A Proposed Expert System for Vertigo Diseases Diagnosis

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Abstract— Vertigo is a common symptom that can result from various underlying diseases and conditions, ranging from benign to severe. Accurate and timely diagnosis of the cause of vertigo is crucial for appropriate management and treatment. In this research, we propose the development of an expert system for vertigo diseases diagnosis, utilizing artificial intelligence (AI) and the proposed Expert System which was produced to help assist healthcare professionals in diagnosing the cause of vertigo based on a patient's symptoms, medical history, and other relevant clinical information. The proposed expert system presents an overview about vertigo diseases are given, the cause of disease is outlined and the treatment or recommendation of disease whenever possible is given out. CLIPS language was used for designing and implementing the proposed expert system. The potential of the proposed expert system lies in its ability to enhance the accuracy and efficiency of vertigo diagnosis, as well as assist in the proper referral and management of patients.

Keywords— Artificial Intelligence, Expert Systems, CLIPS, Vertigo diseases, Medical.

I. INTRODUCTION

In recent times, the utilization of computer technology in various areas of medicine, such as diagnosis, treatment of illnesses, and patient management, has significantly increased. Despite the inherent complexity and uncertainty in these fields, intelligent systems have been developed to aid in addressing these challenges. Vertigo is not a separate disease process, but a multisensory and sensorimotor syndrome with various etiologies and pathogeneses [1]. Vertigo can be classified into peripheral vertigo, which originates from the inner ear, and central vertigo, which originates from the central nervous system. Accurate diagnosis of the cause of vertigo is essential, as different diseases require different treatment approaches. The medical history of the patient often serves as a vital factor in distinguishing between peripheral and central causes of vertigo. However, diagnosing the cause of vertigo can be challenging, as the symptom can be subjective and overlapping, and the underlying diseases can have similar clinical presentations. Therefore, the development of an expert system for vertigo diseases diagnosis can be valuable in assisting healthcare professionals in making accurate and timely diagnoses. An expert system is an Artificial Intelligence (AI) computer application that comprises a knowledge base and an inference engine. The proposed expert system for vertigo Diseases Diagnosis was implemented using CLIPS language (C Language Integrated Production System), which is a powerful tool for building knowledge-based systems that utilize a knowledge base of facts and rules to make inferences and draw conclusions. The main components of expert system are represented in Figure 1.
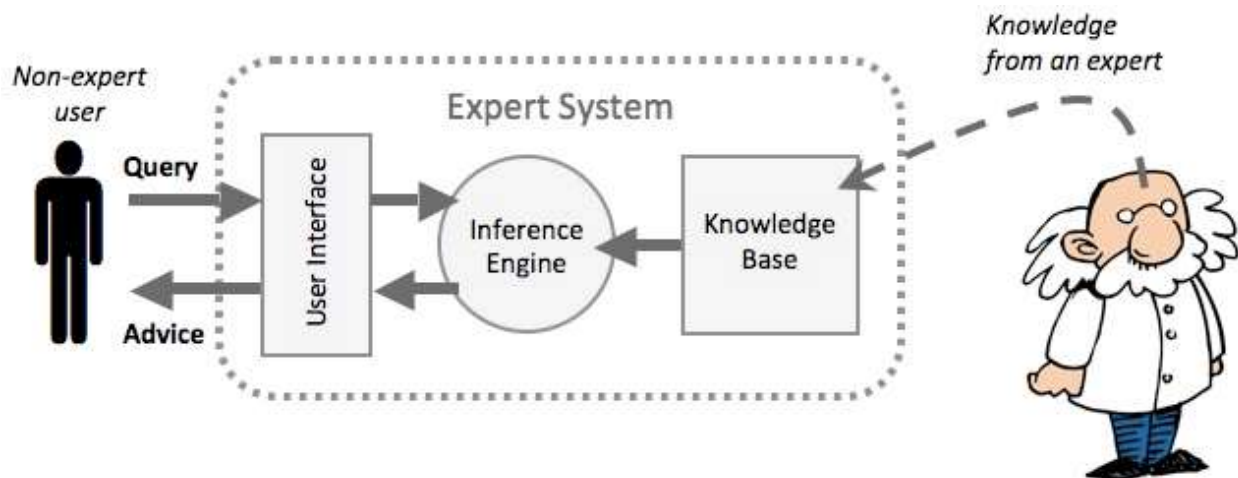

Figure 1. Expert System Architecture

II. MATERIALS AND METHODS

The proposed expert system is designed to diagnose eight different diseases related to vertigo. During the interactive session, the system prompts the user to select the relevant symptoms from the screen. At the conclusion of the dialogue, the system provides the user with the diagnosis and recommendations for the identified disease. Figure 2 illustrates the introduction to vertigo expert system, displaying four buttons that allow users to initiate the expert system. Figure 3 shows a sample of the dialogue between the expert system and the user.
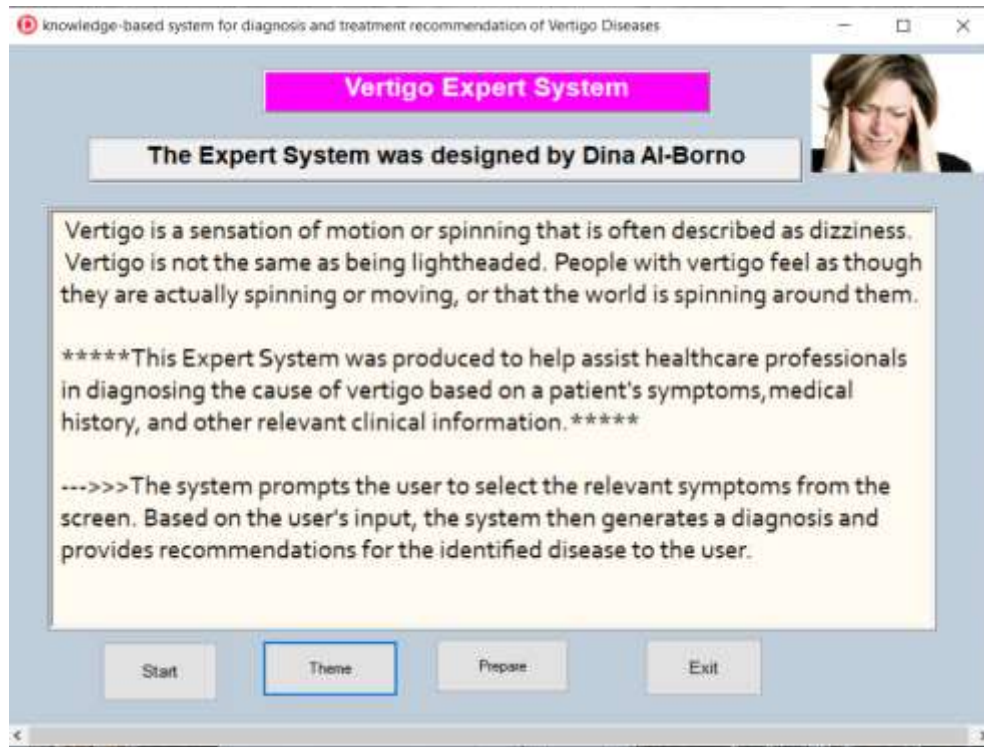

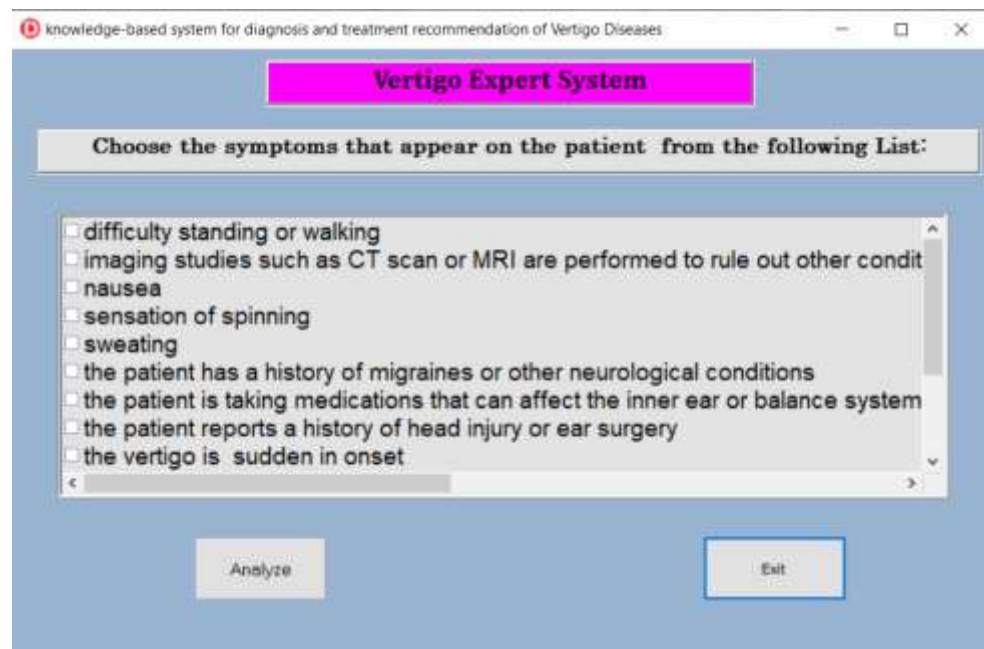**Figure 2:** The figure shows the introduction of the expert system project.

Figure 3: The figure displays the system prompts the user for symptom selection.

III.   LITERATURE REVIEW

Expert systems currently play important roles in medicine, medical practice or medical care. About nine areas of the medical practice have been identified to employ the use of computer expert systems. These are [2], Prediction of Disease, Prevention of Disease, Diagnosis of Disease, Staging of Disease, Therapy of Patient, Rehabilitation of Patient, Health Status of the Patient, Counselling of the Patient, Advocacy for the Patient[3]. Numerous studies have been conducted to develop medical expert systems for diagnosing various diseases. For instance, a study of C P C Munaiseche[1], D R Kaparang[1] and P T D Rompas[1], focused on Diagnosing Eye Diseases using the Forward Chaining Method and assessing user acceptance through usability testing. The study expanded its scope to cover 16 types of eye diseases and 41 symptoms, organized into 16 rules. The findings revealed that the medical expert system demonstrated excellent usability, particularly in terms of learnability, as it accurately diagnosed eye diseases based on user-inputted symptoms. Moreover, the usability acceptance value, measured through various attributes, had an average score above 4, indicating positive user acceptance [4]. Another a Knowledge Based System for Neck Pain Diagnosis [6] The knowledge-based system is can diagnose seven neck diseases of different phases of the human life beginning by asking the user many questions according to their pain symptoms. SL5 Object language, a rule-based language was used in designing and implementing the Knowledge Based System for neck diseases diagnosis.

A classical medical diagnosis expert system is the MYCIN. It was developed to capture the knowledge of medical experts in infectious blood diseases [5]. MYCIN capture the expertise of clinicians, enabling accurate and prompt diagnoses, along with appropriate therapeutic recommendations. Additionally, MYCIN played a crucial role in advancing the understanding and integration of expert systems in workplace environments, contributing to the broader adoption of this technology beyond medical applications. Another study proposed an expert system for diagnosing foot diseases [7]. This system is designed to diagnose eighteen foot problems that may occur at different stages of human life, starting from infancy to adulthood. The diagnosis process involves a series of yes/no questions presented to the end user, who selects the appropriate answers on each screen. Subsequently, the expert system provides a diagnosis and recommendation based on the user's responses, assisting in identifying and addressing foot problems effectively.

An expert system for nausea and vomiting problems in infants and children [8]. This expert system covers a wide range of potential diagnoses, including gastro-esophageal reflux, gastroenteritis, systemic infection, bowel obstruction, tumors, bleeding diseases, tonsillitis, and pharyngeal hepatitis. Developed using the SL5 Object expert system language, this system not only provides diagnoses but also offers valuable information on the identified diseases and guidance on how to manage them effectively.

IV.   KNOWLEDGE REPRESENTATION

The proposed expert system designed using CLIPS, the knowledge base was built by accumulating factual knowledge from medical experts of the specific medical domain of vertigo. The knowledge was represented via a production rule. The proposed expert System contains eight rules covering eight diseases of vertigo.

Rules for the diagnosis of vertigo diseases:

1. IF a patient presents with a sensation of spinning, whirling, or tilting of the environment or oneself THEN consider the possibility of vertigo.

2. IF the vertigo is accompanied by symptoms such as nausea, vomiting, sweating, or difficulty standing or walking THEN consider the possibility of peripheral vertigo.

3. IF the vertigo is sudden in onset and accompanied by hearing loss or ringing in the ears THEN consider the possibility of inner ear disorders such as Meniere's disease or vestibular neuritis.

4. IF the vertigo is associated with head movements or changes in position THEN consider the possibility of benign paroxysmal positional vertigo (BPPV).

5. IF the patient reports a history of head injury or ear surgery THEN consider the possibility of central vertigo due to damage in the brainstem or cerebellum.

6. IF the patient is taking medications that can affect the inner ear or balance system THEN consider the possibility of medication-induced vertigo.

7. IF the patient has a history of migraines or other neurological conditions THEN consider the possibility of central vertigo.

8. IF imaging studies such as CT scan or MRI are performed to rule out other conditions such as brain tumors or stroke THEN consider the possibility of vertigo as the primary diagnosis.

According to pervious rules, there are eight diseases such as, vertigo, peripheral vertigo, inner ear disorders such as Meniere's disease or vestibular neuritis, benign paroxysmal positional vertigo (BPPV), central vertigo due to damage in the brainstem or cerebellum, medication-induced vertigo, central vertigo and vertigo as the primary diagnosis.

The user interface of the proposed expert system is represented by the CLIPs dialog window. The system has a file saved as CLIPS file (example, vertigo.clp). The file contains the knowledge base, from the CLIPS dialog window, the user will load the CLIPS file using command (load" vertigo.clp") and run the program using command (run), as shown in Figure4.
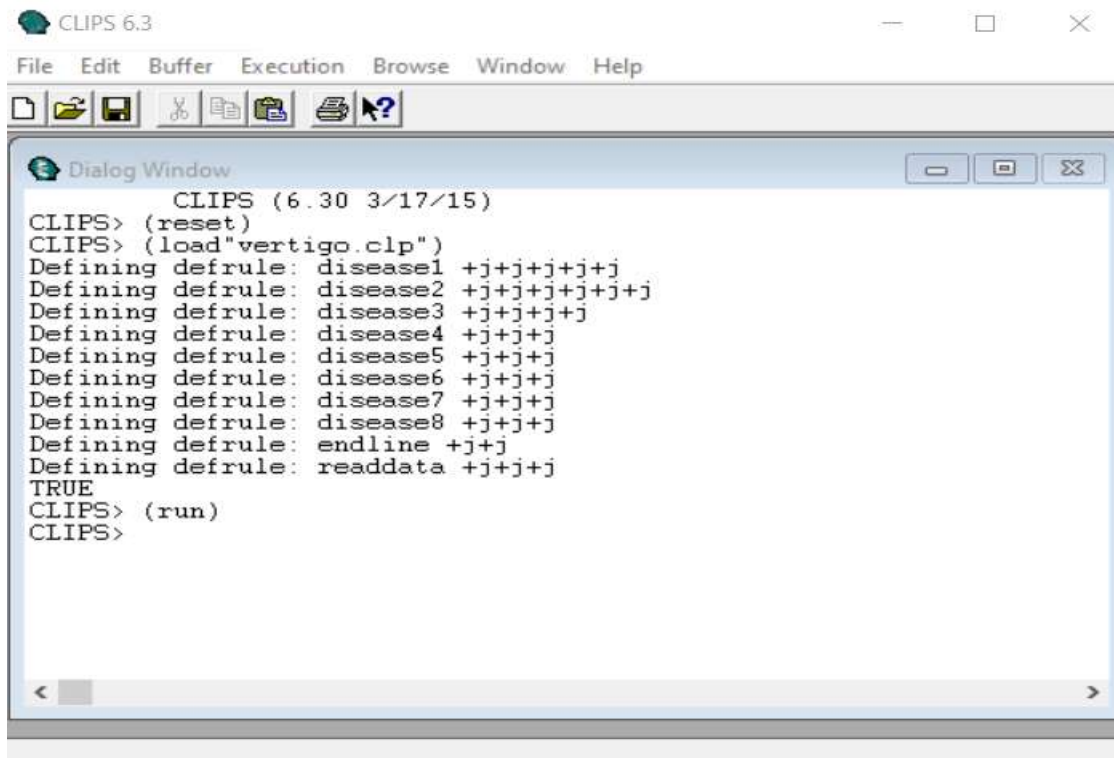

Figure 4: The figure displays the CLIPS window which contain the commands.

providing possible diagnoses based on the selected symptoms. The expert system will use its knowledge base and algorithms to analyze the symptoms and generate a potential diagnosis, as shown in Figure 5 and Figure 6.

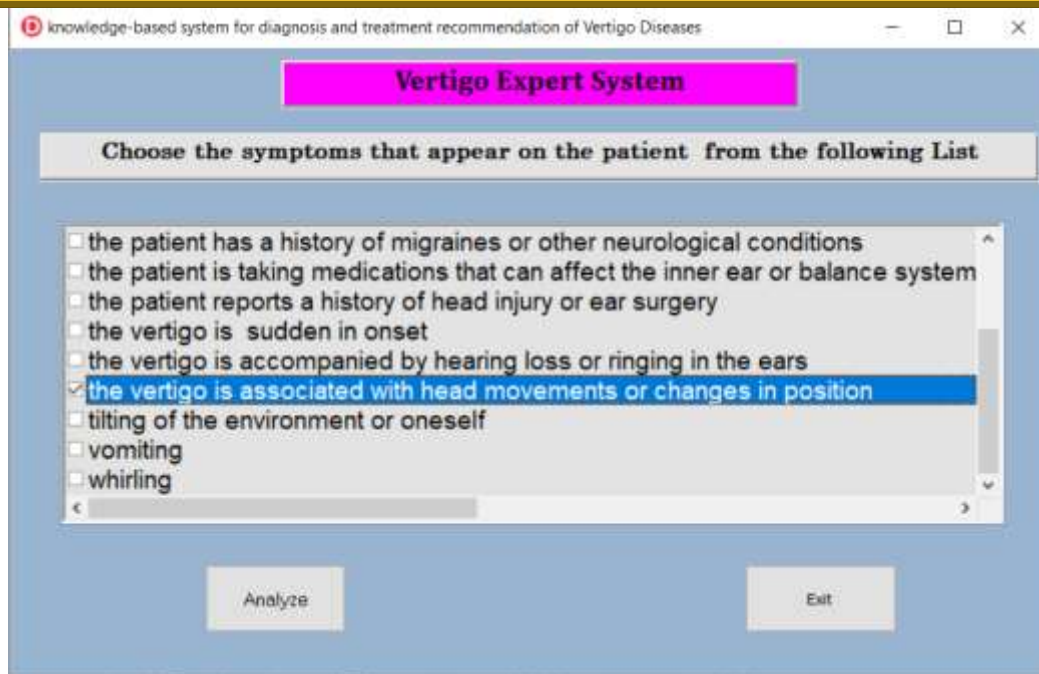**Figure 5:** The figure presents shows when the system asks the user.

Figure 6: The figure shows diagnosis and recommendation of the vertigo expert system.

V.   EXPERT SYSTEM SOURCE CODE

```
(defrule disease1
(sensation of spinning)
```

```
(whirling)
(tilting of the environment or oneself)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "1"  crlf )
)

(defrule disease2
(nausea)
(vomiting)
(sweating)
(difficulty standing or walking)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "2"  crlf )
)

(defrule disease3
(the vertigo is sudden in onset)
(the vertigo is accompanied by hearing loss or ringing in the ears)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "3"  crlf )
)

(defrule disease4
(the vertigo is associated with head movements or changes in position)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "4"  crlf )
)

(defrule disease5
(the patient reports a history of head injury or ear surgery)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "5"  crlf )
)

(defrule disease6
(the patient is taking medications that can affect the inner ear or balance system)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "6"  crlf )
)


(defrule disease7
(the patient has a history of migraines or other neurological conditions)
(not (disease identified))
=>
```

```
(assert (disease identified))
(printout fdatao "7"  crlf )
)

(defrule disease8
(imaging studies such as CT scan or MRI are performed to rule out other conditions such as brain tumors or stroke)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "8"  crlf )
)

(defrule endline
(disease identified)
=>
  (close fdatao)
)


(defrule readdata
  (declare (salience 1000))
  (initial-fact)
  ?fx <- (initial-fact)
=>
  (retract ?fx)
  (open "data.txt" fdata "r")
  (open "result.txt" fdatao "w")

  (bind ?symptom1 (readline fdata))
  (bind ?symptom2 (readline fdata))
  (bind ?symptom3 (readline fdata))
  (bind ?symptom4 (readline fdata))
  (bind ?symptom5 (readline fdata))
  (bind ?symptom6 (readline fdata))
  (bind ?symptom7 (readline fdata))
  (bind ?symptom8 (readline fdata))
  (bind ?symptom9 (readline fdata))
  (bind ?symptom10 (readline fdata))
 (bind ?symptom11 (readline fdata))
 (bind ?symptom12 (readline fdata))
 (bind ?symptom13 (readline fdata))
 (bind ?symptom14 (readline fdata))

 (assert-string (str-cat "(" ?symptom1 ")"))
 (assert-string (str-cat "(" ?symptom2 ")"))
 (assert-string (str-cat "(" ?symptom3 ")"))
 (assert-string (str-cat "(" ?symptom4 ")"))
 (assert-string (str-cat "(" ?symptom5 ")"))
 (assert-string (str-cat "(" ?symptom6 ")"))
 (assert-string (str-cat "(" ?symptom7 ")"))
 (assert-string (str-cat "(" ?symptom8 ")"))
(assert-string (str-cat "(" ?symptom9 ")"))
 (assert-string (str-cat "(" ?symptom10 ")"))
 (assert-string (str-cat "(" ?symptom11 ")"))
 (assert-string (str-cat "(" ?symptom12 ")"))
 (assert-string (str-cat "(" ?symptom13 ")"))
 (assert-string (str-cat "(" ?symptom14 ")"))
```

```
        (close fdata)
    )
```

VI.   LIMITATIONS

The proposed expert system is designed to provide accurate and precise diagnoses for these specific vertigo-related conditions. It is specifically focused on diagnosing eight types of vertigo diseases, which include vertigo, peripheral vertigo, inner ear disorders such as Meniere's disease or vestibular neuritis, benign paroxysmal positional vertigo (BPPV), central vertigo due to damage in the brainstem or cerebellum, medication-induced vertigo, central vertigo and vertigo as the primary diagnosis.

VII.   CONCLUSION

The development of an expert system for diagnosing vertigo diseases holds great promise in the field of medicine. The specialized system, designed to provide accurate and precise diagnoses for specific vertigo-related conditions, offers valuable support to healthcare professionals in effectively managing and treating patients with vertigo symptoms. With its ability to handle the complexity and uncertainty associated with vertigo diagnoses, the expert system has the potential to enhance the accuracy and efficiency of vertigo diagnosis, leading to improved patient care and outcomes. Further research and development in this area could contribute to advancements in vertigo diagnosis and treatment, benefiting both patients and healthcare practitioners alike.

VIII.   FUTURE WORK

The future development of the proposed expert system for diagnosing vertigo diseases could involve refining and expanding its capabilities to incorporate additional vertigo diseases or related conditions as new research and knowledge become available. This could include updating the system with the latest evidence-based guidelines, diagnostic criteria, and treatment recommendations to enhance its accuracy and relevance.

Furthermore, integrating the expert system into clinical practice and evaluating its feasibility, impact on clinical decision-making, patient outcomes, and healthcare resource utilization would be a crucial next step. This could involve conducting pilot studies or clinical trials in real-world settings to assess the effectiveness of the expert system in improving diagnostic accuracy and patient care outcomes. By evaluating the feasibility and impact of the expert system in clinical practice, valuable insights can be gained regarding its usability, acceptance, and potential barriers to implementation. This information can inform further refinements to optimize the system's performance and integration into routine clinical workflows. Additionally, ongoing updates and maintenance of the expert system would be necessary to ensure that it remains current with the latest research and clinical guidelines.

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