CSE 535: MOBILE COMPUTING : EBIAS - YOU ARE WHO YOU THINK YOU ARE

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***Abstract*—The aim of the project is to build a mobile application which can recognize and authenticate a person based on his brain wave activity. We use machine learning models such as Neural Network, Nave Bayes, KNN and Logistic regression to classify the brain waves. The brain wave data is filtered and pre-processed so that it can be fed into the machine learning models. The Application uses a Fog server (Windows IIS), a AWS(Amazon web services) cloud server and the local system to perform the back-end machine learning predictions. The application is context aware since it is dynamically choosing the environment in which to perform the machine learning analysis, based on the battery consumption and latency performance metrics. The metrics are graphed in the application based on the run time analysis of each of the environments and the accuracies of each of the algorithms.**

***Index Terms*—EEG waves, Brain waves, EEG data processing, FOG computing, Cloud server,Windows IIS, Battery Consumption,Mobile Computing.**

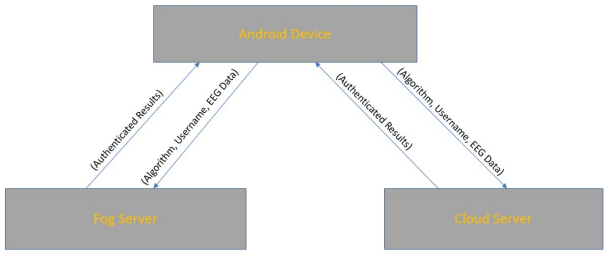

Fig. 1: Basic Architecture of the E-Bias System

I. Introduction

With the increase in the importance for data there has been a similar need for increase in the security for the data. The advent of new technology has brought new techniques to authenticate a user, brain waves are one such biometric that is unique to each individual and is incredibly hard to replicate by anyone else. Since machine learning algorithms have become increasingly sophisticated, they have enabled us to perform incredibly complicated classification tasks. BCI (Brain Computer Interface) is one such task where there has been a lot of recent research being conducted. Our project aims to analyze brain wave activity from multiple users and find patterns using machine learning algorithms. Since we have data from multiple users the problem is converted into a multi classification problem. Where we allow the user to be chosen from a drop down and then we try to classify the test data for that user by predicting his class label, since there are many users we try to see if the user is in the top three label classifications for a seconds worth of test data. We have implemented the machine learning backend on three different environments The Fog server (Windows IIS Server), Cloud Server (AWS cloud) and the Local system. The latency rates and power consumption rates are calculated at each point by the application so that the most optimum backend system is used for the machine learning computation, thus reducing the overall wait time for the authentication

II. Project setup and permission

The system architecture consists of three systems to implemet the machine learning modules. They are as follows:

1) Android device :
   Make and Model: Google Pixel
   OS : Android 8.0 (Oreo)

2) Local FOG Computing Server: The server is set up in a LAN using Windows IIS (Internet Information Services) server, with the android device connected in the same network.
   Make and Model : Dell Inspiron
   OS : Windows 10
   Processor : i5 7th Gen
   RAM : 8 GB DDR5 mem

3) Cloud Server: Here we have set up a remote cloud server, using AWS (Amazon Web Services) server. THis server in turn uses a Windows IIS server to deploy the machine learning models.
   OS : Windows 10
   Processor : i7 7th Gen
   RAM : 1 GB DDR5 mem

III. Architecture

The system architecture allows the user to select the required server in which the authentication process has to take place in. The Device takes inputs and the EEG

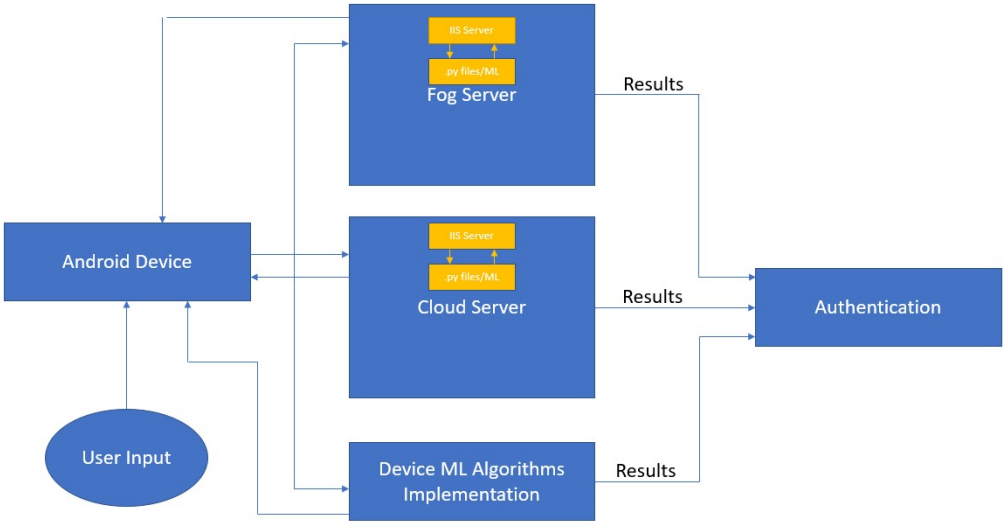

Fig. 2: E-Bias System Complete process flow

data of the user and then sends it to the appropriate servers. In out case the fog server and the cloud server are both independent of each other. And once the processing is done, the results are sent back the device for authentication.

Both the servers implements the Windows IIS server to run our machine learning algorithms in Python. The user selects the user-name, algorithm and server to be implemented in.The python script in the respective server processes the inputs and in return sends the results back to the mobile device.

IV. Data Pre-processing

The raw data brain wave data has been pre-processed using MATLAB. The edf files have been read using the EDFRead library in MATLAB and then header and records were assigned. FFT (Fast Fourier Transform) was performed to convert the raw signal data into frequency domain. On this transformed data we extracted the Alpha band frequencies (8-13) using the band pass filtering technique. We transposed the data in such a way as to be fed into the Machine learning algorithms, with 64 features for each of the records. We then dumped the transformed data into CSV files.

Python scripts were then written to combine the CSV files into test and train files, and labels were built for each of the users.

V. Machine learning Models

After the test and train data was created, the csv files were fed into the machine learning algorithms. The models were trained in python so that the model files could saved and utilized by the android system instead of having to train it every time. The Logistic regression, KNN and Nave Bayes algorithms were coded using the SciKit Learn module in python, the Neural network was coded using the Keras module in python. Once the models were trained they were placed in the Cloud, Fog and Local system to directly use.

VI. Server Implementation

Both the servers FOG and Cloud servers are simple Windows IIS systems which take in inputs from the android device. This calls the specific python model which is available in the server. Once the model is run, the python model then returns the results back to the android device through the IIS server. The Android device then takes these results to authenticate the user. The IIS server uses the directory browsing look to view all the python files and is called using the URL.
In the android code all the changes we will do is the URL to which the device pings in order to run the machine learning models.

VII. Integration

The android device will ping either the fog, cloud or local systems based on the metrics and pass the parameters for the user and run the python script which will take random data for that user from the test file and pass it to the model to see the accuracies and if the user is present in the top three predictions of the model then he is authenticated. The python script then sends an authenticated message in the form of 0 or 1 to the android device which then either throws an error message or successful message accordingly. Some of the screen shots from the system is as follows:

In Figure 2 as we can see The user gives in the User ID, the machine learning algorithm and the server in which it should implement it.
In Figure 3 the user authentication has failed as the user is

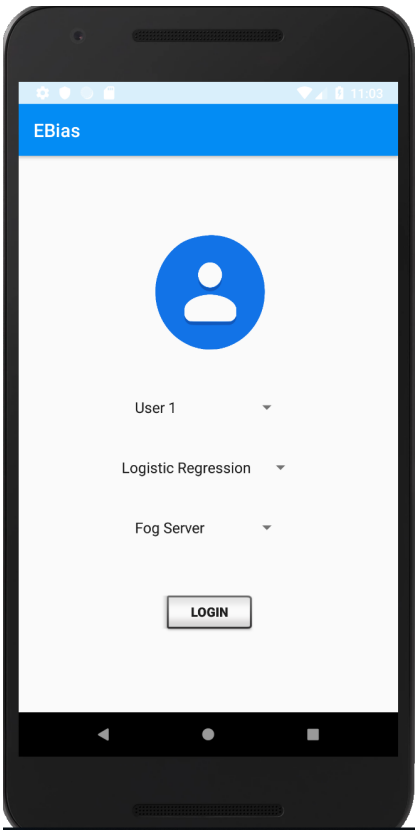

Fig. 3: E-Bias System Log-in Page

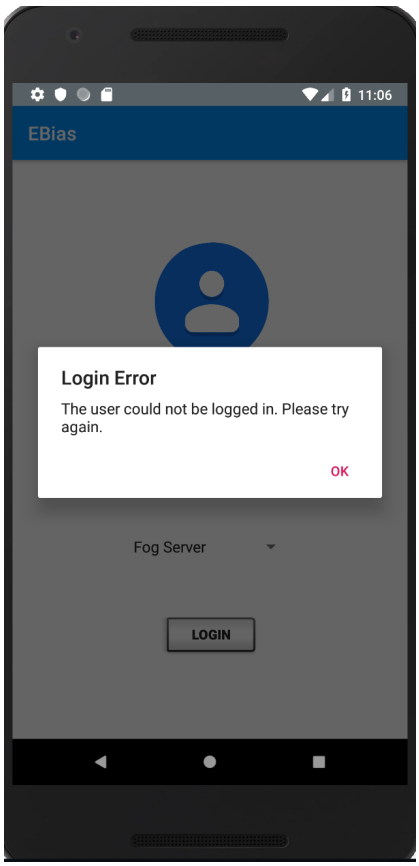

Fig. 4: E-Bias System Authentication Fail

not part of our system using the brain waves.

Figure 3 shows us when the User authentication has succeeded.

VIII. Completion of Tasks

The table TABLE 1 tells us about the list of tasks that have been implemented and executed by the team members.

S. no.	Tasks	Member
Task 1	Pre-processing data	Vishal Tyagi, Pyla Kovidnath Reddy
Task 2	Code to extract frequency domain features from EEG Signal	Vishal Tyagi, Viralam Tharun Kumar
Task 3	Develop Different Machine Learning Algorithms	Pyla Kovidnath Reddy, Arvind Ramesh
Task 4	Develop UI	Vishal Tyagi, Viralam Tharun Kumar
Task 5	Backend Process	Viralam Tharun Kumar, Arvind Ramesh
Task 6	Evaluate Time and Power metrics	Vishal Tyagi, Pyla Kovidnath Reddy
Task 7	Algorithm for offload tactic	Viralam Tharun Kumar, Arvind Ramesh
Task 8	Setting up Fog and Cloud server	Viralam Tharun Kumar, Arvind Ramesh

TABLE I: Tasks done and their contributions

IX. Conclusion and Future Work

The project has provided us with relatively high accuracies considering that it was a multi classification problem, the brain wave activity could be classified and processed after thorough data processing suggesting that a pattern can be un earthed from the brain signal data. Since the data is of high dimensionality we tried to perform a PCA reduction which did not lead to an increase in accuracies, so in maybe a better analysis can be done on the data to try to deuce the dimensionality which can lead to an increase the accuracies. We believe that with a better understanding of the data and the data preprocessing during the EEG signal filtering we could have improved that results.

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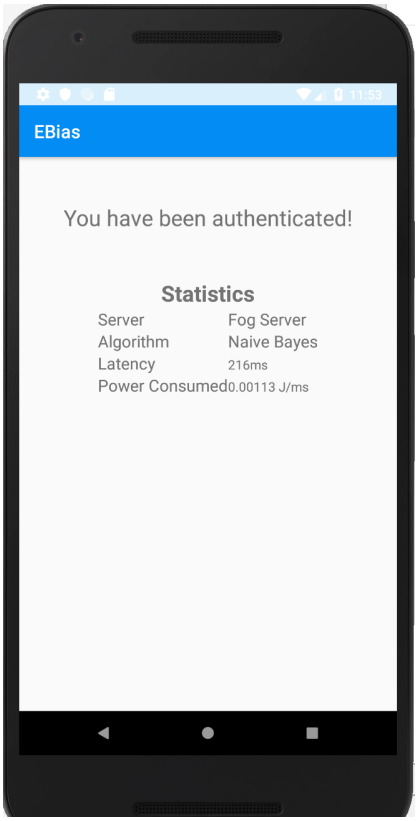

Fig. 5: E-Bias System Log-in Success

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