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Development of an Expert System for Outpatients

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Abstract: Outpatient care plays a crucial role in modern health care, often involving diagnosis, treatment, and follow-up care outside of hospital settings. The complexity of outpatient care coupled with the need for efficient and accurate decision-making, makes expert system a valuable tool for healthcare providers. The system aimed at the development of an expert system that leverages in artificial intelligence and medical knowledge to assist healthcare professionals in diagnosis. Evaluating the system's ability to provide timely and accurate treatment recommendations, analyzing the user-friendliness of the system's interface for healthcare practitioners and optimizing workflow processes are also captured. A thorough system study and investigation were done and data collected via interview; analysis about the current system using document and data flow diagrams was carried out. The methodology adopted is Top Down Model approach. Data flow, Entity Relationship diagram, Laravel (which is a dynamic PhP frame work) were the tools used for the development of the software. This work's finding underscores the potential of expert system to enhance outpatient healthcare by improving diagnostic accuracy and facilitating evidence-based treatment decision. Evaluation with target users depicted that the system is efficient and user friendly.

Keywords: Expert System, Outpatients, Diagnose, Treatment, Knowledge based, Healthcare, Web-based and Algorithm.

I. Introduction

An expert system for outpatient care is a specialized computer program designed to assist healthcare professionals in diagnosing and treating patients who do not require hospitalization. It leverages on Artificial intelligence and knowledge from medical experts and artificial intelligence to provide accurate assessments, recommendations and treatment plans for various medical conditions, allowing for more efficient and consistent outpatient care. These systems use algorithms and patient data to mimic the decision-making processes of skilled healthcare providers, ultimately providing and improving the quality of care and patient outcomes in outpatient settings.

Outpatient care is a fundamental component of the healthcare system, providing medical services to patients who do not require hospitalization or overnight stay. It encompasses a wide range of healthcare activities, including diagnosis treatment, follow-up, and preventive measures. However, the complexity of outpatient care, the increasing volume of patients, and the need for accurate and timely decision-making present challenges to healthcare professionals. To address these challenges and improve the quality of outpatient care, there has been a growing interest in developing intelligent system such as expert system, to support healthcare professionals in decision-making processes. In the context of outpatient, an expert system can assist healthcare professionals, in diagnosing patients, selecting appropriate treatment options and providing decision support. One crucial aspect of the study involves knowledge representation; the expert system needs to accurately represent relevant information pertaining to outpatient.

This study will achieve the following objectives:

- Design a comprehensive knowledge base that encompasses medical literature, clinical guidelines and expert knowledge specific to outpatient.
- Design a user-friendly interface that is intensive, easy to navigate, and integrates seamlessly into the clinical workflow
- Implement appropriate reasoning mechanism such as rule-based systems, decision trees or machine learning algorithms, to analyze patient data, medical history, symptoms and test results.

II. Literature Review

Almalki and Aldosari (2019) proposed an expert system for outpatient diabetes management; their systems utilized a rule-based approach incorporating a knowledge base with extensive information on diabetes symptoms, medications, and lifestyle modifications. The study demonstrated the effectiveness of the expert system in assisting healthcare professionals by providing accurate diagnoses, personalized treatment recommendations and lifestyle guidance. However, the system has limited scope of Research, which leads to bias in data sources and over reliance on rule-based approach. Our system will handle this drawback by integrating the broaden research focus, which will integrate the border context of diabetes management, including integration

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with electronic healthcare systems. Researchers can enhance the robustness, usability and effectiveness of an expert system for outpatient diabetes management with data quality assurance, Hybrid AI Approach and clinical validation.

In another study; Abdulsalam, Al-kabi, and Mohammad-Ali (2020) developed an expert system for outpatient diabetes cares. Their systems used algorithms approach to analyze patient data, including blood glucose levels, medications and dietary information. Their system is considered to have Data integration challenges and Algorithmic complexity (Bhakoo and Chan, 2020). Our study will implement unified data integration strategy that ensures data Consistency and validation mechanism. The Algorithms used in the system will be transparent and explainable to decision-making processes and potentials to assist healthcare professionals in monitoring patient progress, detecting abnormalities and suggesting appropriate treatment adjustment.

Furthermore, Sezgin and Kucuk (2020) proposed an expert system for diabetes self-management in outpatient. Their systems focused on empowering diabetic patient to better manage their condition through personalized guidance and educational resources, its pitfall is insufficient attention to data privacy and security which can deter users from sharing their sensitive health information, limiting the system's ability to provide personalized guidance. Implementing strong data encryption, user consent mechanisms and compliance with relevant data protection regulations (e. g GDPR Or HPAA) to address privacy and security concerns to improve patient self-care behaviors and glycemic control in our study will proffer solution to the aforementioned pitfalls.

These studies collectively indicate that the design and implementation of an expert system for outpatient diabetes have potential to enhance the accuracy and efficiency of diabetes management. By incorporating a comprehensive knowledge base, these symptoms can provide accurate diagnoses, personalized treatment recommendations, and valuable self-care guidance to diabetes patients.

In 2017 Li et. al. developed an expert system for outpatient management of chronic heart failure. The system integrated a heart balance medical rule approach, utilizing a comprehensive knowledge base to access patient symptoms, laboratory results and medical history. Performance of the system is weakened by inadequate knowledge base, complexity and usability issues which are threats to user-friendliness functionality. Ensuring that the system's knowledge base is regularly updated with the latest medical guidelines and prioritize user experience by designing an intuitive and user-friendly interface that healthcare professionals can easily navigate, improving the assessment and management of patients will definitely take care of these demerits as opined by Bendavid et. al. (2010).

Zhang et. al., (2018) designed an expert system for the management of chronic obstructive pulmonary disease in outpatient. The system employed machine learning techniques to analyze patient data including lung function tests, symptoms and co morbidities. The study is limited in performance to patient with high COPD () due to over reliance on machine learning and Model generalization, as the machine learning models used are not well-validated or fail to generalize to diverse patient population. To enhance the system, our system will be able to have feedback mechanism and explainable AI to provide transparency treatment by helping healthcare professionals in diagnosing COPD.

Xie et. al. (2019) systematically designed and developed an expert system for outpatient of autoimmune diseases, such as rheumatoid arthritis and systemic lupus erythematosus. The system utilized a well knowledge base approach incorporating diseases – specific guidance and expert knowledge to control the disease. As the diseases are widely known among patients, it lacks personalization and inadequate knowledge base quality which causes suboptimal management for autoimmune diseases. The researchers will enrich the system with adequate knowledge base and implement machine learning algorithms that can adapt to individual patient data and preferences, providing personalized recommendations, which will provide accuracy of diagnose, modification, recommendations and diseases management strategies for autoimmune diseases.

In another study, Khanam and Aris (2018) designed an expert system for hypertension management in outpatient care. The system utilized a fuzzy logic approach to analyze and sensor patient data including blood pressure readings, medical history and lifestyle factors. Depending too heavily on fuzzy logic without considering clinical guidelines and expert opinions may result in recommendations that do not align with best practices in hypertension management (Laudon, 2018). Our system will combine fuzzy logic with clinical guidelines and expert opinions to strike a balance between data-driven analysis and evidence-based practices in assisting healthcare professionals or expert in monitoring and sensory patient progress, detecting abnormal blood pressure patterns and suggesting adequate treatment adjustment.

Amara et. al., (2019) developed a web-based outpatient information systems integrated with expert system for decision support oncology. The expert system has the knowledge to utilize a clinical guideline and expert knowledge to provide personalized treatment recommendations for cancer patients. Their study lack commendation for depending in oncology decision support. The current system will engage in interdisciplinary or multidisciplinary team of healthcare experts, including oncologist, radiologists, and data scientists to showcase the effectiveness of the system in supporting healthcare experts in making information treatment decision and improving patient outcomes.

Liu, Zhu and Zhou (2020) designed a web-based expert system for medication management in outpatient care. Their systems have the systematic ability to analyze patient data, including medication list, medical history and drug-drug interactions; but due to lack of clinical validation their system has incomplete medication data which leads to challenges in determining the system's accuracy in assessing drug-drug interactions. Collaborating with healthcare professionals to conduct clinical validation studies

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involving real-world patient cases, demonstrating an assistance to medical expert in detecting potential medical errors, recommending appropriate drug therapies, and improving medical safety will resolve these drawbacks (Thron et. al., 2007).

Sander (2016) stated that the computerization of medical care will free physicians from routine testing procedures to improve patient diagnoses and treatment. Computerization of an outpatient information system will make it possible for proper surveillance in health related issue worldwide, and it will give proper documentation of information on certain diseases and areas where it is most prevalent (Peters, 2019). Digital divide and over-reliance on automation is an issue, as not all patients have equal access to computerized healthcare systems, potentially creating disparities in access to healthcare services and health surveillance. To tackle this, our system will have balance automation and accessibility initiatives.

III. Methodology

In investigating any system, different data gathering tools such as observation, interview or questionnaire can be used depending on the analyst. The data used in this study were gotten from primary and secondary source in which interview and observation method were used for data gathering. The researchers carried out a face-to-face detailed interview with various stakeholders involved in outpatient, such as medical experts, administrators and IT staff. In this process some problem facing outpatient information system both the user and staff were discussed. The researcher observed the existing outpatient care processes to understand how the healthcare professionals make decisions, diagnose patient and provide treatment. Existing documentation related to outpatient care were reviewed including medical guidelines, polices, and any previous studies or reports.

The design methodology adopted for this research work is iterative waterfall model approach. In this model, system follows a series of events from the requirement definition, system and software design, implementation and unit testing, integration and system testing, and operational maintenance.

3.1 Use Case Diagram

The comprehensive use case of the new system can be represented showing various operations of the proposed system.

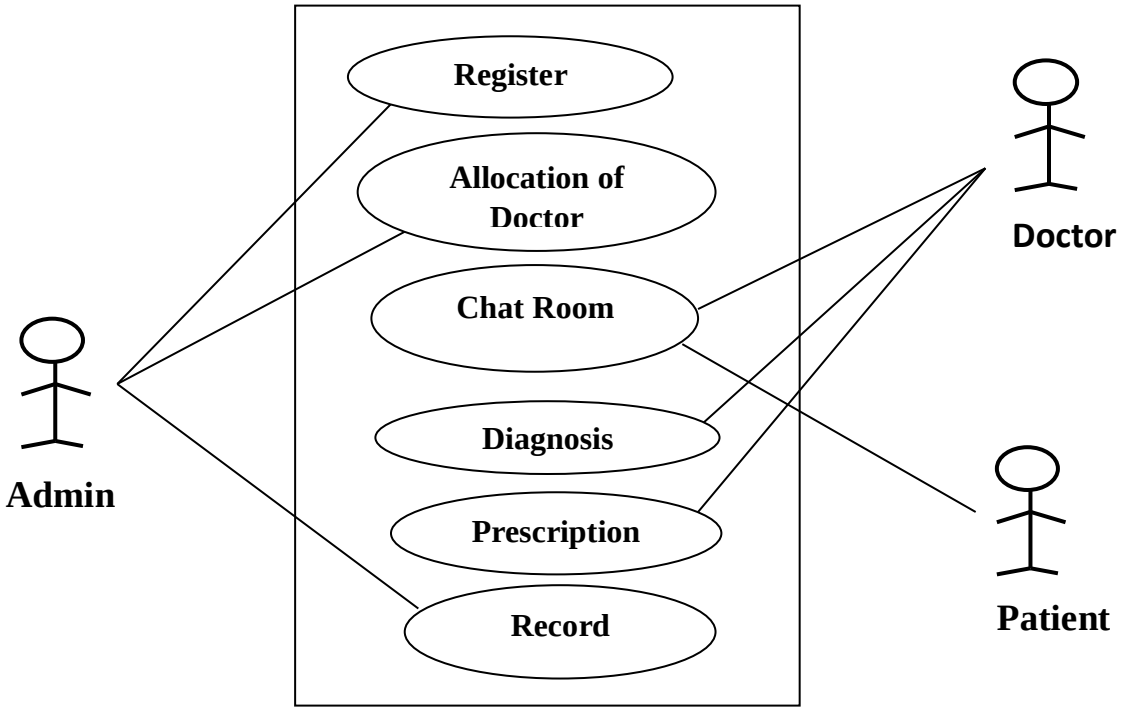

Figure 1: Use Case Diagram

Figure 1 shows a use case diagram of the proposed system using UML (Unified Modeling Language). UML is a standard language for modeling software systems. It provides a set of diagrams that can be used to visualize and describe different aspects of a system, such as its structure, behavior, and interactions.

The image shows a use case diagram, which is a type of UML diagram that shows the interactions between objects in a system over time. In this case, the objects are the doctor, patient, and admin.

The diagram shows that the patient registers for the system and is then allocated a doctor. The doctor and patient then communicate in a chat room to discuss the patient's condition. The doctor makes a diagnosis and prescribes medication. The admin then records the patient's diagnosis and prescription.

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3.2 Entity Relationship Diagram

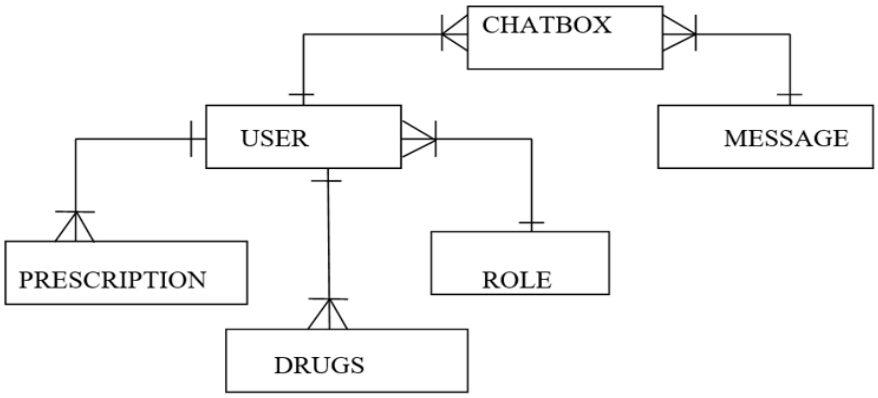

Figure 2: Entity Relationship Diagram

Figure 2 shows an entity relationship diagram (ERD) of the system. ERDs are used to model the data structure of a database. It depicts the entities involved as well as the relationship between them. The ERD in the figure shows the following entities: CHATBOX, USER, MESSAGE, PRESCRIPTION, ROLE and DRUGS. The following relationships are shown between the entities: USER can have many MESSAGES, MESSAGE can belong to one CHATBOX, USER can have one ROLE, PRESCRIPTION can belong to one USER and PRESCRIPTION can have many DRUGS.

IV. Results and Discussion

Building an expert system for outpatient care is a complex but valuable endeavor that can enhance healthcare delivery, improve patient outcomes, and reduce the burden on healthcare providers. Careful planning and collaboration with healthcare professionals are crucial throughout the design and implementation process.

Target and end users also rated expert systems for outpatient care favorably in terms of accuracy and personalization. In a study of patients who used an expert system for diagnosing and treating asthma, 80% of patients said that the expert system's diagnosis was accurate. In a study of patients who used an expert system for managing chronic pain, 75% of patients said that the expert system's treatment plan was personalized to their individual needs.

However, there are some challenges and limitations that need to be considered when using expert systems for outpatient care. One challenge is that expert systems can be expensive to develop and maintain. Another challenge is that expert systems can be complex to use, and physicians and patients may need training in order to use them effectively. Finally, it is important to note that expert systems are not a replacement for human judgment. Physicians and patients should always use their own judgment when making decisions about their care.

Despite these challenges, expert systems for outpatient care have the potential to improve the quality of care for outpatients. By carefully addressing the challenges and limitations, expert systems can be used to provide physicians and patients with valuable tools to improve the diagnosis, treatment, and management of chronic conditions.

V. Conclusion

The successful design and implementation of an expert system for outpatient care can lead to improved diagnostic accuracy, more efficient healthcare delivery, and ultimately better patient outcomes. However, it's crucial to remain vigilant about ethical and regulatory considerations, as well as the ongoing need for knowledge maintenance and system improvement to keep pace with evolving medical knowledge and patient needs.

Expert system for outpatient care is a multifaceted endeavor that demands meticulous planning and collaboration between healthcare professionals, software developers, and data scientists. This advanced healthcare technology holds the potential to enhance patient care and streamline clinic operations.

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