the SRS. The second possibility is that a system developer could write the SRS. The two approaches produce very distinct circumstances and establish completely different goals for the paper. The needs and expectations of the consumers are defined using the first case, SRS. The second example, SRS, is created with several objectives in mind and acts as a contract between the client and the developer.

4.1 Hardware Requirements

- Operating System: Windows 10, Linux
- Processor: Intel(R) Core(TM) i5-5200U
- RAM: 8.00 GB
- Video Memory:
- Device: Webcam

4.2 Software Requirements

- IDE: Jupiter Notebook
- Frame work: Django
- Database: MYSQL
- Programming Languages: HTML,CSS,JavaScript,Python

The preferred markup language for building Web pages is HTML. It describes a Web page's structure. It comprises of a number of elements, and the elements tell the browser how to display the content.
The declarative language CSS (Cascading Style Sheets) governs how websites appear in browsers. To properly display certain components, the browser applies CSS style declarations.
JavaScript is a programming language used to produce and manage dynamic website content, or anything that moves, refreshes, or otherwise changes on your screen without necessitating a manual page reload. characteristics such as interactive forms.
Python is an interpreted, object-oriented, high-level, dynamically semantic programming language. It is particularly desirable for Rapid Application Development as well as for usage as a scripting or glue language to tie existing components together due to its high-level built-in data structures, dynamic typing, and dynamic binding. Python's straightforward syntax emphasises readability and makes it simple to learn, which lowers the cost of program maintenance. Python's support for modules and packages promotes the module and reuse of code in programs. For all popular platforms, the Python interpreter and the comprehensive standard library are freely distributable and available in source or binary form.
Django is made in a way that encourages web designers to create websites that are simple, quick, and functional. Where Django distinguishes out from the competition is in its pragmatic approach to problem-solving. Django is one of the greatest frameworks to take into consideration if you're trying to create a highly configurable project, such as a social media website. The interactivity of Django's users or its capacity to share various media formats are among its strong points. One of Django's greatest advantages is its capacity to tap into a sizable community-based support network, which offers you access to highly customizable third-party plugins that are ready to use in your projects.
An HTML form is a collection of one or more fields or widgets on a web page that can be used to gather user data before sending it to a server. Because there are suitable widgets for entering a wide variety of data, such as text boxes, check boxes, radio buttons, date pickers, and so forth, forms offer

a flexible technique for gathering user input. The ability to submit data through POST requests with cross-site request forgery protection makes forms another pretty secure method of communicating data with the server.

It can be challenging to use forms! Developers must write the HTML for the form, validate and sanitise the data entered on the server (and possibly also in the browser), re-post the form with error messages to inform users of any invalid fields, handle the data when it has been successfully submitted, and then respond to the user in some manner to indicate success. The framework provided by Django Forms allows you to programmatically build forms and their fields. You can then use these objects to both generate the HTML code for the form and to handle the majority of the validation and user interaction.

Originally created by Intel, Open CV (Open Source Computer Vision Library) is a library of programming functions primarily for real-time computer vision. The library is cross-platform and licensed as free and open-source software under Apache Licence 2. Starting in 2011, Open CV features GPU acceleration for real-time operations.

Although its main interface, Open CV, is created in the programming language C++, the older, less feature-rich C interface is still there. All more recent innovations and algorithms can be found in the C++ interface. Python, Java, MATLAB/Octave, and more languages all have language bindings. The online documentation contains the application programming interface (API) for various interfaces. To promote adoption by a larger audience, wrapper libraries have been created in a number of different languages. JavaScript bindings for a specific subset of Open CV functions were made available as Open CV.js in version 3.4 for use with web platforms.

4.3 Summary

In this chapter we have described about what is software requirement specifications and software and hardware requirements Such as libraries used for implementation, operating system supported, Processor speed supported, devices used in our proposed system, IDE used for execution of the system, framework used for back-end connectivity, programming languages used for creating User-interface and here it also defines about the integrity of the design process of this system.

Chapter 5

Architecture and System Design

Systems design is the process of defining a system's components, including modules, architecture, components, and their interfaces and data, based on the specified requirements.System design aims to divide up a huge system's requirements among its hardware and software parts. Following the completion of the system requirements study, the system design activity begins.The programme modules should be arranged in a way that makes the system straightforward to create and modify. The scale and complexity of programmes are dealt with by developers using structured design strategies. For developers, analysts write instructions on how to write code and how to put parts of code together to make programmes. A software system's design strategy is the method used to create it. It is possible to create software systems using a variety of methods.

- Top-down Design
- Bottom-up Design
- Iterative Design
- Incremental Design
- Agile Design

The exact needs of the software system, its size and complexity, and the development process being utilised will all influence the choice of system design strategy. A well-designed system can streamline the software development process, boost the software's quality, and make it simpler to maintain.

The overview of the system is represented in figure 5, this includes the modules involved in the proposed System i.e,

- Computer Vision.
- Kalman Filter.
- Lightweight Deep model

5.1 Software Overview

5.1.1 System Block Diagram

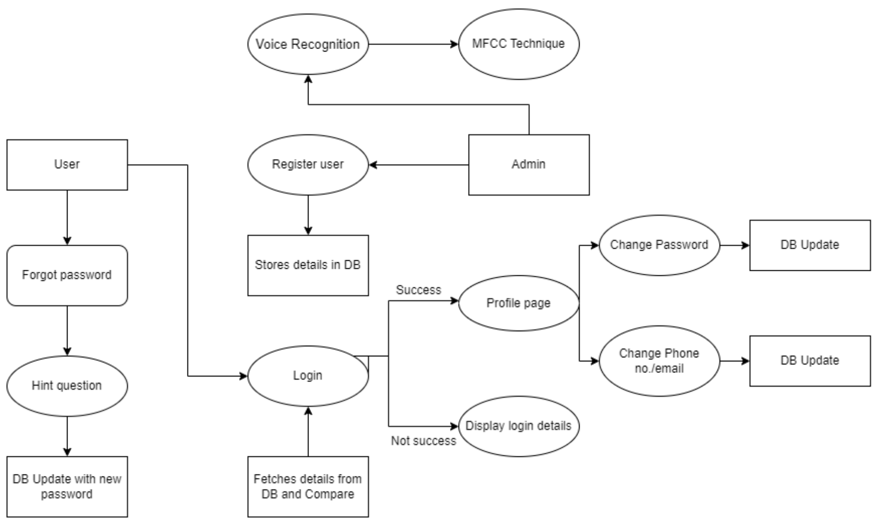

Figure 5.1: Block Diagram of OADHDs

The above figure 5.1 describes about architecture flow of proposed system. Firstly the website will launch the voice recognition process to validate the administrator.The subsequent phase begins with the capture of the hand motions from the webcam that were used in the previous stage to authenticate the user. Following the three functions for drawing the doodle, the second factor authentication process—voice recognition of the user with an audio file already present in the database. For hand gesture recognition kalman filter and media pipe function has been used to get the accurate hand movement. For the voice modulation MFCC function has been used for checking the voice modulation.

The data will be stored in database and rendered with the help of django connection server.Utilising colour recognition, we will be able to comprehend motions and carry out commands based on those gestures.The database will store the each month data when user verifies his/her doodle along with voice, if these are not verified then it will not update until the proper authentication. So that no one can misuse the other persons ration the overall process will be handled by Admin. The has authority to verify other user when his voice was correctly recognized. The trained and training voice set of each user was stored in local system and used for comparison.

5.1.2 Data flow Diagram

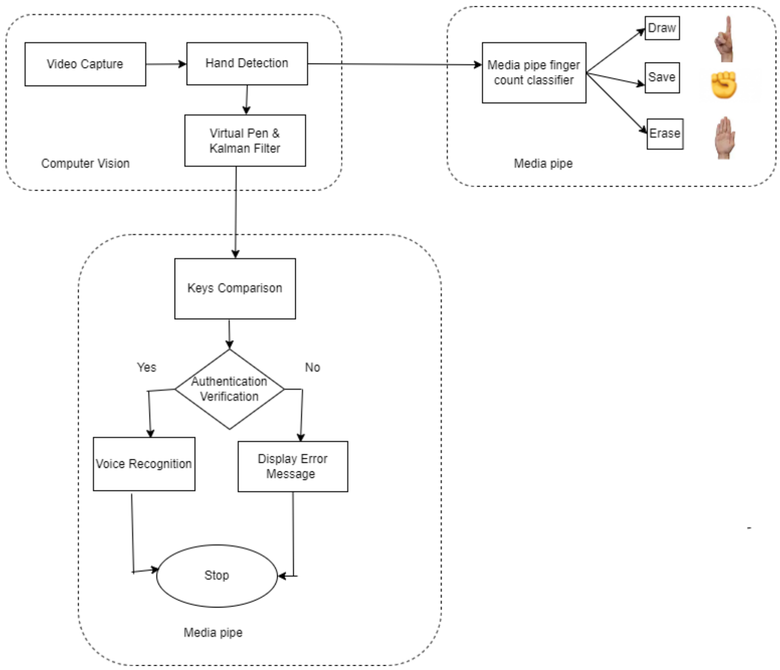

Figure 5.2: Data flow Diagram of OAHDS

The above figure 5.2 describes about data flow from on module to another.Where each module has different functionality.Fist is to create a virtual pen and detect hands, a computer vision technology was first employed. The hand automatically picks up the virtual pen when it is in front of the camera. The classification of three-hand gestures was done using a lightweight deep media pipe for dynamic hand gesture detection. The drawing was made with the index finger extended. Erasing was accomplished using an open-handed motion. To save, he made a closed-hand sign. Third, the algorithm used by the Kalman filter is easy to use and quick. Hand-drawn symbols were smudge-free on the air thanks to this technology.Fourth, there are three steps in the login authentication and verification process. The login is initially drawn to the symbols of the authentication key. Keys were then retrieved. Third, authentication keys were checked using a media pipe. After all this functionality the database will be connected using Django software.

1. User Interaction: Through an interface, such as a web application or specialised device, users communicate with the system. They carry out tasks like raising their arms in the air or giving spoken orders.

2. Hand Doodle Recognition: The system recognizes and captures the hand doodles made by the user. This can be done using computer vision techniques, such as image processing and object detection algorithms.

3. Voice Recognition: The technology also records spoken or voice commands made by the user. Speech to text conversion uses voice recognition technology like Automatic Speech Recognition (ASR).

4. Data Processing: To extract useful information, the voice orders and captured hand sketches are processed. Pre-processing, feature extraction, and data normalisation might be included in this.

5. Doodle Rendering: On a display or screen, the rendered hand sketches are produced.This can entail transforming the doodling into a digital format, like bitmap images or vector graphics.

6. Display/Output: The viewer sees the produced drawings as well as any additional visual cues or textual information.This might be displayed on a screen, projected onto a wall, or sent to a distant device.

   The general data flow and interactions inside a "On Air Hand Doodle System" with voice recognition capabilities are depicted in this data flow diagram.

5.1.3 Usecase Diagram

That the use case graphic below offers a high-level summary of the system's key functions and interactions. The hand doodling system can be connected with the voice recognition component in this use case illustration, it will focuses on capturing and recognising voice input. This allows for spoken commands or voice-based interactions.

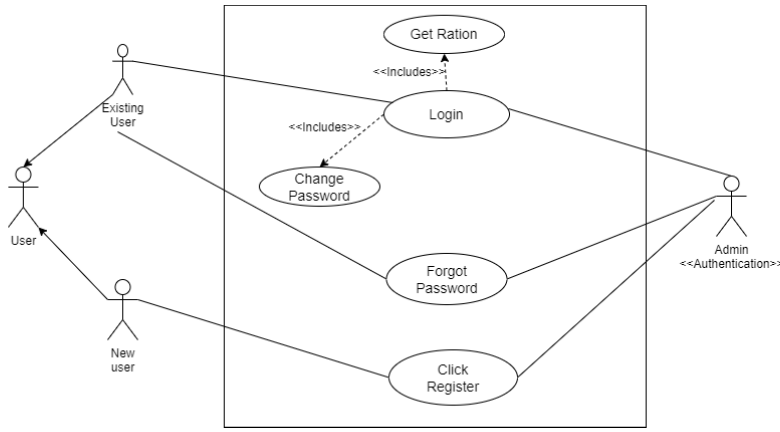

Figure 5.3: Use-case Diagram OAHDS

1. User Interaction: Exemplifies the user's interactions with the "On Air Hand Doodle System". Includes activities like doodle sketching and voice commands.

2. Draw Doodle: Represents the use case when a user creates a hand-drawn doodle on a touch-enabled screen using a stylus or their finger. In this use case, the user's drawing is recorded and sent to the system for analysis.

3. Recognize Voice: Represents the use scenario where the system interprets user speech commands using voice recognition technology. In this use case, speech input from the user is recorded, processed by a voice recognition system, and then the necessary answers or actions are produced.

4. Voice Recognition System: Represents the part of the system in charge of voice recognition. Voice inputs are processed, spoken commands are recognised, and the "On Air Hand Doodle System" is informed of the recognised commands for the necessary actions to be taken.

5.1.4 Sequence Diagram

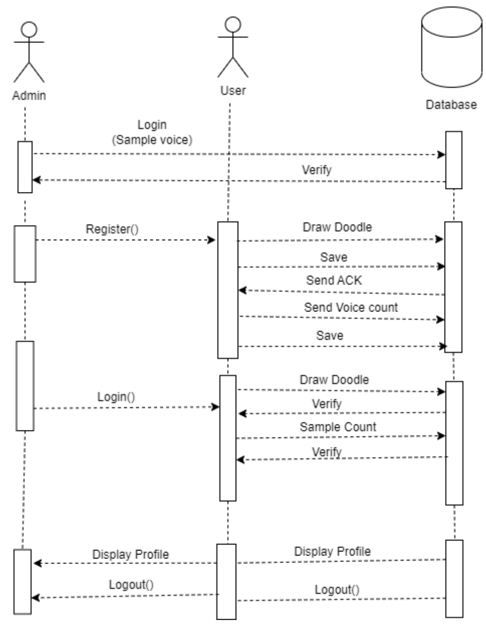

Figure 5.4: Sequence Diagram of OAHDS process

The process of making and broadcasting a hand doodle is shown in the sequence diagram along with the interactions between the User, the Database, and the Admin. First admin login through voice record and database will store that,compare for every login. After admin login admin will register/login the user by calling function register() and user starts drawing the doodle along with the voice record will be saved in doodle. For every user login the data will be updated and displayed in profile page .after all this process the admin will logout the user.By invoking the StartDoodle function in the air, the User starts the doodling process. Following receipt of the request, the Drawinng method gets ready to draw. By executing the Draw(hand Doodle) method in the air and including the hand-drawn doodle as a parameter, the User can interact with it. The database will store the first admin login through voice record and compare it to subsequent logins. After logging in as the administrator, the administrator uses the function register() to register/login the user before the user starts sketching in the doodle and the voice recording is saved in the doodle. Every time a user logs in, their information is updated and shown on their profile page.After finishing up, the administrator will log the user out.

5.2 Summary

Here,we are concluding this chapter by different models used to represent the proposed system design by using diagrams such as block diagram,data flow diagram,use-case diagram and sequence diagram.All the four models were representing the flow of the system and how each modules were connected to each other.It shows user interaction along with admin and database. Finally it shows the representation of each users with their activity and entire process of working of the proposed system.

Chapter 6

Implementation

6.1 Implementation Details

6.1.1 Organization of Files

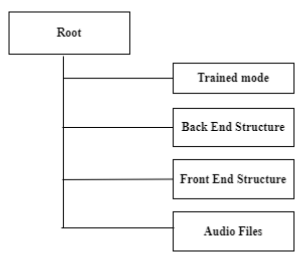

Figure 6.1: Root Directory Structure

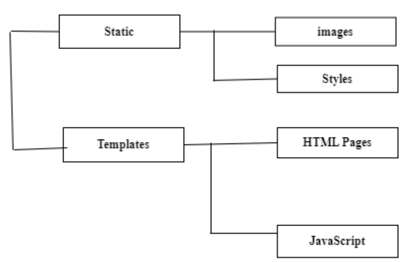

Figure 6.2: Front End directory structure

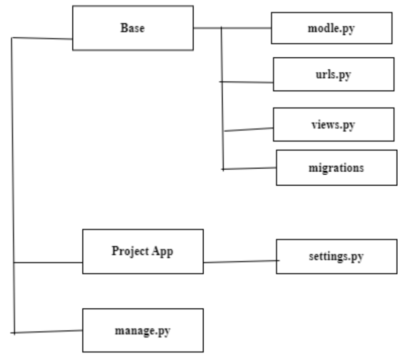

Figure 6.3: Server directory structure

The project consists of two services, the back-end doodle and voice detection framework which is run on a server and a client viewable front end. The we used django based database as a mediator between the two. As a result, both can be run and hosted independent of each other. Server can be hosted on a powerful machine and the front end can be hosted on any static web hosting service. There are 2 main folders, Server and Web.

As the name suggests, server contains all the necessary files for detecting the hand doodle and voice recognition, which include the media pipe and migrations model, configuration for mode model, the urls model, the views and the core logic itself for detecting doodles in main.py. The web user interface folder consists of 1 folder - settings. Where it contains the minified and compressed HTML and JS, which is meant and optimised for deployment.And also it contains the structure of the front-end which contains the code for all the routes such as login, dashboard, history and location settings.

6.1.2 Implementation Workflow

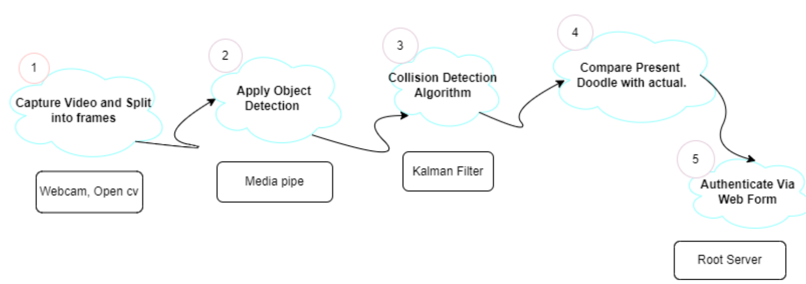

Figure 6.4: Step-wise Implementation

- Step 1: Frame Extraction,The first step involves the extraction of the frames from the input video. The video stream is divided down into its constituent frames, which are individually taken and used for processing to detect potential Hand land marks.

- Step 2: Object Detection, The second step works based on frames detected for future extraction for this it used land marks labelling from previous step and object will be detected for drawing.
- Step 3: The third step in the process is to detect potential collisions in the frame. For the same, we have created a samples based on the kalman filter algorithm We use the co-ordinates of matrix generated from the previous step to check for an overlap between different doodles. If we do detect an incorrect doodle the authentication will be failed.
- Step 4: Doodle Classification, The fourth stage of the process is the The user creates a password symbol in real time. The image of the authentication sign is extracted and altered. Finally, the media pipe model is used to verify the authentication sign picture.If the accurate level is high then next process will be executed.
- Step 5: Reporting the final step, in this step the user will be authenticated and get the Ration and this will be marked as tick if his/her data was been processed correctly.

6.2 Modules used and Screenshots

There are few of the modules which play an important role in execution process they are media pipe, play audio, open cv etc.

- Media pipe: A framework called MediaPipe is used to create machine learning pipelines for processing time-series data, such as audio and video. The desktop/server, Android, iOS, and embedded devices like the Raspberry Pi and Jetson Nano are all supported by this cross-platform framework.This helps to find the landmarks of hand in our project.To find hand landmarks, we use the media pipeline library. A basis for constructing computer vision interfaces over sensory input like audio and video will be given by the media pipeline. Here, audio and visual data will be processed using time series and the cv2 library. The media pipeline operates in real-time applications using data from the camera module initially, it takes in a stream of images as input and outputs hand landmarks for positioning. These landmarks give the finger positions and position numbers. We shall learn many hand actions thanks to this. Computer vision is used for hand identification and creating virtual pens. While the virtual pen is in front of the camera, the hand takes it up. This process has been displayed in below figure how it works in our project.

Figure 6.5: Working of media pipe

- A key component of many applications, including those for artificial intelligence and home automation, is speech recognition. The other module we used in our project is called playsound, and it just has one function, called playsound().The path to the file containing the sound we need to play is the only argument needed. It could be a URL or a local file. The second input, block, is optional and by default has the value True. In order to have the function run asynchronously, we can change it to False.And both WAV and MP3 files can be used to store the recorded voice.
- Kalman Filter: Kalman filter is the algorithms which was used in existing methods for the estimation of the state of a system based on observations or measurements. We also make of this kalman filter algorithm for hand recognition and positioning.

Kalman filter

Input: x_{est} , P_{est} , z , Q , R

Output: $x_{updated}$, $P_{updated}$

Step 1: Initialize F matrix and H matrix

Step 2: Predicted state vector and covariance:

$$x_{prd} = F\, x_{est}$$

$$P_{prd} = F\, P_{est}\, F^{T} + Q$$

Step 3: Estimation:

$$S = H\, P_{prd}\, H^{T} + R$$

Step 4: Compute Kalman gain factor

$$K_{gain} = P_{prd}\, H^{T}\, S^{-1}$$

Step 5: Correction based on observation:

$$x_{updated} = x_{prd} + K_{gain}\, (z - H\, x_{prd})$$

$$P_{updated} = P_{prd} - K_{gain}\, H\, P_{prd}$$

Step 6: Return $x_{updated}$, $P_{updated}$

Figure 6.6: Working of kalman filter

6.3 Summary

This chapter includes step-wise implementation of the proposed system.Here we have explained in detail how each modules are working there functionalities.Also we have shown how each files are organized in structure.The various modules used to run this System is shown in this chapter.

Chapter 7

Testing

Software testing is the process of assessing and confirming that a software application or product performs as intended. Testing has advantages such as bug prevention, lower development costs, and better performance.

Types of Testing:

- Acceptance testing: Confirming that the system overall functions as planned.Verifying that software functions or components work together through integration testing.
- Unit testing verifies that each piece of software operates as expected. The smallest measurable element of an application is called a unit.
- Functional testing is the process of verifying how well a function works by simulating business scenarios. Function verification is frequently done via black-box testing.
- Performance testing: Analysing the software's responsiveness to various workloads. For instance, load testing is performed to assess performance under actual load situations.
- Regression testing: Verifying whether new features cause functionality to break or deteriorate. Menus can be checked using sanity testing, When a thorough regression test cannot be performed, functions and commands at the surface level must be used.Tests to determine how much stress a system can withstand before failing. it is regarded as a form of non-functional testing.
- Usability testing verifies how well a user can execute a job using a system or web application. Validating base requirements is an important evaluation in any situation. Exploratory testing is

crucial in assisting a tester or testing team in identifying challenging scenarios and circumstances that may result in software defects.A simple application might be put through a lot of different tests. A test management plan aids in prioritising which testing kinds, given the time and resources at hand, are most valuable. By using the fewest possible tests to identify the greatest possible number of flaws, testing efficacy is maximised.

Software testing uses a standard procedure. Determining the test environment, creating test cases, writing scripts, examining test results, and sending defect reports are tasks or steps.Testing might take a lot of time. For tiny builds, manual or impromptu testing may be sufficient. However, technologies are commonly employed to automate operations for larger systems. Teams may test alternative scenarios, differentiators (such shifting components into a cloud environment), and quickly receive feedback on what works and what doesn't with the aid of automated testing. Application programming interface (API), user interface, and system levels are all included in a successful testing strategy. Additionally, the more early and automated tests that are conducted, the better. Some teams create their own internal test automation technologies. Vendor solutions, however, provide capabilities that can simplify essential test administration.

Continuous testing involves testing each build as it is released by the project teams. Software testing of this kind is automated and integrated with the deployment procedure. It enables software to be evaluated earlier in the process in realistic test environments, enhancing design and lowering risks. Configuration management involves tracking which software builds are used for testing and centrally maintaining test artefacts. Assets including code, requirements, design documents, models, test scripts, and test results are made available to teams. To assist teams achieve compliance requirements with the least amount of administrative work, good systems incorporate user authentication and audit trails.

Service virtualization: Especially early in the creation of the code, testing environments might not be available. Teams are able to reduce dependencies and conduct testing more quickly thanks to service virtualization, which simulates the services and systems that are either incomplete or missing. They may reuse, deploy, and alter a configuration without changing the original environment to test various situations.Tracking defects, often known as bugs, is crucial for development and testing teams to measure and boost quality. Teams can track faults, assess their breadth and impact, and find connected problems thanks to automated technologies.

Metrics and reporting: Analytics and reporting allow team members to communicate about status, objectives, and test outcomes. Service virtualization: Testing environments could not be accessible, particularly early in the development of the code. Service virtualization, which replicates the services and systems that are either incomplete or missing, enables teams to minimise dependencies and carry out testing more quickly. To test different scenarios, they can reuse, deploy, and modify a configuration without affecting the original environment.

To monitor and improve quality, development and testing teams must keep track of defects, also referred to as bugs. Thanks to automated tools, teams can detect errors, evaluate their scope and impact, and identify related issues. Reporting and metrics Team members may communicate status, goals, and test results thanks to analytics and reporting.

Table 7.1: Described Test cases of the execution process

Test Case No.	**Test Case**	**Steps**	**Expected Result**	**Actual Output**
1	Launch a web browser	1. Enter the URL of the website in the browser's address bar. 2. Press the Enter key. 3. Wait for the website to load. 4. Verify that the website's home page is displayed. 5. Check for any error messages or alerts displayed on the website.	Verify home page is displayed properly.	Home page is displaying properly.

2	Verify that the website content and images are loading correctly.	1.Enter the URL of the website in the browser's address bar. 2. Press the Enter key. 3.Wait for the website to load.	Verify that the website's voice recognition page is displayed, and images are displayed correctly.	Website's voice recognize page is displayed, and image displayed correctly.
3	Verify that start button is clickable or not.	1.Enter the URL of the website in the browser's address bar. 2.Press the Enter key. 3.Wait for the website to load. 4.Click on start button.	Verify that the start button is working correctly when mouse move on that.	Start button is working correctly.
4	Verify model is producing correct recognition of voice.	1.Enter the URL of the website in the browser's address bar. 2.Press the Enter key. 3.Wait for the website to load. 4.Click on start button. 5.Reload the code for voice recognition.	Verify that the system can interpret and respond correctly when a voice command is accompanied.	Voice recognition is doing properly.

5	Verify that page is redirected after admin voice to register /login page.	1.Enter the URL of the website in the browser's address bar. 2.Press the Enter key. 3.Wait for the website to load. 4.Click on start button. 5.Reload the code for voice recognition.	Verify Admin page is displaying properly.	Admin page is display properly.
6	Verify that audio is generated correctly.	1.Enter the URL of the website in the browser's address bar. 2.Press the Enter key. 3.Wait for the website to load. 4.Click on start button.	Verify that the audio is working correctly after start recording is over.	Audio is playing correctly.
7	Verify the register webpage content and images are loading.	1.Enter the URL of the website in the browser's address bar. 2.Press the Enter key. 3.Wait for the website to load. 4.Click on start button. 5.Reload the code for voice recognition. 6.Enter prediction page. 7.Input a detail and click on submit.	Verify that the details are stored correctly for correct id.	Register user details is working properly.

8	Verify that camera is working in capture doodle page.	1.Wait for the website to load. 2.Click on start button. 3.Reload the code for voice recognition. 4.Enter prediction page. 5.Input a detail and click on submit.	Verify that camera working properly and recognising hand.	Model predict land marks correctly.
9	Verify that model is recognising correct doodle.	1.Wait for the website to load. 2.Click on start button. 3.Reload the code for voice recognition. 4.Enter prediction page. 5.Input a detail and click on submit. 6.Enter prediction page.	Verify that camera is working properly and recognising doodle.	Model predict correct doodle.

10	Verify that page is redirected after use voice recognition.	1.Wait for the website to load. 2.Click on start button. 3.Reload the code for voice recognition. 4.Enter prediction page. 5.Input a detail and click on submit. 6.Enter prediction page. 7.Input a doodle and python libraries. 8. Enter prediction using Python code function.	Verify that model predicting voice and opening register page.	Model predict correct voice open register page.
11	Verify that next website content is display or not.	1.Wait for the website to load. 2.Click on start button. 3.Reload the code for voice recognition.	Verify that website voice image recognition page displayed correctly.	Website working properly.

12	Verify that data has marked correctly on web page.	1.Wait for the website to load. 2.Click on start button. 3.Reload the code for voice recognition. 4.Enter prediction page. 5.Input a detail and click on submit. 6.Enter prediction page. 7.Input a doodle and python libraries. 8. Enter prediction using Python code function.	Verify that the model recognition verification is done correctly, details filled correctly.	Model is working properly.

The table 7.1 details about test cases which helps to know the better working of the system. Helps to improve the accuracy of model among existing technologies. The test cases are included for each and every step of execution process not only the steps, the models used for the system are also be tested fro better working before final execution.

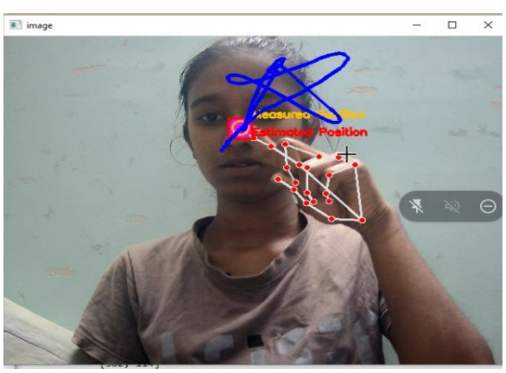

Figure 7.1: Drawing Basic Doodle

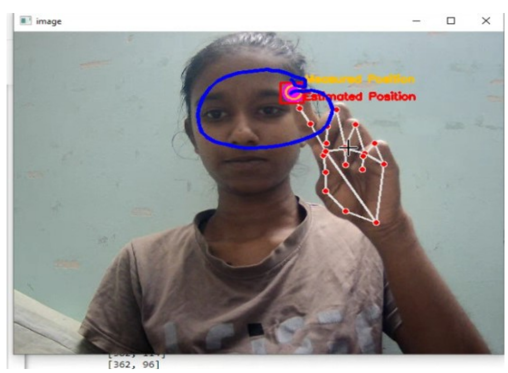

Figure 7.2: Basic Doodle

The above mentioned figures describes about working of code and webcam Quality. Where the Estimated and measured positions will be accessed throughout the drawing process, this will help the model to avoid the noise among the doodle and will get the accurate results of doodle for authentication.The estimated and measured position can be accessed by mathematical equation among the 'X' and 'Y' co-ordinates. The 'X' and 'Y' co-ordinates consists of before and future estimates.This will be updated on the basis of time update equation. The x and y coordinates will store the hand landmarks in matrix form based on that the measured positions will be same as estimated position in all the cases.

7.1 Summary

Here,we have covered that Testing is a very important aspect that provides assurance that proposed system is working efficiently to different environment,conditions,test cases etc.So there are plenty of testing types are present to test the system functionalities working correctly. we have written test cases to test the various functionalities and did comparison of expected results with actual results to check the accuracy of the system. We have described them in this chapter.Finally we have shown our system testing outputs in this chapter figures covered.

Chapter 8

Experimentation and Results

We evaluated the execution process in the below :

Figure 8.1: Voice Recognition

Figure 8.2: Admin Entry

The above figure are the first step of the proposed system, which includes the voice recognition and admin login process. The first step will be executed when the server starts it's process this will help to execute run the process through web application. After server starts the first voice recognition will be enabled and executed, this is related to the admin. Once admin voice was recognized then the admin will able to process the next process. The next continuation process is user login/registration which was done by admin.Once admin login/register the user the next doodle system will be executed.

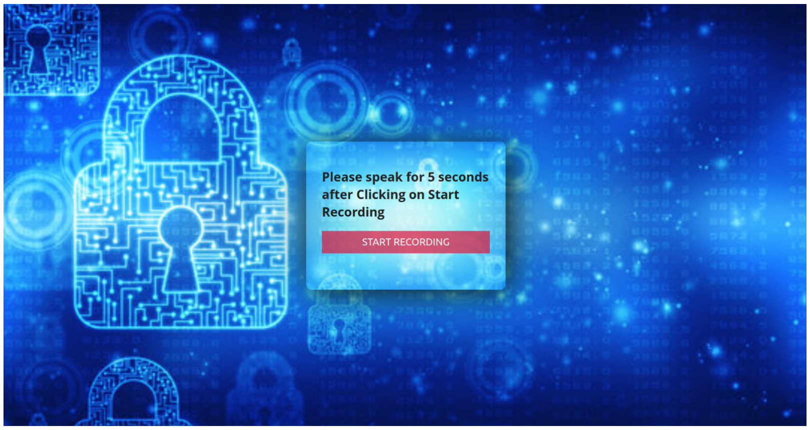

Figure 8.3: Admin Voice Recognition

The execution of the proposed system using websites is shown in the above image.Firstly, the administrator should use speech recognition to access the application.The login process will restart if the voice was correctly recognised, If the admin voice is not correctly recognised, then admin will be in the same page (reloaded again).The admin has to click on the start recording button and has to speak for identification of his/her authentication.Once the admin receives "Welcome Admin" voice then the admin can register new users.

Figure 8.4: User login/Register

Figure above shows what happens once admin completes his login.Only admin can register new users. If the user is new then he/she has to register by admin so that the register page will be popped at that time, if the user has already an account he/she will be pooped by clicking the login button.

Figure 8.5: User login

In this user login,the user has to enter the Ration Card Number and Click on submit button to take ration.If the User does not have account ,Firstly he/she has register by clicking register button.If the user has logged in successfully he/she has to draw in front of the camera for first level of authentication and the voice recognition module is called for second level of authentication where the user has to speak for authentication.If the user is authenticated successfully ration will be provided.

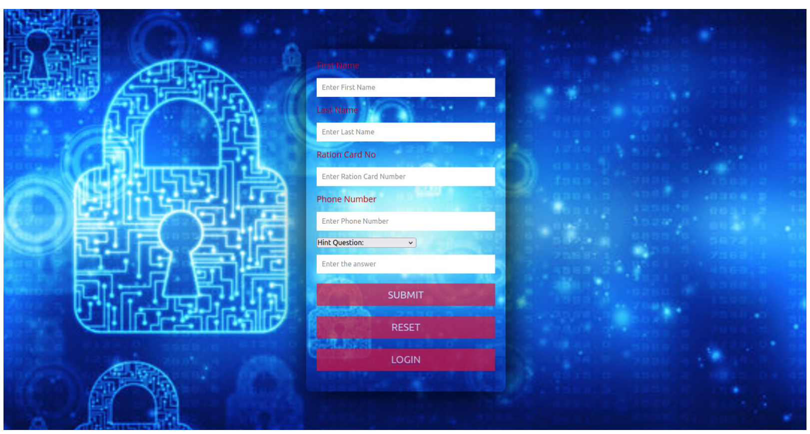

Figure 8.6: User Registration

The registration page is shown in the figure below. An administrator must register a new user by adding the specific fields mentioned in the web page. Then that information will be stored into the database, whenever the user first contacts the administrator the above steps will be followed.When the user returns to the admin, these details will once again be rendered from the database for authentication.

Figure 8.7: Forgot Password

This figure will describes about forgot password.If the already existing user forgot his/her password then he has a option to regenerate his new password in same login id.This includes the int question solving option.

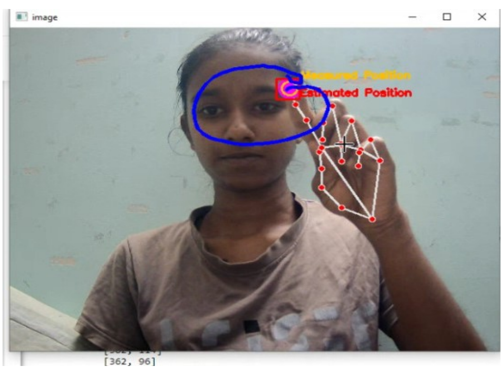

Figure 8.8: Drawing Basic Doodle

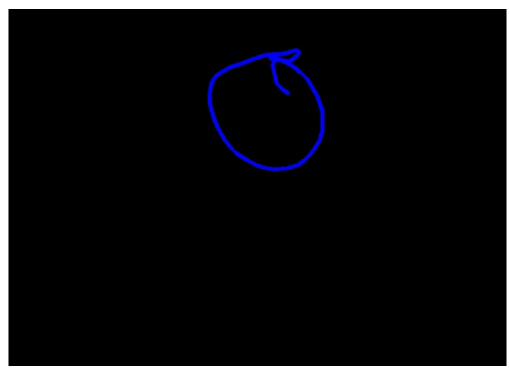

Figure 8.9: Basic Doodle

The above figure describes the actual output of the system which is used for comparison with the existing one. The drawing doodle process includes the hand tracking and gesture recognition with their excepted and actual prediction. The final drawn image will be saved and compared for next process. After this process the voice recognition will come into picture which is our second factor authentication in our proposed system, this will avoid the frauds in login process and all over authentication process.

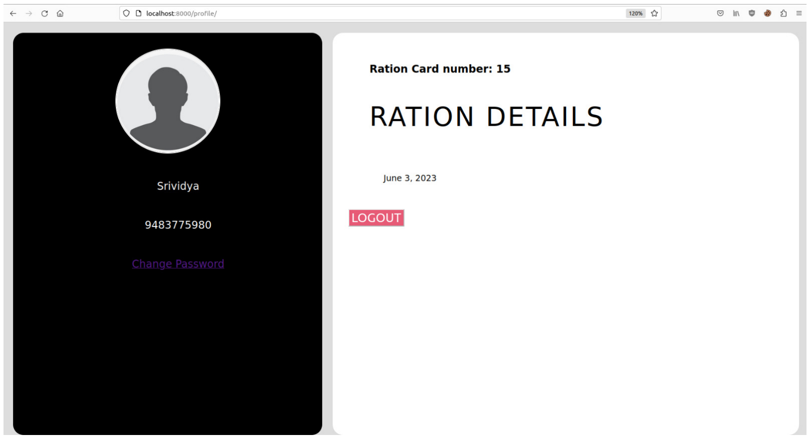

Figure 8.10: User profile page

The figure 8.10 is the final step which includes the individual data updating according to there successful login completion. This page includes the month wise ration distribution date so no one will get any data theft etc.

8.1 Summary

Finally in this chapter we have shown the execution results of our system and how it is feasible for authentication.

Chapter 9

Conclusion

The "on-air hand doodle system" offers an interactive and unique way for users to express their creativity through hand gestures, opening up possibilities for various applications, such as virtual painting, interactive presentations, or educational tools.The proposed system involves using of computer vision techniques to track hand movements and allow users to draw in the air. The system typically utilizes a camera to capture hand gestures, processes the video frames to isolate the hand, and maps the hand movements to draw on a screen or canvas.The goal of our project was to create an accurate end to end system, utilizing the passwords as doodle infrastructure along with our processing framework and an end user web-based portal to display the report of the password detection. For the same, we came up with a five stage process, starting with the frames being extracted from the video, through the code for objection detection, our custom collision detection algorithm and our self-trained classifier to classify the images as correct doodles, to finally displaying the results of the classification process to a web platform that would be made available to admin and users in the Ration Distribution. Our testing revealed several positives, with our framework accurately detecting doodles in the test video set. Our model was also highly accurate, delivering an output. Even with these promising results, there is a lot of scope for future improvement.

The proposed system was demonstrated the acceptability and significance of the suggested authentication technique using usability factors like accuracy, efficiency, and user satisfaction. The suggested approach is safe and resistant to dangers from physical observation. This technique is completely independent of any depth camera or motion sensor, making it suitable for managing future on-air writing. The voice based authentication is mainly over come the security factors occurred by doodle system. The both techniques wil help the applications secure and safe with there efficient usability.

9.1 Future Enhancement

- There are other strategies that we can incorporate into this improved system in addition to air writing and hand recognition. We created this method by incorporating voice recognition and doodling for verification; however, in addition to these, we can also integrate an OTP module.

- For the forgot password module, we have added a hint question option in this suggested system so that it can be replaced by an OTP verification that is delivered to the user's registered mobile number. Additionally, we can create a web application that would function as a standalone programme rather than hosting it on a web server.

- Instead of using the system's built-in libraries, the Raspberry Pi can implement this system.Additionally, we added a speech recognition system to the current system by speaking random sentences, allowing us to improvise by adding a language- and audio-based captcha. The other way to improve the current system is to allow users to log in and register on a session basis.

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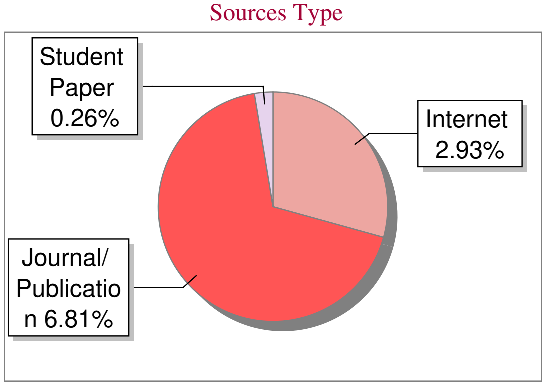

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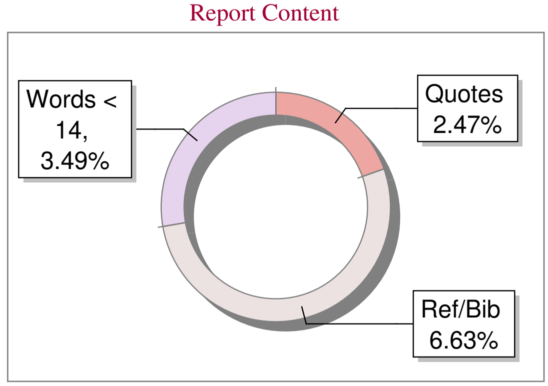

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Systematic Review on on-Air Hand Doodle System for the Purpose of Authentication

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Abstract— **Air-drawing for authentication or gesture recognition is vastly studied such that new methods for the character drawn can be identified with better accuracy and be independent of any hardware components such as gloves to detect the fingertip movement or any wearable sensor or using any external pen. This article surveys how air-writing is done. Some of them include using fingertips as a pen and having the trained CNN model against it using the techniques DNST and Bi-LSTM for the regression and hand gesture identification and classification. This system had an overall accuracy of 88 percentage. Another system solves the air-writing issue by using deep learning architecture, by executing it on 3D space where the next evolution is numerical digits structured into multiple dimensions time-series extracted from a sensor called LMC. In another system, wi-write recognizes hand writing mainly to overcome blurred vision and neurological diseases in people, this will use COTS WiFi but is a device-free handwriting recognition system. In many other systems deep learning models are used and those parameters can be used to achieve higher recognition rate for example 98 percentage above.**

Keywords*— CNN (Convolution Neural Network), Kalman Filter, hand gesture recognition, Doodle, deep learning, Air writing, wearable sensors, DNST (Differentiable Spatial to Numerical Transform), Bi-LSTM (Bidirectional Long Short-Term Memory), LMC (Leap motion Controller), DTW (Dynamic Time Warping), RNN (Recurrent Neural Network), TA-RNNs (Time-Aligned Recurrent Neural Network).

I. INTRODUCTION

On-Air writing is a method which can replace the traditional method of interacting with the typewriter with having no requirements for a touchpad/touchscreen kind of surface. While handwriting and gesture recognition techniques are developed and studied frequently, most of them require the use of hardware components such as cameras, sensors which are used to capture fingertip movement, or hardware which have restricted movements and so on and hence new methods are studied to ease the task. Even though the domain is studied it has many challenges, it can provide security to the users personal information and be used as a form of authentication like a graphical password. Passwords are a form of authentication which provides the platform for security but there can be cases where these are vulnerability and hence multi-factor authentication is preferred but these multi-factor can cause irritation to users as they require extra-interaction with the system, while the drawing is used as one form of password since graphical passwords are better to remember for humans than typing password. There are also chances that a certain community of people, for example, elderly community may find it difficult to use touch screens in smartphones or type the characters in the screen due to the screen size and unfamiliarity. The systems which enable the users to write the characters on screen using the smartphone camera and having no extra hardware or sensor cost can be beneficial to the users.

II. RELATED WORK

The concept of on-air writing is not new, it is done using some techniques which involve the use of radio waves, wearable sensors or computer vision. Some of the related works based on the use of radio frequency involve:
Regani et al., in this the air- writing and hand gestures which include gesture recognition and handwriting recognition techniques [2].

To improvise this many method are invested to give the accuracy of handwriting tracking. In this paper they described mm write which is high-precision passive handwriting tracking and this will use single commodity millimeter wave radio. It provides the minimum distance coverage and short wavelength, high bandwidth of signals and high phased array. mmWrite transforms from different regions into interacting surfaces. This will process at limited hardware and helps to boost the service by deleting the unwanted background and objects on the interface. mmWrite as the ability to track the pen/finger moments with the median and will reduce the written characters. mmWrite algorithm works based on CTp time series recorded by radar. Mainly this describes over all writing trace system by finding object for process step and provides the accuracy among characters.

Chen et al., paper describes the advanced technique used, which is the 3D pen positioning system [3]. The technique is done with a high refinement 3D ultrasonic positioning method. Another method used is with "Highest exact Time-of-flight(TOF) detection" and this is used on the basis of "dynamic threshold and zero-crossing detection method". In this it overcomes the positioning method by uniform setting of 60 test positions in a surface area. For this the "static and dynamic positioning" accurate value will be applied to all test positions. The first is that the EM positioning technique uses fewer devices to check the places and alignment related to the frequency sources produced by a transmitted equipment. The next is "optic based 3D locate technique" that uses both sighted and sensing, to find 3D positioning of a pen. High frequency was used by the Acoustic method for sound waves, to find the distance among each static node and target. Finally, this provides High-position accuracy and millimeter level positioning will be achieved within a working area.

Arsalan et al. proposes the effective sensor utilization and recognition of air writing [5]. This makes use of 2 or 3(min) radars, helps to sense the hand trajectory and avoids the high usage of sensor devices. Trilateration is the algorithm which feeds the output of radar sensors and networks in the range. This technique evaluates the global coordinate of the fix-up by using local range estimators of maximum reference nodes. This ensures the usage of a "1D temporal convolution network (TCN)" for continuous features. This is the feature which held for extraction & recognition of drawn characters from local trajectory. It makes use of 60 GHZ mm wave FMCWRadar used for recording the dataset values among 3000-character instances. Ensures the accurate deep architecture and 99%,91% solution among one and two radar This overcome limitation associated with radar placements on screen and cost. This system improves the identification of characters in virtual machine.

Wang et al., proposes to use gesture interaction which is one of the deviceless methods [6]. Gesture air-writing avoids the use of conventional devices and this system is implemented based on frequency range that covers 24-GHZ frequency and it is modulated on "24-GHZ FMCW radar and System on-ship. Radar chip" helps to cover the transmitted chirp signal width up to 4 Ghz length & gives wide area of aspiration on tracking of hand gestures. In this it provides the construction of air written symbols on observation planes by developing SIMO antennas. Device design/signal processing is the method used by gestured applications. "Triangulation of Radar base" algorithm is use for tracking and getting air written alphabets on 3D area. CFAR used to monitor starting/stopping time of productive action. RTS and Kalman is used for smoothing alpha beta filters. This system proposes the Dynamic gesture recognition with deep learning technique was used for effectiveness of future extraction, alphabetic symbols along with numerical symbols are written in 2D space.

Fang et al. describes the key intuition handwriting actions introduce different noise in "WiFi signals" and can be used to get perfect patterns in the "time series of CSI [7].WiFi-based system called Wima, is used as a best resolving solution for identification of alphabets written by hand. Taking features and substituting it to classifiers is done directly from CSI by Wima accordingly. For extracting the high-level features, the DL based method was installed on to the system.CSI letters like amplitude/phase transferred to pictures through Wima and after that it will extract the features using CNN. SoftMax is the algorithm used to build a classifier. Deep-learning network, technique which is applied on continuously as getting similar feature for man-made items identification by "WiFi CSS". By IEEE 1n the NICs exhibit about Wima which will generate a minimum Finding of alphabets at 95%.

Leem et al. describes the classification of numeric written on air by using hand actions [9]. It considers "data acquisition" by radar sensing devices based on IR-UWB sensor. The radars are inserted in triangular geometry. This introduces gesture classification using CNN which is based on conventional radar-based gesture recognition. This method uses huge data matrices for classification. CNN classifier is used to get a robust gesture recognition, the hand trajectory is used to get easy and robust on hand's orientation and classification." Image transformation algorithm" was applies to the trajectory matrix for providing pictorial data which is applies to input for CNN and algorithms will monitors for a particular time stamps which equals to the minimum time stamps necessary for a gesture movement. Outlier rejection algorithm is used to eliminate the noise line and nonnumeric points. The technique presents for air digit writing through radio-sensors. image-based numeric findings are used for high recognition accuracy from many people.

Lu et al. a new way was designed, a "virtual writing tablet system", this was describing on general using laptops to avoid touch screens [10]. The VPad is attached with speakers and microphone, this will be used for trajectory tracking for avoidance of additional hardware. For recognition & tacking of hand movement, writing in air it employs the acoustic signals repeatedly. The inaudible signals will be emitted from both the speakers in VPad. Sliding window overlap Fourier transformation technique is applied on VPad for finding Doppler frequency shift." Stroke direction sequence model" is used for approximation and identify the characters. FT algorithm is used for time resolution, trajectory tracking algorithm is applied for horizontal hand movements. It describes the online writing tablet which is based on acoustic signals. Accurate tracking of hand movements was done and sliding window will help to find Doppler shift which has high resolution and sequence-based model is used to get perfect character identification. Extensive experiments will verify the feasible and effectiveness of Virtual Pad and help to get accurate output.

Some of the related works using device-based technique are: Bastas et al. was processing air-writing through many different architectures [13]. It solves the air-writing issue by using deep learning architecture, by executing it in 3D space. The next evolution is numerical digits structured into multiple dimensions time series extracted through a sensor called "Leap motion Controller (LMC)". The momentum of the model is done on both static and dynamic approach and the LSTM, BLSTM was used to combine the input sequence vector. The technique will classify and pass input to a dense layer & CNN will encode input features before inputting to the LSTM & CNN. The TNN method uses dilated convolution along deep CNN for automation feature learning. Finally, it executes in predicting digit labels for followed data collections and leads to get limited data collections for exact point output.

Taktak et al a "3D handwriting character recognition algorithm" is used with a 3D Gyroscope sensor [16]. This algorithm is introduced to recognize lowercase letters in the alphabet. The angular velocity signals are used here which directly reads from a sensor called MEMS internal gyroscope and that is included in smartphones. The main purpose behind this project is to improve the storage capacity and time processing of smartphones. The first experiment is about historical databases, by which the Symbolic Aggregate approximation exact search is used for performing classification with 1NN rule. The "lucky time warping algorithm" is applied for multiple dimensional ITS and then it turns into one dimensional through sliding a window. The multidimensional data can be handled by extending the distance measure and classification is obtained by the algorithm called greedy wrapping of time. The effective programming which defeats the quadratic complexity on time of warping search. 1d-SAX transformation merges with angular distance measure of SAX. 1d-SAX gives additional information about the current environment. Finally, it shows accuracy of algorithms.

Wang et al. relevant wireless mouse is designed. The wireless squirrels do not need any plane, and this requires to attain demands of controlling Air, without wired transmission and minimal electricity consumption using wireless flying mouse [17]. This project uses the NXP's LPC 54100 mc for the mouse master sliding to the minimum power designs. LPC54100 is the main part of the mouse which is considered for the exact controller. MPU6050 is the movement control section, depicted to capture the finger regulating data/characters. This system uses wake upping peripheral interfaces like UART serial communication interface, I2C, SWD debugging and other 3 general purpose IO ports etc. The jetter generated left and right keys are reduced using TTP229 capacitive touch chip. QN9021 is the Bluetooth module used as a receiver communication model and mouse. The external circuit of each model is designed after the basic function is achieved. This design provides a debugging interface which is used for debugging and uses altium designer to make printed circuit boards.

Some of the related works with on-air writing involving wearable sensor technique are:
Behera et al. introduces the minimum use of electronic components and sensors [19]. Basic sensor has connected with advanced sensor as electroencephalogram (EEG) is included in CE devices (consumer electronic). The authentication is the main topic enabled for users, it helps from victims & dataloss.Finger movement was analyzed by 3D geometrical devices. Air-writing & CNN activities are combined together which helps for sensors. The training of system is done by Hidden Markov model & Random forest classifiers. EEG has high co-related hand movements on air writing & false-positive rates are decreased randomly verification accuracy is high on HMM & RF on testing the dataset. HMM works by using Baum-welch training algorithm. This technology increases the research areas including human-computer interfaces. The integration of sensor will help in rapid-speed of devices.

Lu et al. presents a hand movement authentication method [25]. It uses wearable inertial sensors for capturing movements for automation. It makes use of both data and writing convention for identification. SVM is works based on extraction from hand movement signals.t-SNE is the technique that is embedding with high dimensional data points for visualization. The performance measurements are considered by changing the threshold on support vector machine score was implemented.

Some of the related works involving computer vision technique include:

Malik et al. work is based on verification of signature which presents a new method for peer-to-peer deep learning, about verification [26]. For signature verification it uses a depth sensor, CNN is used for medium range dataset creation. CNN has an accurate 3D hand pose estimation algorithm. It collects up to 1000 signatures from different subjects for verification. DTW will be the most effective & commonly used method. Autoencoder is recommended for reconstruction of signatures, formulation spatial & depth feature is for signatures on image, cloud representation. EER achieved 0.055% of our dataset. DTW and HMM algorithms are used for verification based on accuracy. It also provides an accurate air signatures framework, robustness of finger tracking.

Alam et al. discusses writing in air, that is, either numeric or alphabet letters in the space by using either hand finger or using any external marker movement [28]. The movements are precisely recorded using advanced sensor technology. In this system, CNN is used to track the trajectory and "10-fold cross-validation" was used to validate. "Categorical cross-entropy" was used to measure the model loss on accuracy. Total 30000 characters are present in the dataset for data processing. The accuracy of the proposed model used Intel RealSense SR300 camera and resulted with 97.29% accuracy along with 14ms recognition time which could be used in real time. The proposed system even had good accuracy but had poor accuracy for certain characters mainly F because of its resemblance to the character E and R hence improvisation has to be done in that region.

Li et al. uses a depth-sensing camera for human computer interface which can be used for entertainment for certain games like Gluttonous snake, etc [29]. by hand rather than any other computer input devices which makes it more natural and easier to use. In this technique computer vision is used for hand detection where an algorithm "Kalman" filter is adopted to predict the accurate location of the hand. By keeping track of the hand, the supposed gesture is recognized. The application is tested in two ways, using a writing board where the user can draw what he wishes to and another one is using a game, Gluttonous snake. Limitation of this system is that it can only track static hand gestures. Improvisation to this project mainly includes making it capable of tracking multiple hands at once and also recognizing along with many user cooperation at once.

Hegde et al. proposes a system which works on using “RGB input” rather than using the techniques such as HoloLens, Meta” which are expensive [30]. In the system, the fingertip is considered as a pen. CNN model is trained along with “DSNT for fingertip regression” and “Bi-LSTM for recognizing the hand position at real time”. The system had an accuracy of 88% with running speed 1.73s and memory usage of 14MB on egocentric video dataset. The major challenge in the system was collecting the dataset for training the CNN model. This system is easily portable on smartphones because of its low memory and requirement criteria.

Roy et al. presents a CNN dependent model for the air, writing developed using a video camera [32]. In these, gestures are recognized by using a marker of fixed color which will be present in front of the camera, using the trajectory of the pen and the trained CNN model, classification of gesture is done. This system is not dependent on any of the depth sensors like Kinect, LEAP, Myo, etc. unlike other systems. The main challenge involved resolving illumination conditions. In proper illumination condition the system got 97.7%, 95.4%, 93.7% recognition accuracy for English, Bengali, Devanagari script which were earlier trained. The improvisation to this project can be made by trying to remove the marker and directly using the hand.

Lakshmi and Harish proposed a system where a camera was used to record the hand finger movement and requires no external device to display the data that is drawn in the air [33]. This application also has a GUI designed using Qt while processing and capturing of hand movement by camera is done through OpenCV library. This system is designed using the following components for its functionality: “SD card required to load the Linux OS for Raspberry Pi, Raspberry Pi board for processing and UVC Driver camera for image frame capture along with the usage of keyboard, display unit and mouse”. This system captures 30 frames per second and these images can be saved on the HTML page. This system is primarily developed for control and interaction of digital systems where all hardware and software components features are well integrated and they are used for best working along with low cost in the unit.

Some of the related works which uses drawing based authentication are:
Wazir et al., Here to enable the security from the authentication scheme here doodles (graphical pictures) are used integrating with Augmented Reality and Virtual Reality [1]. This technique can be used on a real time size and coordinates. The system starts the creation of a doodle password by a touch gesture in the smartphone. After the password is drawn it is compared with the last 5 drawn doodles and authentication happens only if the size and coordinate of the two doodles match. The system is tested on its usability, usefulness by using a survey, and security is checked by using the confusion matrix which can evaluate the success and fail authentication by prediction. These schemes are difficult to break as there are a number of possible shapes and AR is not easy to compute and hence can be used as an authentication scheme which has security.
Liu et al. discusses that single factor authentication can be compromised easily rather than multi-factor authentication but the issue with multi-factor authentication is that it requires extra interaction with the system which may be irritating to many users [14]. In this system, 5-factor authentication is done using the following techniques: geometry, impedance, behavioral and material features and key pattern. Key pattern is recognised using the gradient recognition algorithm while other four are recognised using “CNN-LSTM” based classifier. This is achieved by drawing to the “RFID” and simultaneously carrying the “fusion features” by “backscattered signals” to the server which has the following four components: “signal processing”, “gradient pattern extraction”, “user identity recognition” and “key match” to perform the matching task. By using this technique, the false reject rate was identified to be 1.3% which also depicted it to be capable of defending against various types of attack.

Khan and Chefranov proposed a system that provides security to the user’s personal information by using Graphical password scheme and for user authentication, since they are better rememberable to humans than complex texts [21]. They used picture-based techniques for combining of the “BDAS”, “CaRP” and “Pass-Go” like password scheme, that is further classified as two sub-category techniques such as "CODP" - which is clicking on object for drawing a pattern and "COSS" - this is to clicking to choose secrets from objects. The required picture is created by the use of the “CSAV algorithm”. This system uses the above-mentioned “CODP and COSS” techniques to solve social engineering issues such as “shoulder surfing”, like unlocking the device by pattern and giving a more possible password range. This project can be improvised by studying the CaRP image segmentation for the recognition and including it with the biometric system.

Tolosana et al. discusses that passwords are used for providing security [31]. But there is a chance that the same password may be the reason and cause for vulnerability, hence here a two-factor authentication system is developed where instead of typing the password the user is made to draw the same password. In this system MobileTouchDB dataset is used which contains 61000 characters along with e-BioDigitDB dataset. The project includes the qualities of both “DTW” and “RNN” as “TA-RNNs” that are trained for protecting against attacks. The system had an approximate 2% EER by the use of a four numeric letter drawing as an authentication medium. The system can be improvised by studying new features in “MobileTouchDB” to improve the system performance which includes finger, accelerometer and gyroscope.
Table I narrates different algorithms and techniques which are used in papers for on-air drawing and authentication systems. The table contains the title of the paper along with their performance metric, algorithms used and some of the advantages and limitations mentioned in the paper. The

table summarizes 14 paper content along the following columns.

Table I Comparison of different technique for on-air hand doodle system

Sl No	Paper Name	Algorithm/Techniques	Performance	Advantages	Limitations
1.	RF-Wri: An Efficient Framework for RF-Based Device-Free Air-Writing Recognition	Software defined radios (SDR),Discrete Wavelet Transform(DWT) filters and letter segmentation algorithms.	95% accuracy in the classification of all air-written letters and recognition approaches.	Letter segmentation processes increase the quality of the collected data.	The large-scale movements are used and this will decrease the recognition accuracy.
2.	WiWrite: An Accurate Device-Free Handwriting Recognition System with COTS WiFi	Commercial off-the-shelf(COTS) , SElf paced dense convolution network(SPDCN), CNN and COIS wifi hardware.	This will avoid handwriting and mainly overcome blurred vision and neurological diseases in the people.	A Wi-write and CSI division scheme is used to reduce amplitude noise.	Fine-grained finger tracking for automatic retain of low noise data.
3.	In-Air Continuous Writing Using UWB Impulse Radar Sensors	Radio ultra-wideband (IR-UWB) radar-based , Kalman filter,State-of-the-art algorithm and CNN.	Accuracy was improved by 8.2% for 10 characters.	It allows combining of characters written midair with and without artifacts.	The localization algorithm is used for preprocessing before transferring into tangent ratio data along a time axis.
4.	Hand Gesture Recognition Model using Standard Deviation-based Dynamic Time Warping Technique	Dynamic Time Wrapping used for recognition of letters, Leap motion and Sequence matching algorithm.	Dynamic Time Wrapping helps to display letters in two dimensional values.	The combination of leap motion and Sequence matching algorithm will solve the misclassifications between letters in dynamic time Wrapping.	Guessing of letters and hand gestures and supporting Dynamic Time Technique.
5.	Research on Conscious Interactive Angle of Pen in 3D Contactless Air-Drawing and Writing	Three-dimensional pen interaction, penrole angle and yaw angle and row angle.	Rolling angle was -135°< D<20° and 20°<D<135° with angle of resolution 10° with Task time, error rate and missed number of target areas are used for performance.	Efficient because here we are considering 2 variables, angular width(W) and angular distance (D) to evaluate the performance.	These techniques are hopeful but still in carry stages of design. This needs small adjustment and formal assessment.
6.	Challenge-Response Authentication using In-Air Handwriting Style Verification	Challenge-response (CR), The MoCRA system,support vector machine (SVM).	The result shows that MoCRA can authenticate one of 24 subjects with an average equal error rate of 1.18%.	It rejects the pretenders with the error rate of 2.45% and also attackers who are writing multiple times.	Challenge-response can be used even if the communication channel is insecure.
7.	Wearable Air-writing Recognition System employing Dynamic Time Warping	Inertial Measurement Unit (IMU), TTL-USB conversion interface,DTW is a classical algorithm.	Good performance and have high accuracy especially under the limitation of time and sample size.	This air-writing system has great potential for people with disabilities.	To improve the recognition and accuracy.
8.	MicaPen: A Pen to Write in Air Using Mica Motes	MicaPen,Micaz motes,accelerometer MTS310 sensor board and MICAz sensor.	Characters written in cursive which will be different from recognizing strokes.	This concept is used for various hand gestures and sign-language recognition	Low-cost and used by only disabled who don't have fingers or limbs.

			This also incorporates MicaPen.	in real world applications.	
9.	AirNote – Pen it Down!	Smart wearables,deep learning techniques ,RCNN and SSD.	Faster RCNN was much better in terms of accuracy as compared to SSD.	Useful to senior citizens or people who don't like using phones.	Handwriting recognizer and lack in solving the pen-up and pen-down issue.
10.	Visual Gesture Recognition for Text writing in Air	CNN,Gaussian blurring and threshold algorithm	The accuracy which was attained using the system was 86.9%.	Interaction with other applications, and used to unlock the smartphone as a password by drawing.	The problems associated with accuracy are stroke shape of word and complicated background.
11.	BioTouchPass: Handwritten Passwords for Touchscreen Biometrics	Support Vector Machines (SVM) and Gaussian Mixture Models (GMM),RNNs algorithms and DTW	This approach achieves good results with EERs 4.0%.	This approach achieves good results with EERs and 4.0% when considering imitation attacks, outperforming other traditional biometric verification traits.	Improvised by scaling the dataset to include lower, uppercase characters with complex deep learning
12.	A Sketch Classifier Technique with Deep Learning Models with Embedded System	CNN, deep neural network, Principal components analysis (PCA), Radial basis function(RBF),K-nearest-neighbors, SVM.	System recognition rate is above 98% on average.	We use the deep learning model and simplify the parameters to achieve the high-performance result.	For reducing the number of parameters, computation, Handwriting recognition.
13.	A Captcha-Based Graphical Password With Strong Password Space and Usability Study	Clicked on Object to Draw Pattern (CODP) and Click on an Object to Select Secrets (COSS), CSAV algorithm.	Unlock the smartphone's pattern and provide a strong password space.	Graphical passwords schemes CODP and COSS schemes which can overcome the shoulder surfing attacks.	They need a separate graphical scheme for integration of the CaRP, Pass-Go and BDAS graphical password.
14.	A CNN Based Framework for Unistroke Numeral Recognition in Air-Writing	CNN, sensor Kinect, LEAP Motion, Hidden Markov Model (HMM) and Gated Recurrent Units (GRU).	Framework achieved 97.7%, 95.4% and 93.7% recognition rate.	System is able to recognize isolated unistroke numerals of multiple languages.	Pre-trained CNN for performance improvement through fine-tuning on air-writing data.

III. METHODOLOGY

Different methodology is used for the purpose of writing in the air some of the workflows are mentioned below:

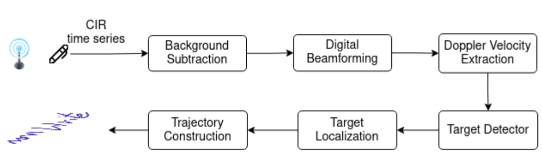

Fig. 1 Workflow for mmWrite

Fig. 1 shows the system overview for the system presented by Regani et al. [2]. In the mmWrite algorithm, background substitution is done such that static object noise can be reduced in the received signal. After performing background substitution, spatial information is obtained which is then succeeded by performing "transformation to the doppler domain", which can differentiate between static and dynamic objects. The object detection then occurs by "3D-CFAR" and clustering techniques followed by target localisation step which is done inside the "spatial bins" which are identified by the "subsample interpolation technique". At last, the tracked points are used to get the movement traced to which DCT smoothing technique is applied to obtain the mmWrite trajectory with the written words.

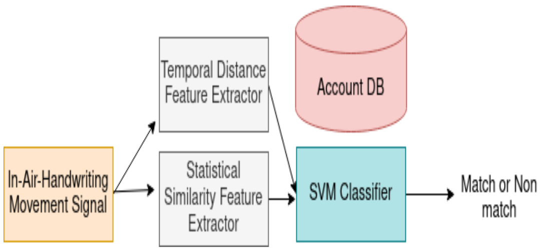

Fig. 2 Authentication System Architecture

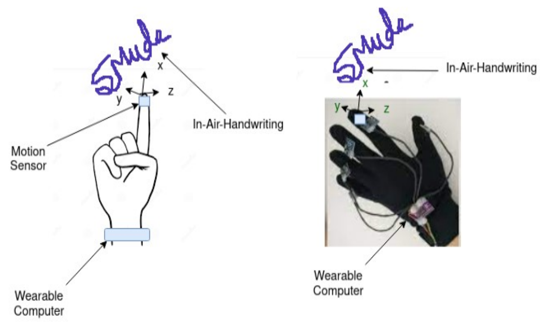

Fig. 3 Hand movement tracking device

Fig. 2 & 3 shows the system for systems developed by Lu et al. [25]. Fig. 2 depicts the system architecture where it uses a hardware device to track the hand movement, also it contains an "account database" to store the details beforehand, "feature extractors" to get precisely the exact movement and "SVM classifier" to correctly predict the written word. Fig. 3 depicts the handwriting capturing device with the left being illustration and right being the glove prototype created.

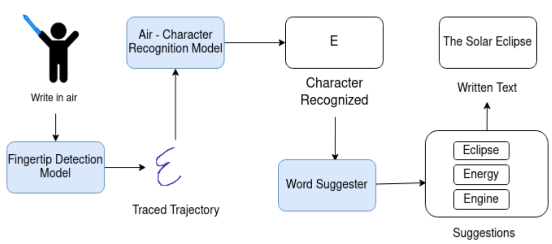

Fig. 4 Overview of AirNote

Fig 4. shows the overview of the system by Puranik et al. [27]. It consists of two models for prediction which use two datasets correspondingly. The two models are Fingertip Detection Model which captures the motion of the finger, it is also used to provide control for word-prediction, spacing, any word suggestion while another model Air-Character Model is used to detect the character and then word which is drawn in air. Fig. 5 shows the two main components of the systemby Elshenaway et al. [23].

(i) EEG signal processing where signal acquisition, signal capture and conversion to activate binary levels happen.

(ii) Hand gesture component which uses computer vision for hand detection using CNN technique and classify gesture.

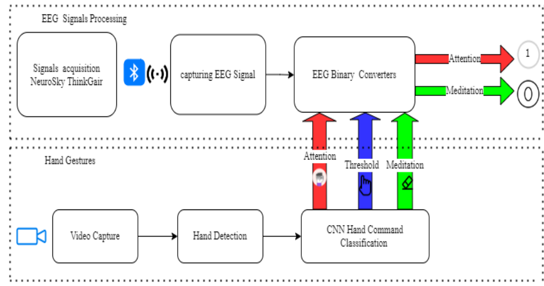

Fig. 5 Main component of system

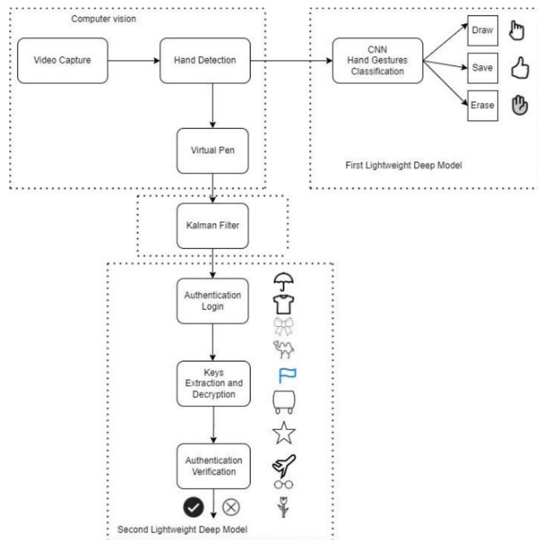

Fig. 6 Main modules involved in on-air Doodle authentication system

Fig. 6 shows the main modules used in the system for authentication in the paper by Elshenaway and Guirguis [11]. The four modules include:

(i) "Computer Vision" technique is used to generate a pen from the hand which is picked up by the camera without needing to use any extra device for using the pen.

(ii) "Lightweight deep CNN" technique to recognize and classify the three-hand posture by the user which are associated with the functions as follows where only upperpart of hand is considered:

(a) One finger open to start the drawing for recognition.

(b) All five fingers open to erase already drawn writing.

(c) All five fingers closed for saving drawn writing.

(iii) "Kalman filter" is the algorithm used to smoothen the symbols drawn on the air such that accuracy of the system increases by reducing the noise.

(iv) In Authentication, first the symbols are drawn to login, which are then extracted and matched with the keys already present to verify the identity of the user

IV. CONCLUSION

Here, we have discussed different ways to draw "on-air", that may be using radio frequency, wearable sensors, device-based or using computer vision. With the advancement of technology, it is predominant that the system is moving towards a method where it is fully independent of any extra hardware requirement. We have discussed some of the works which can be used for drawing in air and then authenticating based on it. The given systems may face certain challenges which may be gesture challenges, environment and system challenges. It also requires the pre-trained dataset for the recognised character. A comparative study of different algorithms used in papers and their advantages and limitations are also discussed. Addressing the limitations and improvising them will help meet the demands and advance the gesture recognition field.

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