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Web Based Medical Consulting Information Flow for Hospital Out-Patients Using Machine Learning Techniques

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ABSTRACT: Medical consulting today is characterized by numerous demanding tasks that are prone to illness and need to be efficiently managed by medical practitioners using emerging techniques and solutions. Although there are concerted efforts by both the doctors and other medical stakeholders aimed at improving the condition, human errors abound. Sequel to this, the level of management bottlenecks recorded in the hospitals on a daily basis abound, such as the unordered information flow in the outpatients department (OPD); thus, effective health service delivery is being stifled. In this regard, the application of natural language-based medical consulting information flow cannot be undermined. This work seeks to develop a natural language-based medical consulting information flow for hospital outpatients using machine learning techniques. The architecture of the system was modeled using universal modeling language (UML) tools. The medical information flow is processed using machine learning techniques (MLT), which are named Word Rank. The word rank positions and sorts all sentences accordingly in an input corpus of a patient case report and is presented in a summarized version of the word. So, the word-rank algorithm generates a summary of the patient's record based on the input corpus. The implemented system can be deployed in the Nigerian Electronic Health Records (NEHR) used in hospitals to ensure efficient information flow for patients in the outpatient department of every hospital. The system would therefore reduce the effort expended by the medical practitioners in comprehending a case report and offering various medical services since it would be very easy to view the salient parts promptly, resulting in a reasonably smooth information flow, an easier consultation process, and a reduction in patient waiting time. Cosine similarity Identify the applicable funding agency here. If none, delete this. is used as the metric to evaluate the accuracy of the output from the algorithm when weighted against the traditional information flow in the outpatient department.

KEYWORDS: Machine Learning, Data Mining Techniques, Natural language processing (NLP) and Medical consultancy.

I. INTRODUCTION

The healthcare sector is one of the fields within which software engineering is shown to be extremely capable of handling tasks. Man-made intelligence is increasingly being used across the medical care business, from fundamental-level practices to specialized ones, and a plethora of the most astounding simulated intelligence applications affect language handling (NLP). The capacity associated with these simulated intelligence methods may enable the identification of distinct clinical characteristics among patients, which aids in clinical evaluation and reduces strategy heterogeneity in clinical investigation concerning various wellness illnesses. Normal language processing (NLP) is concerned with taking down text and dialogue in order to derive meaning from words. Recurrent brain organizations (RNNs)—deep learning computations—play an important role in dealing with consecutive data sources such as spoken language, discussion, and time-series data [1].

II.

Profound learning is a subclass of AI that can learn unassisted information via unstructured or unlabeled data. On the other hand, AI will aim to extract optimal highlights from available data without the need for human intervention. The term "natural language handling" refers to the most popular method of using PC computations in order to distinguish essential components in natural language and focus emphasis on unstructured spoken or written input. NLP necessitates skills in artificial intelligence, cognitive logic, and other AI areas [2]. There are two strategies for dealing with NLP.

1. A rule-based strategy in which the computer adheres to pre-defined rules in the program;

2. Machine learning-based strategy in which we can employ both supervised and unsupervised learning strategies. In unsupervised learning, there is no human interaction, but in supervised learning, the computer learns latent rules with human guidance known as annotation. NLP algorithms begin by extracting data or concepts from electronic health records (EHRs), then process that data, and finally classify patients into subgroups based on rules and learners. Strategies for NLP are perplexing in light of the fact that it comprises of various methods together.

Data Mining Techniques: There are two high-level primary goals of data mining; NLP will map phrases or words to concepts of interest, and it will convert text from its natural form into a document using careful pre-processing [3].

They are models that can predict and describe things. In order to predict the target that the user is interested in, predictive mining tasks draw conclusions from the current data. The goal of descriptive mining is to present patterns that can be understood by the user and describe the data.

Language is an important and necessary tool available to man for the facilitation of his day to day activities. It is a distinctive quality unique to man. Naturally, Man communicates his thoughts, feelings and ideas using language. Language is the tool or code that enables man to express himself and communicate effectively with his fellow man in his environment. Natural Language Processing (NLP) is a subfield of computer science that is concerned with using computational techniques to learn, understand, and produce human language content [5]. Some of the applications of NLP include: information extraction, which converts unstructured textual data into structured data [6]; conversational agents, which help humans and machines communicate with one another; or machine translation, which uses computers to automate the process of translating between languages to help humans communicate with one another [5] According to [5], the following factors have enabled the development of NLP over the past two decades:

A. *Expansion in registering power*

The abundance of linguistic data that is accessible, the creation of efficient machine learning techniques, and a deeper comprehension of human language's structure and application in social settings. Text is reformatted in NLP to make it suitable for machine learning or artificial intelligence-based analysis. That text might come from clinician documentation, charging documentation, records of patient supplier or supplier associations, or even web-based entertainment conversations. It transforms text into a textual data stream that can be paired with data streams from physiological monitors (such as heart rate monitors and pulse oximeters), wearable devices, and laboratory tests. NLP has been successful in expanding some aspects of medical decision-making, creating tools for risk stratification, utilizing physician notes to identify postoperative complications following inpatient surgery, and triaging patients based on the identification of syndromes. Translating or mapping words or phrases onto concepts is an important application of NLP. We want the computer to look at the denoted concept beyond the letter sequence. Hypoxia is not simply a string of letters that we parse. The steps involved in mapping words or phrases to concepts are:

1. Dividing a sentence into tokens (also known as tokenization);
2. Lemmatizing every token (lemmatization); and
3. Mapping each lemma, or word in its standard form, to one or more concepts.

A few utilizations of NLP just perform stages 1 and 2, dissecting lemmata rather than ideas. This works well in areas where the mapping between concepts and lemmata is very close to one-to-one or where there is no accepted mapping.

Phonological and phonetic knowledge are two categories that can be used in NLP to classify the various types of linguistic knowledge:

1. Morphological Understanding;
2. Syntactic Skills;
3. Semantic Information;
4. Practical Skills;
5. World Wisdom;
6. Talk Information.

II. NLP IN HEALTHCARE

The medical services industry is one of the quickest developing. In order to overcome any regional disadvantages (access in rural areas through E-Health services), it has been integrating technology applications with healthcare practices like diagnosis and treatment to provide effective and efficient services that can be accessed by the majority of people. Notwithstanding, how much information being gathered through this cycle, as like EHRs (Electronic Wellbeing Records), sensor data, analyze, checking information, medical care tasks and the board information is immense. NLP, in this context, can be considered as one of the effective approaches for addressing these problems by using it to parse information and extract critical strings of data, thereby offering an opportunity to leverage unstructured data. It has been determined that approximately 80 percent of the healthcare data is unstructured, of poor quality, and considering the format that it is in at the moment, it is effectively unusable [7]. It has already been utilized in numerous healthcare operations worldwide. The following are the primary drivers of NLP applications in healthcare [7]:

1. The rising requirement for taking care of the flood in clinical information;
2. Support for population health management and value-based care;
3. Working on clinical documentation and making PC helped coding more proficient;
4. Improving connections among patients and healthcare professionals;

5. Empowering patients with health information;
6. Rising demand for healthcare of a higher quality.

Up until this point, the utilizations of NLP in medical care have accomplished momentous outcomes, because of which its organization in medical care advances has been expanding lately. In 2013, the Department of Veterans Affairs (USA) used NLP techniques to examine more than 2 billion EHR documents for signs of PTSD, depression, and potential self-harm in veterans [2]. In a similar vein, an analytics algorithm that made use of NLP was able to accurately predict the onset of psychosis in high-risk adolescents in another study [2]. In a similar vein, researchers from the University of Alabama found that a manual review of medical records was 22.6% more accurate than using NLP to identify reportable cancer cases [8]. In addition, a number of other studies have identified potential advantages, such as physicians' ability to make sound decisions; reducing physician burnout (the disillusionment of doctors who are tired of doing the same administrative and data entry tasks over and over and spending too much time looking through patient data); meeting the increasing demand for medical treatment; and employing NLP approaches in the healthcare environment to deal with the increasing quantity of medical care claims [12]. RESTRICTED BOLTZMANN MACHINES (RBMS)

As far back as the 1930s, humans have created a long line of machines in imitation of living organism. These machines Yule describes as mechanical marvel [13]. Restricted Boltzmann Machines (RBMs) Created by Geoffrey Hinton, RBMs are stochastic brain networks that can gain from a likelihood conveyance over a bunch of sources of information dimensionality reduction, classification, regression, collaborative filtering, feature learning, and topic modeling all make use of this deep learning algorithm. The fundamental components of DBNs are RBMsRBMs are composed of two layers:

1. Units that are visible Secret units each apparent unit is associated with all secret units. RBMs lack output nodes and have a bias unit that is connected to all visible and hidden units. The following are the ways RBMs works: 1. Two phases make up RBMs: both forward and backward passes
2. In the forward pass, RBMs encode the inputs by translating them into a number sequence.
3. RBMs combine every input with a single bias and individual weight. The calculation passes the result to the secret layer.
4. RBMs take that set of numbers and translate them into the reconstructed inputs during the backward pass.
5. RBMs send the output to the visible layer for reconstruction and combine each activation's individual weight and overall bias.
6. At the apparent layer, the RBM contrasts the remaking and the first contribution to dissect the nature of the outcome.

The following figure depicts how RBMs work:

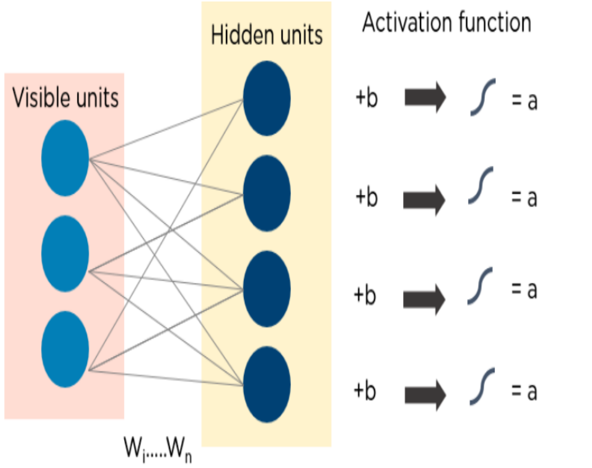

Fig. 2.10: Restricted Boltzmann Machines (source: Avijeet, 2022)

Natural Language Processing for Smart Healthcare

Smart healthcare is a healthcare system that exploits emerging technologies, such as artificial intelligence (AI), blockchain, big data, cloud/edge computing, and the internet of things (IOT), for realizing various intelligent systems to connect healthcare participants and promote the quality of healthcare [9] Major participants in smart healthcare can be classified into three categories, i.e., the public, healthcare service providers, and third-party healthcare participants. Re Representative smart healthcare scenarios, according to the participants, includes smart houses, smart hospitals, intelligent R&D of life sciences, management of public health, rehabilitation treatment, and so on. Related to the participants, representative smart healthcare scenarios include smart homes, smart hospitals, intelligent research and development for life science, health management, public health, rehabilitation therapy, and etc. Figure 2.13 shows the major participants, emerging technologies, and representative scenarios of smart healthcare.

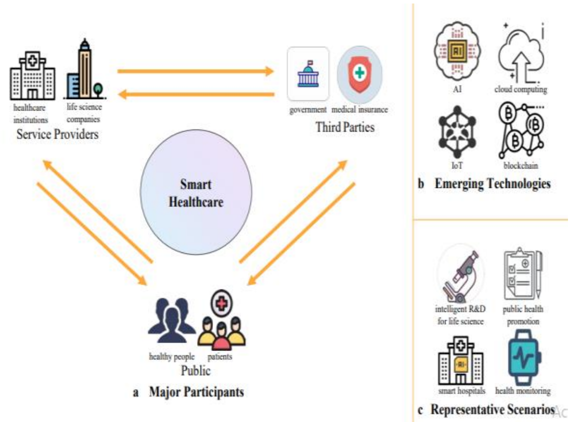

Fig. 2.13: Smart healthcare (source: Tian, 2019)

Figure 2.13a is the major participants in smart healthcare include the public, healthcare service providers, and third-party healthcare participants. Figure 2.13b is example emerging technologies enable smart healthcare applications include artificial intelligence - the science of making machines do things that would require human intelligence, blockchain, cloud computing, the internet of things, and etc. figure 2.13c is representative smart healthcare scenarios include intelligent research and development for life science, public health promotion, smart hospitals, health monitoring, and etc. Natural language processing (NLP) is a subfield of linguistics, computer science and artificial intelligence that is concerned with the automatic analysis, representation and understanding of human language [10]. NLP has become a hot research area and has attracted widespread attention from many research communities in the past several years. Language we all know serve as a primary means of constructing and maintaining a society. As human language is a general form of data entry for intelligent systems, NLP enables machines to understand human language and interact with humans, making it essential to smart healthcare. Computer programs \soft wares are created and installed in the machine to help it receive, access and respond to linguistic input or command received. The main manifestations of natural language are text and speech, where text encompasses text records, articles, book chapters, dictionaries, and so forth, while speech occurs in human-human and human-machine dialogues. NLP has been developed for several decades following the early origin of artificial intelligence in the 1950s. Approaches to conduct NLP are generally divided into three categories: rule-based approaches, statistical approaches, and deep learning-based approaches (Young et al, 2018). From the 1950s to 1980s, NLP research mainly focused on rule-based approaches, which required expertise in both computer science and linguistics to design rules that fit human language. However, even well-designed rules are quite limited for covering human language due to its flexibility and complex patterns. Since the 1980s, statistical NLP systems have been designed by extracting features from corpora using statistical and machine learning algorithms and have gradually replaced rule-based NLP systems due to their superiority in performance and robustness. With the early application of the neural probabilistic language model [12].and the rapid development of deep learning since 2013, neural NLP, by using neural networks and large corpora for automated feature learning, has dominated current research and achieved SOTA performance of many NLP tasks [10].In smart healthcare, NLP is applied to process text data and is associated with human-machine/human-human communication. The text data can be classified into 2 categories: clinical text and other text data [10] Clinical text comes from all clinical scenarios and mainly comprises of unstructured text records from electronic health record (EHR) systems, including medical notes, diagnostic reports, electronic prescriptions, and etc. Other text data include all text that appears within other healthcare scenarios, e.g., surveys in population screening and articles for evidence-based reference. Communication is common in all smart healthcare scenarios, such as patient-provider communication in clinical inquiry and human-robot interaction in rehabilitation therapy, accompanied by applications such as machine translations and user interfaces for rehabilitation robots.

III. ANALYSIS OF THE SYSTEM ARCHITECTURE

In the proposed system, development of natural language based medical consultancy information flow for hospital out-patients using machine learning technique was the main focus of the design. The proposed NLP-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. 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 healthcare. Such user interfaces can be implemented by using NLP techniques, especially speech recognition and natural language understanding. Clinical data, including but not limited to demographics, medical history, medical notes, physical examination notes, electronic recordings from medical devices, and clinical laboratory testing data and medical images, are the most important data for diagnosis, treatment and even further retrospection. Patient-provider communication is an important way to obtain first-hand clinical data. So in the proposed system, free text notes can be taken through speech recognition, which can significantly reduce medical staff’s time on labour intensive clinical documentation. Also the proposed system implemented Clinical decision support (CDS) systems which can provide physicians with diagnosis and treatment suggestions, which play an increasingly important role in clinical medicine with the surge of clinical cases and growing concerns regarding public healthcare. With the development of question answering systems, clinical decision support based on question answering has emerged and become common, as it is closer to traditional patient-provider communication. NLP techniques have shown great ability to build clinical decision support systems by extracting various useful information for making diagnosis and therapeutic decisions, such as family history information, treatment and prognosis data, clinical data concepts and features. The proposed system was also integrated with a collaborative patient interface that enables the patient have a download overview of his health history via his own health information. Patients may now publish and submit modified medical demands to the attending doctor, giving them even more authority. These uploads and updates might contain medical photographs as well as summaries of clinical observations, investigations, and examinations, which are all important components of healthcare management.

In simple terms, the new system was meant to enable uninterrupted access to healthcare, regardless of time or place, and to continue clinician-patient connections outside the hospital's boundaries. The medical consulting system was created with safety, security, and continuous accessibility for medical and health information in mind, regardless of time or place. The medical clerking method was created to fit this requirement, just as physicians had gotten accustomed to freestyle clinical recording. From clinical observations and investigations through physical observations and laboratory findings, physicians have the ability to produce and convey their reports and views as they see fit without being constrained by any system design components.

The proposed system will add the following features to the existing system

- Free text notes can be taken through speech recognition
- Integration of data across various hospitals to aid in data sharing and decision making
- To provide support by integrating clinical guideline-based prompts into the patient report such as guideline based interval for assessment of test for diseases, recommended treatments and guidelines for medical care.

More advanced rule-based prompting incorporates patient-specific information and is able to generate customized care recommendations such as treatment prescriptions, recommendation of next test because of patients health is falling short of the desired outcome.

The proposed system will track patient’s visits and will generate a reminder for patient or physician of the needed follow-up or preventive care against a discovered disease. The typical work flow begins with the physician reviewing a patient’s information from a computer terminal to view the information online.

Also the proposed system is an enhancement on the existing system to include addition of new features.

1. The proposed system register all individual members of the public
2. The registered member of the public has a personal access code which they can use to access their page.
3. All data collected in all correspondences are saves in a database.
4. Health information about a patient are generated in an SMS format and sent to the patient

IV. INPUT SPECIFICATION AND DESIGN

The following forms in figure 4.6 show the format of input and output forms as designed in the proposed system:

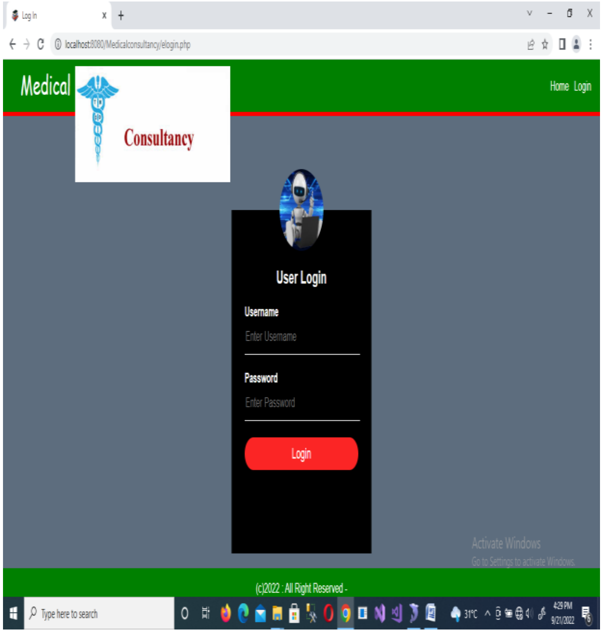

Fig 4.6: Login Form

Figure 4.6 contains the login specification for user on the platform which includes the username and the password. Once the specification is entered, clicking on the login button validate the data before launching the user on the assigned subsystem.

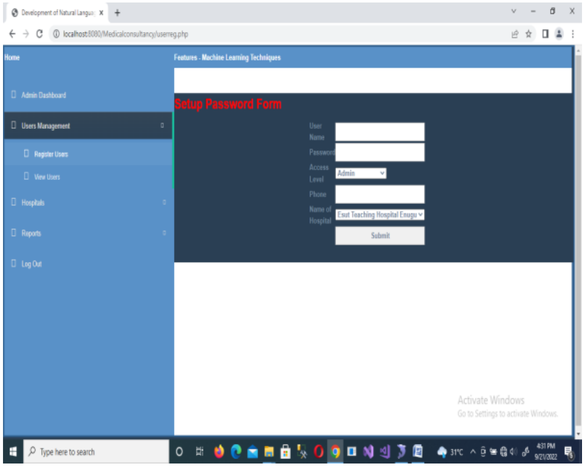

Fig. 4.7: Password registration Form

Figure 4.7 is used to create a new hospital record on the database. It registers the hospital and create access password for the hospital.

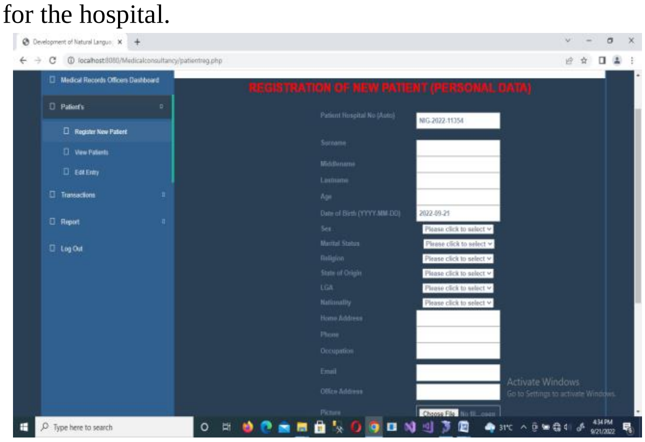

Fig. 4.8: Patient’s registration Form

Figure 4.8 shows the form used to record patient's data in the hospital. It captures the details of the patient and the hospital where the registration took place.

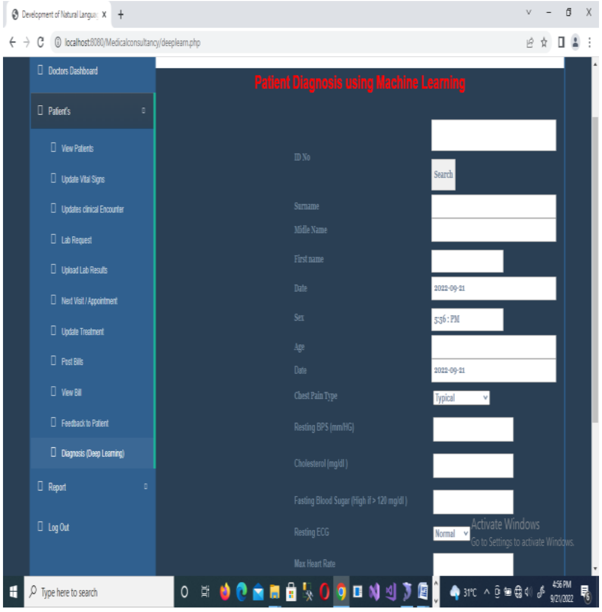

Fig. 4.9: Disease Diagnosis Form

Figure 4.9 is used to capture the patient symptoms and use disease diagnosis i to find the type of disease, the suggested treatment as recommended and other patient's details.

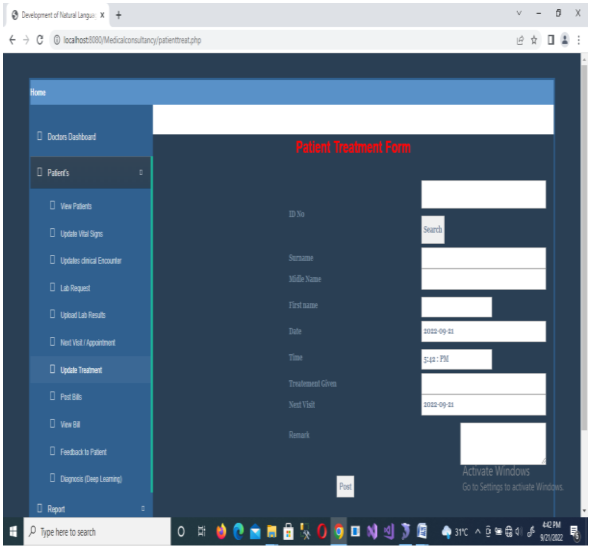

Fig. 4.10: Patient's Treatment Form

The patient's treatment form as shown in figure 4.10 is used to record each drug of treatment given to a patient and the time and date it was administered on the patient.

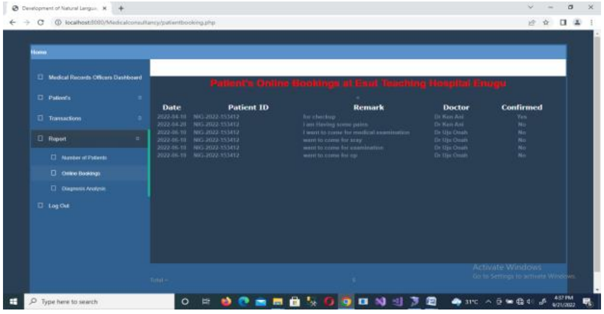

Fig. 4.11: Patients Booking Request

The form shows the patients request to see the doctors.

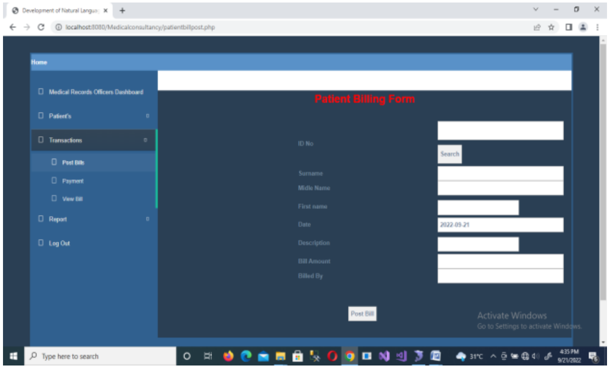

Fig. 4.12: Bill Patient Form

Figure 4.12 is the form used to post patient's bill to the database.

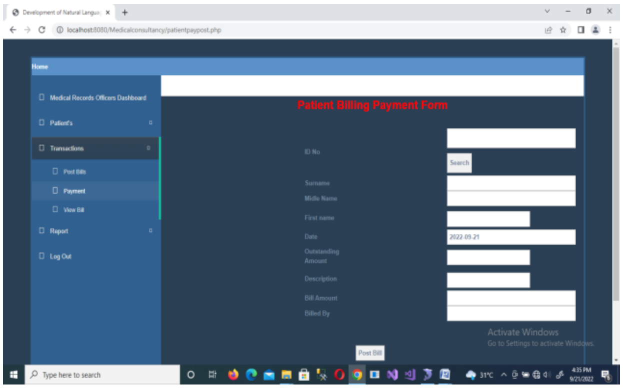

Fig. 4.13: Patient Bill Payment Form

Figure 4.13 is the form used to post patient's bill payment to the database.

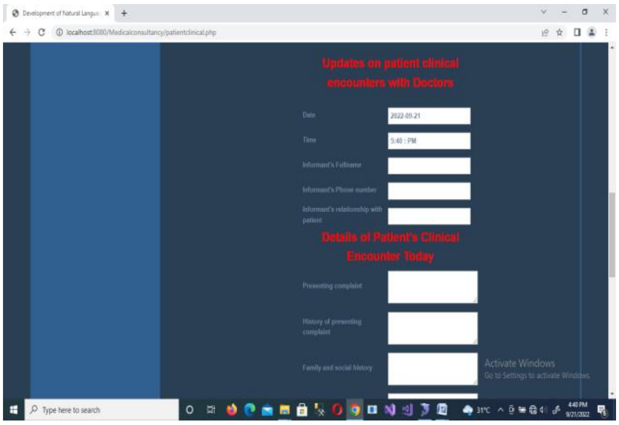

Fig. 4.14: Patient medical consultation Form

Figure 4.4 is the form used to record patient's clinical encounter with the doctor.

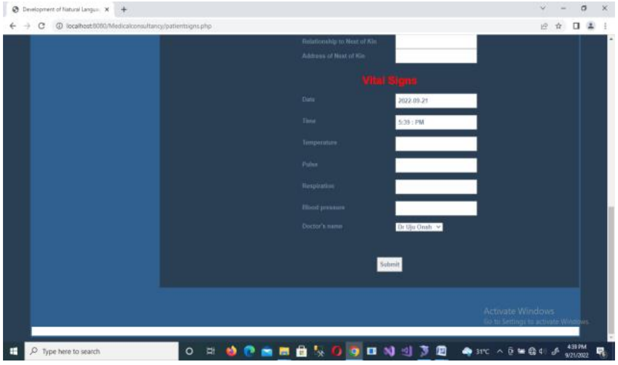

Fig. 4.15: Update Vital Signs Form

Figure 4.15 is the form used by nurses or doctor to record patient's vital signs

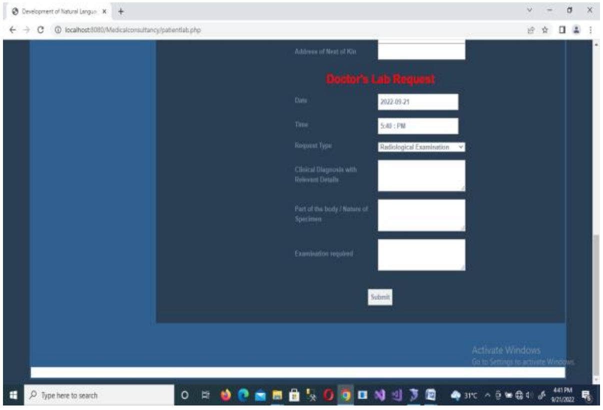

Fig. 4.16: Lab Request Form

Figure 4.16 is the form used by doctor to upload patient lab request.

4.5 Output Specification and Design

The output specifications and design shows the reports generated from the new system designed.

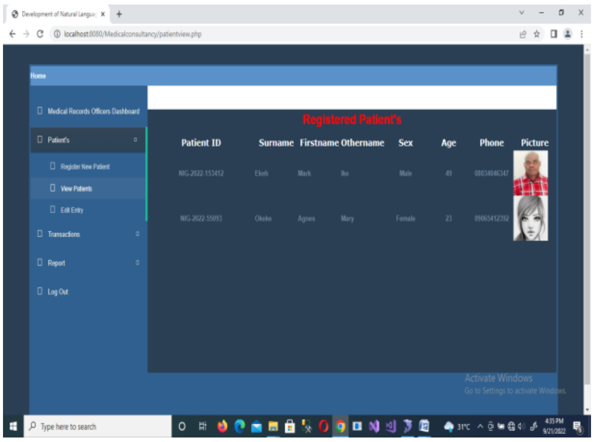

Fig. 4.17: Patient's File

Figure 4.17 is the patient's registry showing the records of patients in the hospital

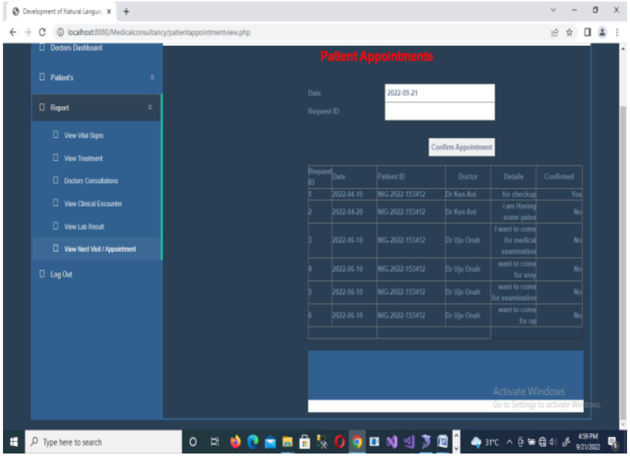

Fig. 4.18: Patient's Next Visit Report

Figure 4.18 is the patient's next visit report and when the form displays, it sends automatic sms to the patients.

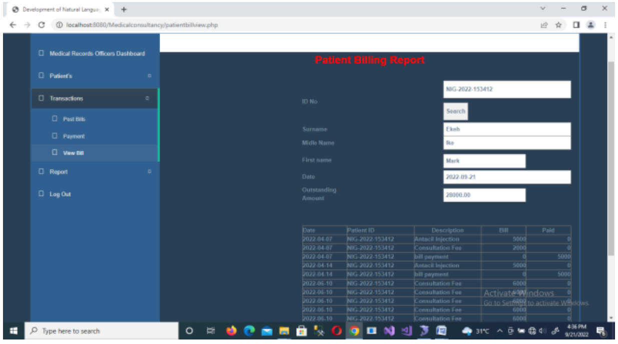

Fig. 4.19: Patient's Bill Report

Figure 4.19 is the patient's bill report that shows all the bills debited to the patient and the payment records showing the outstanding balance.

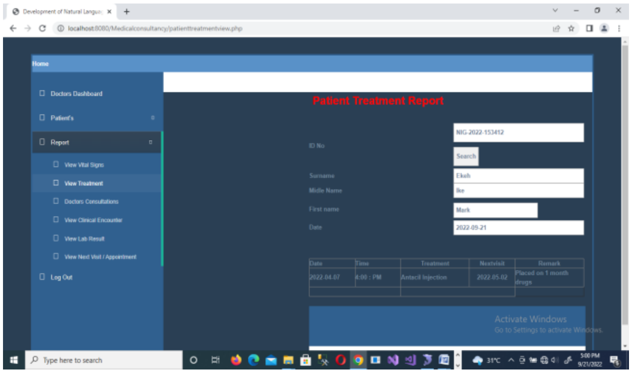

Fig. 4.20: Patient's Treatment Report

Figure 4.20 is the patient's symptoms entry, diagnosis and treatment report.

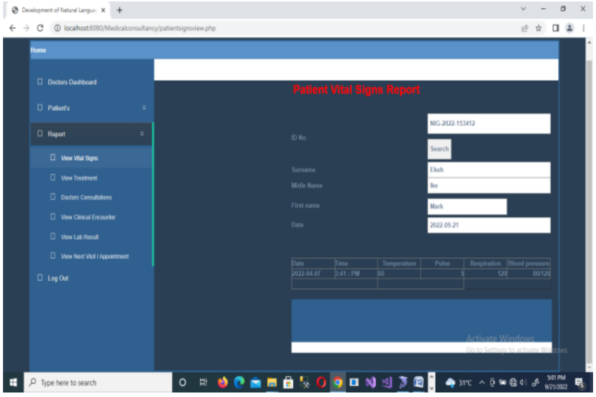

Fig. 4.21: Patient's Vital Signs Report

Figure 4.21 displays the selected patient vital signs taken at different times.

V. FINDINGS

Development of natural language based medical consultancy information flow for hospital out- patients using machine learning techniques was the focus of this research work. From the work carried out, the problems facing medical information processing has been identified as being more of untimely information retrieval and medical diagnosis, medical information documentation takes a lot of time. So the research work modeled a system that can use natural language processing to translate voice to text during medical consultation. This was achieved as the software developed enables the clinicians to record their findings during patient's medical examination using voice data that is translate to text by the natural language processing. This makes recording of patient medical information faster without any delay. Also medical diagnosis with respect to heart disease was implemented using machine learning. The outcome from the implementation shows 90% accuracy in diagnosing a patient.

VI. CONCLUSION

From what have been said so far it can be seen that language is a means of understanding ourselves and our society and it is a useful tool in resolving some of the problems and tensions that arise from human existence and interaction [14]. 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 machine 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 machine learning algorithm, learning can be faster, accurate and helpful in medical practice. So this research work has developed a system that will aid physicians in medical consultation information flow so as to achieve the desired quality health care that is timely and accurate.

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