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EFFECTIVE CROSS-PLATFORM MOBILE APP DEVELOPMENT USING PROGRESSIVE WEB APPS, DEEP LEARNING AND NATURAL LANGUAGE PROCESSING

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Abstract: **The proposed system uses Natural Language Processing (NLP) and Deep Learning (DL) techniques to extract voice data and translate it to text during medical consultations. Iterative model was adopted in the design of the system and the user interfaces was implemented by using NLP techniques, especially speech recognition and natural language understanding. Deep learning algorithm shows a great ability to build clinical decision support systems by extracting various information for medical diagnosis and produce result is few seconds. The result form the system testing shows that the installation size of the Progressive Web App (104 KB) is 42 times smaller than the native Android app (4.37 MB). In terms of render-speeds, the PWA rendered different results. The native app will launch the Android activity after 1408 ms after app icon tap (launch), while the progressive web app launches the application in 230 ms. The advent of cross-platform application development frame-works have made it much easier to create applications for multiple platforms for mobile devices. In spite of reduced learning effort, usually lower costs, and a faster time-to-market cross-platform methods always do not prevail in most cases. Although there are normal exclusions – like graphic-intensive games, which should to be programmed with the native software development kits (SDKS), choice between native apps, cross-platform generated ones, and Web apps can remain delicate. Whereas many diverse efforts have been made with respect to how cross-platform development frameworks ought to work, no technology is deemed unequivocally superior than the others. But a cross-platform mobile app has got an edge over native app development. It also recommends that developers adopt this technology of mobile app development due to its huge gains.**

Keyword: **PWAs, Web, App, Android, iOS, Windows, Cross-platform, Native app.**

I. INTRODUCTION

Cross-platform mobile development refers to creation of software applications that are compatible with multiple mobile operating systems. Originally, the complexity of developing mobile apps was compounded by the difficulty of building out a backend that worked across multiple platforms. One of the key advantages of cross-platform mobile application development frameworks is that it provides a means of writing applications once and deploying it on multiple platforms like BlackBerry, Windows Mobile, Android and iOS. This work looks at implementing Cross platform mobile app development using Progressive Web Apps in healthcare sector. Many healthcare centers run native applications for medical record processing. Accessing the application across various platforms (desktop, mobile, web) is always a challenge. More also enhancing the features of the application to make it smart, intelligent and mobile is something that is so much desired. Hence, implementing deep learning and Natural language technologies will boost applications to achieve the desired features. Natural Language Processing (NLP) and Deep Learning (DL) techniques have been leveraged to extract information in electronic health care system.Natural language processing (NLP) focuses on analyzing text and speech to infer meaning from words. Recurrent neural networks (RNNs) - deep learning algorithms play a key role in processing sequential inputs like language, speech, and time-series data [1]. Deep learning is a subset of machine learning having the capacity of learning unsupervised data from unstructured or unlabeled data. On the other side deep learning will be able to learn optimal features from available

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data without human intervention. Natural language processing is used to describe the process of using computer algorithms to identify key elements in everyday language and extract meaning from unstructured spoken or written input. NLP requires skills in artificial intelligence, computational linguistics, and other machine learning disciplines [2]. In this work, effective cross platform mobile app development using progressive web apps, deep learning and natural language processing is designed, developed, and implemented in the healthcare sector. The system will allow physicians to process patient's medical records easily. It will also enable integration of intelligent system in the area of diagnosis and treatment prescriptions which will be implemented using deep learning. During consultations, the physician voice out the prescriptions and the natural language processing will translate it to text and stored in the database. The proposed system will work in a way that once the back end is designed, the application developed can access the database whether the platform is Windows Mobile or Android. Developing application for firms is recently posing a huge challenge to both application developers and users due to the availability of different mobile platforms. Multiple platforms like BlackBerry, Windows Mobile, Android and iOS exist and this introduced the compatibility challenges being faced today in the software industries. To implement deep learning and natural language processing in extracting voice data and translate it to text during medical consultations.

Hybrid Applications

Hybrid apps are typically cross-platform applications that are made with web technologies such as HTML, CSS and JavaScript. Hybrid apps are based on frameworks, such as Apache Cordova or Electron, that enable the application to function similarly to native apps. Hybrid applications usually work in a browser-based Web View, and they have access to certain hardware capabilities as well. However, those capabilities are somewhat limited depending on the selected framework as some functionality relies on external sources and third-party plugins. Electron is an open-source library for cross-platform desktop application development with JavaScript, HTML and CSS. It uses Chromium and node.js together, building them to a single runtime. Electron apps can be packaged for all three major operating systems. Many popular apps, such as Slack, Skype and Discord are built with Electron. As mentioned, hybrid applications are usually cross-platform apps, which makes them very cost-efficient compared to developing separate native apps. Developing hybrid applications is easier for web developers who are already familiar with web technologies and want to develop cross-platform apps without having to implement native solutions individually to each desired platform, or mobile developers who want to distribute their app without having to re-implement it for each platform [3]. Hybrid apps come with their downsides too. Their performance is often lower than performance in native apps and their functionalities do not match native ones. Even so, the reduced cost of development for multiplatform applications makes hybrid app development very appealing.

Figure 1 shows a diagrammatic view of the Hybrid approach.

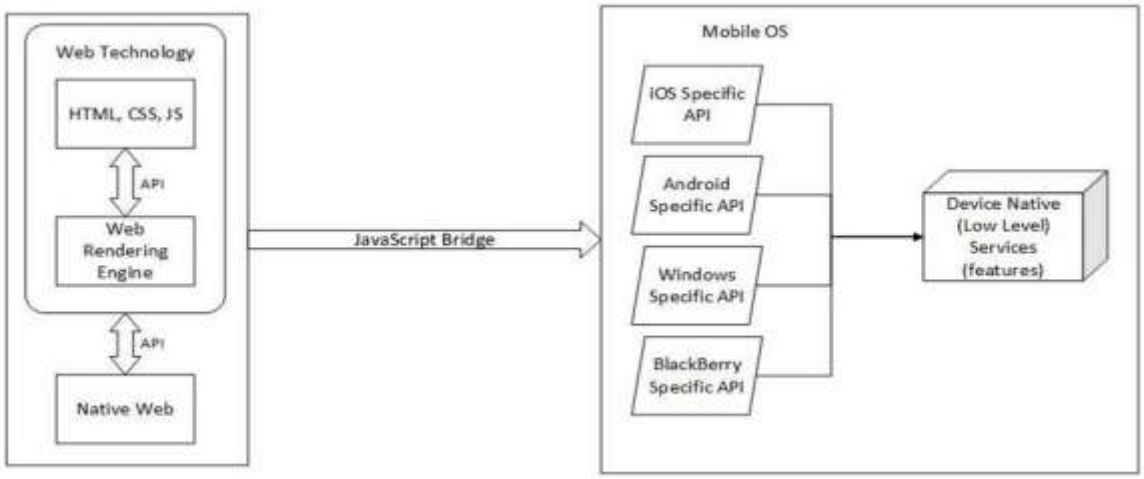

Figure 1: Diagrammatic view of the Hybrid Mobile Development Approach [4]

The strengths and weaknesses of the approach are discussed below:

Strengths

1. Hybrid apps are distributable through dedicated Appstore as opposed to web apps.

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2. Hybrid apps can be packaged and distributed to any supported platform [5]
3. Development process is simplified because a single code base maintained for all platforms
4. Hybrid apps can be adopted for both server backend and standalone apps.
5. Hybrid apps can access device native features of mobile devices.

Weaknesses

1. Hybrid UI are inferior in performance when compared to its native counterparts due to the fact that execution happens in the browser engine [4]
2. The existence of JavaScript bridge imposes an additional overhead in performance when accessing the device specific platform API [6]
3. User experience provided by hybrid app is the same across all platforms which might not fit or integrate into various mobile device structure styles as some devices have a physical back button while the back button of some phones is managed on the screen.
4. Hybrid apps are most time dependent on internet connections.
5. The hybrid app is limited to what the JavaScript Bridge is capable of translating [7]

Natural Language Processing

Natural language processing (NLP) is a subfield of computer science concerned with using computational techniques to learn, understand, and produce human language content [8]. Some applications of NLP include: information extraction, transforming unstructured data found in texts into structured data [9]; conversational agents, that aid human-machine communication [8]; or machine translation, the use of computers to automate the process of translating from one language to another, aiding human-human communication [8]. The factors that have allowed the development of NLP in the last years twenty years, according to [8], are:

1. increase in computing power
2. the availability of large amounts of linguistic data,
3. the development of successful machine learning methods, and
4. A richer understanding of the structure of human language and its deployment in social context.

NLP reformats text to make that text amenable for subsequent analysis with techniques from machine learning or artificial intelligence. That text may come from clinician documentation, billing documentation, transcripts of patient provider or provider-provider interactions, or even social media discussions. It converts text into a textual data stream that may be paired with data streams from physiological monitors (cardiac monitors, pulse oximetry), wearable's, or laboratory tests. NLP has been successful in scaling up some components of medical decision-making, developing tools for risk stratification, identifying postoperative complications after inpatient surgery from physician notes, and triaging patients by identifying syndromes.

An important use of NLP is to translate, or map, words or phrases onto concepts. We want the computer to look past the sequence of letters to the concept denoted. We do not parse hypoxia as merely a string of letters. Mapping from words or phrases to concepts involves:

1. breaking a sentence into tokens (tokenization);
2. lemmatizing each token (lemmatization); and
3. Mapping each lemma (the standard form of a word) onto one or more concepts.

Some applications of NLP only perform steps 1 and 2, analyzing lemmata instead of concepts. This is appropriate for a domain where there is no accepted mapping between lemmata and concepts, or where the mapping is very close to one-to-one. The types of linguistic knowledge in NLP can be divided in the following categories [9]

1. Phonetic and Phonological Knowledge;
2. Morphological Knowledge;
3. Syntactic Knowledge;
4. Semantic Knowledge;
5. Pragmatic Knowledge;
6. World Knowledge;
7. Discourse Knowledge.

II. LITERATURE REVIEW

Table 1: **Related Literatures**

Author	**Techniques**	**Work done**	**Limitations**
[10]	Review	Delivered insight into both approaches by contrasting them based on the characteristics of PWAs	Did not carry out any app development
[11]	Review	Comparison study of React Native Vs Flutter	Did not carry out any app development
[12]	Dynamic passwords	Create a framework implementing modern authentication solutions using dynamic	Support for native applications was not covered in the research work

	and public-key cryptography	passwords and public-key cryptography	
[13]	React.js	The application was fully implemented using most PWA features to work offline, install on home screen, load fast, send push notification, etc	Didn't cover areas like saving images, audios and videos in browser storage
[14]	Hybrid app approach	Development of a mobile Hybrid application, which interacts with an Enterprise Resource Planning (ERP) to access the Transport Documents registered in this ERP	The app developed doesn't facilitate mobility and access through mobile equipment
[15]	Progressive Web APPS	Examines building blocks of Progressive Web Application in cross-platform development	Did not carry out any app development
[16]	React	Created a minimum viable product that would implement only the mandatory features required for tracking work time	All the functionalities of the product were not finished
[17]	Flutter	They automated the operation of these applications, and recorded system information such as CPU, and memory usage	Still missing some features such as support for multiple windows per application or customizable context menus
[18]	Review	Presents a literature review study on Progressive Web Apps and the existing cross-platform development approaches.	Didn't carry out any implementation
[19]	Progressive Web Apps	The research analyze the applicability of PWAs as an alternative to traditional native and web app development	Security of a PWA cannot be warranted for sensitive applications
[20]	Hybrid	The hybrid mobile application developed with the use of Ionic 2 framework and Angular 2 framework allow the user to sign in and log work time	Has limited functionality without the internet connection
[21]	HTML5	Developed a Cross-Platform Mobile Application for Shopping List	The look of the feel of the UI is slightly inferior to that developed on a native mobile development framework
[22]	Hybrid	The paper mainly introduced PhoneGap, Sencha Touch, Titanium and AppCan cross platform development framework, compared to their advantages and disadvantages	No implementation and testing was carried out

Method/ analysis of the proposed system

The purpose of the application is to develop a medical consultations application that can run on windows and android phones. The proposed system focused on development of Progressive Web Apps, integrating deep learning and natural language processing in extracting voice data and translates it to text during medical consultations. Minimum requirements for first working version included just a possibility to input, edit and save medical records entries in the browser.

The app design enables the user to have direct access to the primary actions that are associated to a medical consultations activity. The primary actions identified are physician clerking, editing, extracting voice data and translate it to text during medical consultations using deep learning and natural language processing, deleting of records and navigation. All these actions can be performed directly on the screen view. This design approach helps to simplify the usability of the app as well as reduce the number of times to perform an action. The proposed NLP-

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driven application is composed of two parts: user interface (UI) and backend. The user provides text or speech input to the backend through the UI, and then, the backend processes these inputs with the NLP models and feeds the results back to the user by providing specific services through the UI. Knowledge bases are also required at the backend for applications that essentially rely on knowledge using deep learning. The UI enables information exchange between users and intelligent systems through speech, text, etc. Easily accessible UIs are critical for enhancing the experience of using intelligent systems and realizing smart medical consultation system. Such user interfaces can be implemented by using NLP techniques, especially speech recognition and natural language understanding.Patient-provider communication is an important way to obtain first-hand clinical data. So in the proposed system, machine translation will assist doctors in communicating and free text notes can be taken through speech recognition, which can significantly reduce medical staff's time on labour intensive clinical documentation.

Architecture of Cross-Platform Mobile Application

The Architecture of the cross-platform mobile application is on Figure 2 that shows the MySQL Database that registers all data from medical consultations. The web service was created to support the communication to the mobile app, and the authentication through the Firebase API validation of the user to access information.

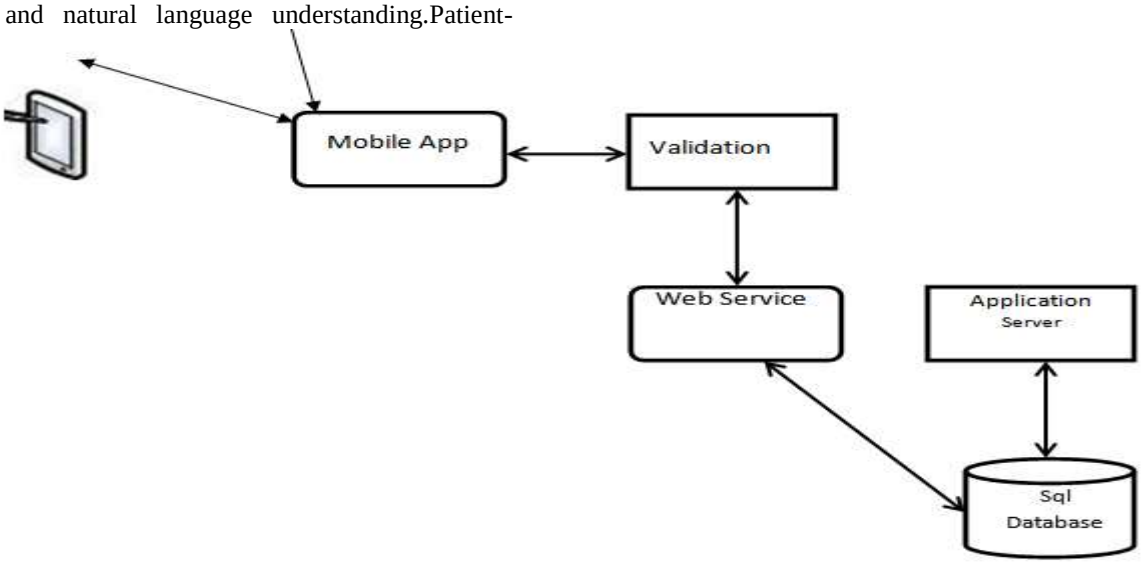

Figure 2: Cross-platform mobile App architecture

Interaction Diagramof the Proposed System

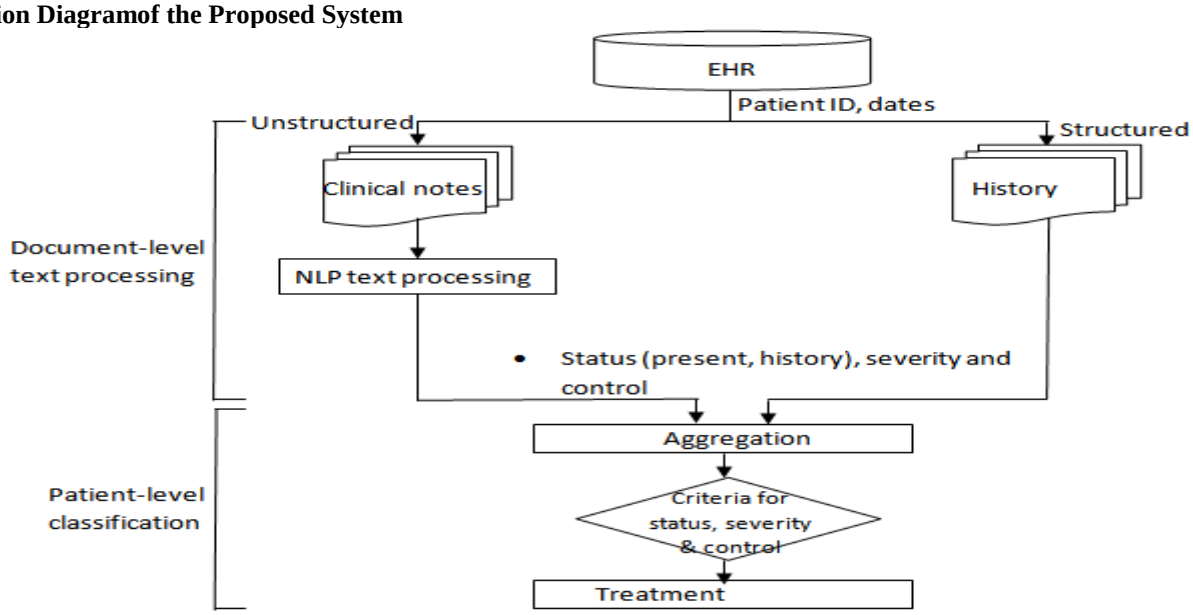

Figure 3: Interaction Diagram of the new System

The Figure 3 depicts the text pre-processing and classification of a patient which represents the interaction diagram or NLP Algorithms for document-level text processing and patient-level classification.

Performance Evaluation

The software performance was tested using three different measurements: installation size, launch time and toolbar render time. Table 2 presents a comparison of three different measurements: installation size, launch time and toolbar render time. The comparison was done between native app and progressive web app.

Table 2: Performance Measurement between Native and Progressive App

Performance Measurement	**Native App**	**Progressive Web App**
Size of installation	4.37 MB	104 KB
Android activity launch time	1408 ms	230 ms
Time from app-icon tap to toolbar render	1688 ms	1319 ms
Responsive	No	Yes

III. CONCLUSION

Mobile app development has been a challenging area because of the variety of platforms that are obtainable in mobile phone industries. Deploying applications on mobile phones have relied so much on versions of the mobile phone and this leads to developing native apps for each version of the phone differently. This has a lot of cost and time consumption implications. So this thesis developed an effective cross-platform mobile App using Progressive Web Apps, Deep Learning and Natural Language Processing. The application developed targeted an application that can run on windows and android phones which was developed using HTML, CSS, Php and JavaScript. The development integrated progressive web app technology and this made the app to be reliable, integrated, fast and engaging. Since the application development focused on health information, the implemented deep learning and natural language processing was applied in extracting voice data and translate it to text during medical consultations, and also during medical diagnosis. The Cross-Platform Mobile App Development using Progressive Web Apps, Deep Learning and Natural Language Processing as developed in this thesis will be beneficial to application users, management and application developers. The application users will have a better reach than mobile apps as many users can have access to the web app. Also, the progressive web app are more engaging and native-like than regular web apps as it will have tools that will interact with the users. It will also consume less data and use less local storage, because it can work offline which requires no data. It works across different platforms, hence reduces the cost of developing different applications for different platforms. Since the mobile app was developed for medical records, it will assist health workers in delivering quality healthcare. Having quality healthcare is a complex endeavor that is highly dependent on patient information and medical knowledge. When decisions about the care of a patient are made, they must, as far as possible, be based on research-derived evidence rather than on clinical skills and experience alone. The role of deep learning and natural language processing in medical information processing is enormous. It helps the physicians to deliver quality healthcare to patients and on time. Medical datasets stores previous information on health issues, the diagnosis parameters and the outcomes. This will assist the physicians to learn from over thousands of records contained in a dataset. The learning cannot be done manual but by utilizing deep learning algorithm, learning can be faster, accurate and helpful in medical practice.

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