

An Expert System for Tooth problems

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Abstract— Everyone knows that straight teeth give you a beautiful smile. Did you know that straighter teeth can also affect your overall health? Left untreated crooked teeth can lead to periodontal disease and create abnormal amounts of stress on teeth and jaws which can lead to premature wear the effects of crooked teeth can worsen. Over time and may adversely affect your overall health common types of misalignment include crowding spacing deep bite. Open bite crossed might edge to edge bite and excessive overjet crooked teeth can affect your bite creating. Unnatural stress and pressure leading to premature wear teeth that are subject to excessive pressure can develop shipping and not just at the gumline. Over time the excessive force may also cause flattened or worn-down teeth or chipping. Fractures at the edges of teeth additionally a bad bite may produce improper forces on the jaw that may lead to pain in the jaw.

Keywords— Artificial Intelligence; Expert Systems; Tooth problems; crooked teeth

I. INTRODUCTION

Dental problems are never any fun, but the good news is that most of them can be easily prevented. Brushing twice a day, flossing daily, eating properly, and regular dental check-ups are essential steps in preventing dental problems. Headaches premature wear can lead to gum recession poor bone support at the roots blues teeth and eventually tooth loss teeth that fit together correctly last longer and are likely to need less costly dentistry in the future. Affect your periodontal health because it's difficult to remove plaque and bacteria from the crowded areas bacteria. That is not properly removed will multiply and trigger periodontal disease which begins as gum inflammation. Redness and bleeding while brushing and flossing if left untreated overtime gum information will progress to chronic infection soft tissue damage. Receding gums periodontal pockets bone loss and eventually. Tooth loss these conditions can lead to painful repair and maintenance in the future which could amount to thousands of dollars in expense and countless hours in the dentist's chair problems. In the oral cavity are best treated in the early stages crooked teeth that are left untreated contract bacteria that damage gum tissue cells and invade blood vessels. This can cause damage to cells that line your coronary arteries increasing your risk for heart disease stroke and other illness. Correctly positioning your teeth for proper alignment and function will help prevent future dental problems and make a significant difference toward a healthy mouth and keeping your teeth[1].



Fig. 1 Tooth problem

II. EXPERT SYSTEM

Expert system is a computer system that emulates the decision-making ability of a human expert[3-23]. Expert systems are designed to solve complex problems by reasoning through bodies of knowledge represented mainly as if-then rules the typical expert system consists of

1. Interface is the system that allows a non-expert user to query or question the expert system and to receive advice the user interface is designed to be a simple to use as possible on the other hand the inference engine may also include abilities for explanation so that it can explain to a user the chain of reasoning used to arrive at a particular conclusion by tracing back over the firing of rules that resulted.

2. Knowledge base: knowledge base, which is a collection of facts created from information provided by human experts. It is a database designed in a way to allow the storage and retrieval requirements of the expert systems next rules base. It is a set of rules for making deductions from the data this is made up of a series of inference rules represented mainly as if-then rules this inference rules which closely follow human reasoning are used by the inference engine to draw conclusions.

3. An inference engine which acts like the search engine that applies inference rules in examining the knowledge base for information that meshes the users query it attends to drive answers from the knowledgebase using a form of reasoning.

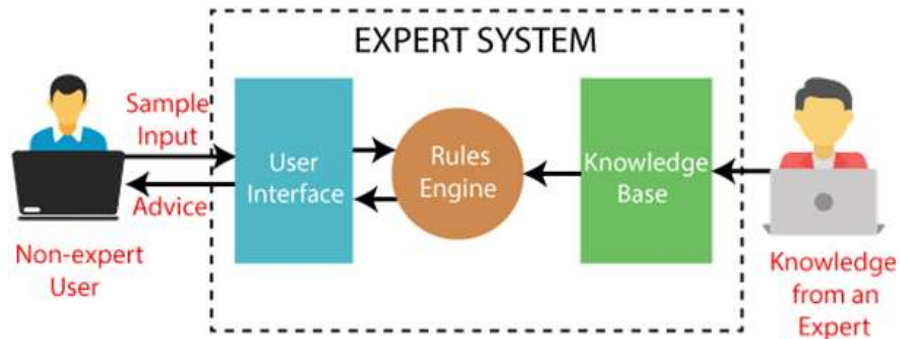


Fig. 2: Components of an expert system

The proposed Expert System for Tooth problems diagnosis was designed and implemented using, interface program, developed under Delphi, which communicate with CLIPS expert system language.

III. MATERIALS AND METHODS

The proposed expert system will ask the user to answer the questions about the symptoms of the patient and end up with the diagnosis; accordingly, the expert system shows the user some information about the disease and some recommendation telling the Patient how to deal with the Tooth. Figure 3 shows the decision tree of the expert system for diagnosing the ankle problems[2].

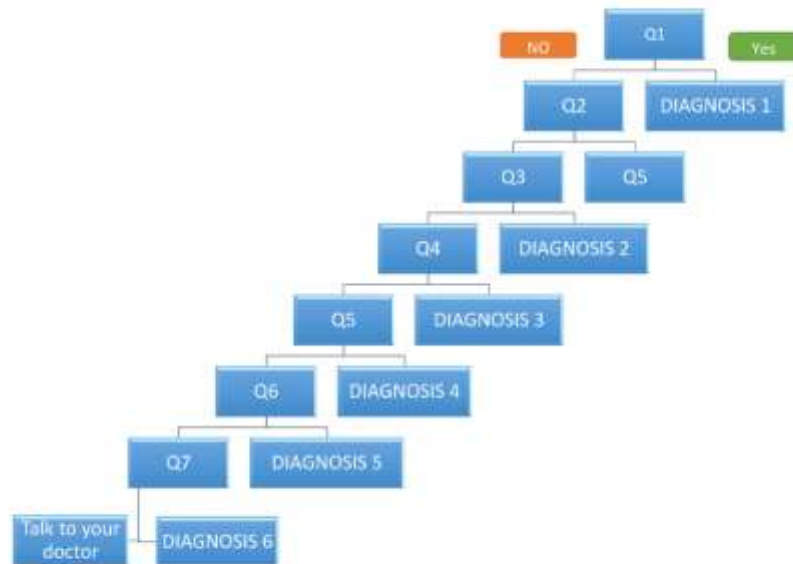


Fig. 3: Decision tree of the expert system.

Q1 Did you have an injury that knocked out a tooth?

Q2 Do you have pain that is specific to one tooth?

Q3 Have you broken or chipped a tooth, or is the tooth loose in its socket?

Q4 Do you feel pain when you eat cold foods or liquids?

Q5 Do you have redness or swelling around one or more teeth, in your gums or in your face?

Q6 Do you have redness and swelling in large areas of your gums, or is the skin inside your mouth peeling?

Q7 Do you have headaches, pain near your ear, or do you hear a cracking sound when you bite or chew?

DIAGNOSIS1

You have TOOTH LOSS

SELF CARE

DENTAL EMERGENCY

See your dentist or go to the emergency room right away. Keep the tooth moist. It's best to keep the tooth in your mouth until you get to the dentist or emergency room. The tooth may be saved"

DIAGNOSIS2

Your pain may be from a FRACTURED, CRACKED, or LOOSE TOOTH.

SELF CARE

Save any pieces of the tooth, wrap them in a cool, moist cloth or keep them in your mouth (without swallowing them) and see your dentist as soon as possible."

DIAGNOSIS3

Your pain may be from a CAVITY or SENSITIVE TEETH.

SELF CARE

Make an appointment to see your dentist. Proper brushing and flossing along with fluoride rinses and coatings, as suggested by your dentist, may prevent tooth decay."

DIAGNOSIS4

You may have a dental ABSCESS or an INFECTION in a tooth, gums or other tissues.

SELF CARE

URGENT

See your dentist or doctor right away."

DIAGNOSIS5

You may have an infection such as TRENCH MOUTH, GINGIVITIS, or PERIODONTITIS. A rare medication reaction, STEVENS-JOHNSON REACTION, may also cause this.

SELF CARE

See your dentist or doctor right away. You may be given antibiotics to stop the infection. Over-the-counter pain relievers, such as acetaminophen, may relieve discomfort. Many of these infections can be prevented with proper dental care, such as brushing and flossing regularly. Stop any new medications until you have seen your doctor."

DIAGNOSIS6

Your pain may be from TEMPOROMANDIBULAR JOINT (TMJ) SYNDROME, a condition that affects the jaw. This can also be worsened by grinding your teeth, which can occur while you are sleeping.

SELF CARE

Try relaxing your jaw when you are tense or nervous. Stop chewing gum. Try a mild anti-inflammatory medicine, such as ibuprofen. If you don't get better, see your dentist."

IV. BACKGROUND

TOOTH LOSS: all our teeth are held securely in the jawbone disease decay or trauma may lead to tooth loss if a lost tooth is not immediately replaced the surrounding bone begins to collapse and shrink. With no adjacent support the neighboring teeth begin to drift toward the area of the missing tooth the amount of bone loss and the pattern of drifting will vary depending. on the individual and the location of tooth loss the drifting of one tooth may lead to the drifting of several teeth resulting in a significant amount of

movement periodontal disease. May begin to form after your teeth have drifted and erupted because it becomes difficult to properly clean your gums and reach all the pockets in those areas this may lead to tooth decay receding gums and further tooth loss[1,2].



Fig. 4: Tooth Loss

FRACTURED, CRACKED, or LOOSE TOOTH: sometimes teeth can develop cracks and when not treated this can have serious consequences for your oral health cracks can come from injury or large fillings that weaken the rest of the tooth even small cracks can allow bacteria into the tooth causing decay or infection leading to further destruction a cracked tooth may or may not be sensitive to hot and cold or be painful when biting or chewing cracks that progress too far can result in entire sections of the tooth breaking off and in some cases loss of the tooth entirely[1,2].



Fig. 5: Fractured, Cracked, Or Loose Tooth

CAVITY or SENSITIVE TEETH: sensitivity of teeth is mind-boggling aspect, and we find more and more at materials and advertisements coming about sensitivity. People randomly using desensitizing pastes and desensitizing mouth rinses. The cause of sensitivity in most cases sensitivity is caused because of loss of enamel on top of the teeth which exposes the next layer of the tooth which is the nerve, and this results in sensitivity because when you eat something cold or art the nerve. First diagnose and understand why you have loss of an apple one of the most common causes is clenching or grinding of the teeth which wears off an apple. Second is excessive brushing or very hard toothbrushing. It is advised that using a soft toothbrush don't use medium or hard everybody needs to brush with a soft toothbrush. Third cost could be the fact that you're having a lot of aerated drinks sodas and colas and these are not good for the teeth they wear off your enamel these are the main causes of sensitivity rather than self-medicating[1,2].



Fig. 6: Cavity or Sensitive Teeth

ABSCESS or an INFECTION: the localized collection of pus that can form in different parts of a tooth as a result of infection an abscessed tooth is accompanied by moderate to severe pain. That can sometimes radiate to the ear or neck anyone can get an abscess tooth it can also be called dental abscess, abscess or dental abscess. There are different types of abscessed tooth depending on the location the main types are peri apical abscess, which is located at the tip or apex or root of a tooth. It is the most common type of abscess tooth periodontal abscess is located in the gum next to a tooth root. This type of abscess may also spread to the surrounding tissue and bone. It is the second most common type gingival abscess is located on the gum without affecting either the tooth or the periodontal ligaments para coronal abscess is located in a soft tissue surrounding the crown of the tooth if left untreated an abscessed tooth may get serious and result in life-threatening conditions such as sepsis. The infection may spread to the jaw and to other parts of the head and neck causes. The tooth is hard on the outside, but the innermost part of the tooth is filled with a pulp that contains blood vessels nerves and connective tissues an abscessed tooth is formed when bacteria enters. The teeth or gum bacteria can enter a deep dental cavity or tooth decay or a crack in the tooth and spread all the way to the root. This can result in swelling and inflammation at the tip of the root certain factors that may increase your risk of a tooth abscess include poor dental hygiene a diet high in sugar symptoms severe sharp or shooting pain near a tooth or in the gum pain when chewing or biting on the side of the affected tooth when touching the affected tooth or when putting pressure or warmth on it [1,2].



Fig. 7: Abscess Or An Infection

TRENCH MOUTH, GINGIVITIS, or PERIODONTITIS: With gingivitis, gingiva refers to the gums, and -itis refers to inflammation, so gingivitis is inflammation of the gums. With periodontitis, peri- means around, and odon-, refers to the tooth, so it's inflammation and destruction of the supporting structures around the teeth. Broadly speaking, the two are on a spectrum starting with simple gingivitis on one end, and if the process doesn't get treated, it can develop into more severe disease - periodontitis, which is on the other end of the spectrum. Let's start by building a model of a tooth and its surrounding structures. In the mouth, the bone beneath the bottom row of teeth is the mandible, and the bone above the top row of teeth is the maxilla. Both bones have an alveolus, or socket, for each tooth. The socket is lined on the inside by a periodontal ligament. Protecting the alveolus on the outside, is a layer of soft, supportive tissue called the gingiva, or gums, that sits on top of the bone. The tooth itself can be roughly divided into two parts. The first part is the root, and it sits within the alveolus. The root is covered by a bonelike substance called cementum, and that's what the periodontal ligament's fibers attach to. Next, there's a short zone called the neck, which is the transition between the root and the crown. The crown is the visible part of the tooth that protrudes from the gingiva, and it's covered in enamel. Enamel has such a high mineral content that it's the hardest substance in the human body. The portion

of gingiva that sticks up and is not anchored to the tooth is sometimes called the free gingiva, and the space between the free gingiva and the crown is called the gingival crevice or gingival sulcus[1,2].



Fig. 8: Trench Mouth, Gingivitis, or Periodontitis

TEMPOROMANDIBULAR JOINT (TMJ) SYNDROME: The temporomandibular joint -- the TMJ - is the joint between the lower jawbone - the mandible - and the temporal bone of the skull. The TMJ is responsible for jaw movement and is the most used joint in the body. The TMJ is essentially the articulation between the condyle of the mandible and the mandibular fossa - a socket in the temporal bone. The unique feature of the TMJ is the articular disc - a flexible and elastic cartilage that serves as a cushion between the two bone surfaces. The disc lacks nerve endings and blood vessels in its center and therefore is insensitive to pain. Anteriorly it attaches to lateral pterygoid muscle - a muscle of chewing. Posteriorly it continues as retrodiscal tissue fully supplied with blood vessels and nerves. The mandible is the only bone that moves when the mouth opens. The first 20 mm opening involves only a rotational movement of the condyle within the socket. For the mouth to open wider, the condyle and the disc have to move out of the socket, forward and down the articular eminence, a convex bone surface located anteriorly to the socket . This movement is called translation. The most common disorder of the TMJ is disc displacement, and in most of the cases, the disc is dislocated anteriorly. As the disc moves forward, the retrodiscal tissue is pulled in between the two bones. This can be very painful as this tissue is fully vascular and innervated, unlike the disc. The forward dislocated disc forms an obstacle for the condyle movement when the mouth is opening. In order to fully open the jaw, the condyle has to jump over the back end of the disc and onto its center. This produces a clicking or popping sound. Upon closing, the condyle slides back out of the disc hence another "click" or "pop". This condition is called disc displacement with reduction . In later stage of disc dislocation, the condyle stays behind the disc all the time, unable to get back onto the disc, the clicking sound disappeared but mouth opening is limited. This is usually the most symptomatic stage - the jaw is said to be "locked" as it is unable to open wide. At this stage the condition is called disc displacement without reduction Fortunately, in majority of the cases, the condition resolves by itself after some time. This is thanks to a process called natural adaptation of the retrodiscal tissue, which after a while becomes scar tissue and can functionally replace the disc. In fact, it becomes so similar to the disc that it is called a pseudodisc[1,2].

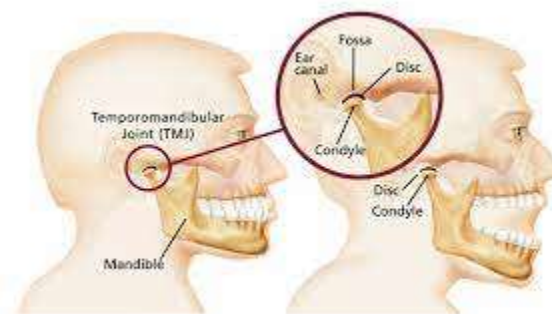


Fig. 9: Temporomandibular Joint (Tmj) Syndrome

V. CONCLUSION

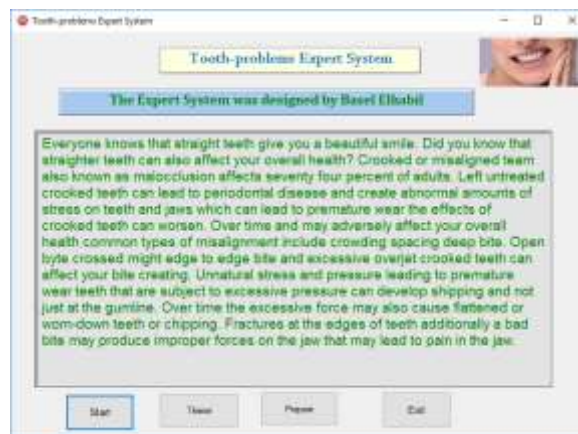
In this paper, a proposed expert system was designed and developed using use interface written in Delphi language and CLIPS expert systems language in order to help physicians and parents in diagnosing the tooth problems in an easier and more precise way than before. This expert system is simple, fast and easy to use.

VI. FUTURE WORK

The expert systems will be used with electronic medical record systems and this allows for automated updates to be made to the patient's files, so that it's very clear and smooth about what the patient is there for and what their patient history has been without all the paperwork that will be required to go through. If it wasn't all an electron medical record system and this way the system can send out warnings on a patient and this would be based on the patient's past treatment medical history. This is basically all to try to keep the patient as safe as you can possibly keep them why should medical expert systems be you and this is because they have been proven to increase the quality of care delivered by medical personnel.

VII. EXPERT SYSTEM INTERFACE

Figure 10, shows a few screen shots about the execution of the Tooth diagnosing expert system. The first one contains some information about the purpose of the expert system. The second one contains how could a user interact with expert system by choosing an answer for the questions asked. The last one contains the conclusion showing windows for the title of the expert system, window for the diagnosed problem, and a window for the advice to the user telling him/her how to treat a problem.



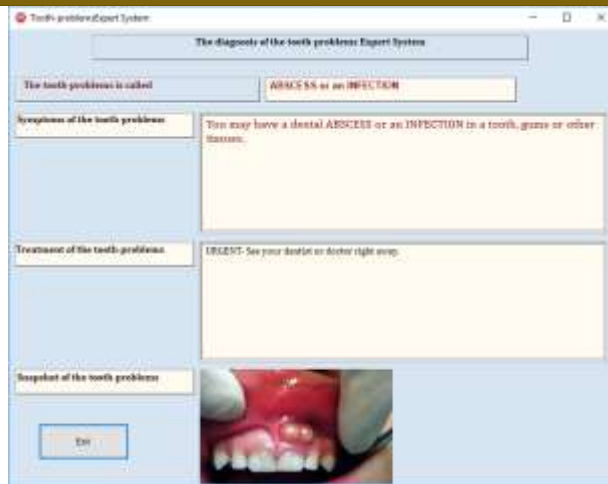


Fig. 10 some screen shots between the expert system and the end user

VIII. EXPERT SYSTEM SOURCE CODE:

```
(defrule disease1
(Q1. Did you have an injury that knocked out a tooth?)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "1" crlf )
)

(defrule disease2
(Q3. Have you broken or chipped a tooth, or is the tooth loose in its socket?)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "2" crlf )
)

(defrule disease3
(Q2. Do you have pain that is specific to one tooth?)
(Q4. Do you feel pain when you eat cold foods or liquids?)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "3" crlf )
)

(defrule disease4
(Q2. Do you have pain that is specific to one tooth?)
(Q5. Do you have redness or swelling around one or more teeth, in your gums or in your face?)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "4" crlf )
)

(defrule disease5
(Q2. Do you have pain that is specific to one tooth?)
(Q6. Do you have redness and swelling in large areas of your gums, or is the skin inside your mouth peeling?)
(not (disease identified))
=>
(assert (disease identified))
```



```
(printout fdatao "5" crlf )
)
(defrule disease6
(Q2. Do you have pain that is specific to one tooth?)
(Q7. Do you have headaches, pain near your ear, or do you hear a cracking sound when you bite or chew?)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "6" crlf )
)
(defrule endline
(disease identified)
=>
(close fdatao)
)

(defrule readdata
(declare (saliency 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)
)
```

REFERENCES

1. <http://www.mayoclinic.org/>. Date visited 1-3-2021.
2. <http://familydoctor.org/familydoctor/en/health-tools/search-by-symptom/mouth-problems-infants-children.html>, Date visited 1-3-2021.
3. Abu Ghali, M. J., et al. (2017). "Expert System for Problems of Teeth and Gums." *International Journal of Engineering and Information Systems (IJEAIS)* 1(4): 198-206.
4. Al Rekhawi, H. A., et al. (2017). "Rickets Expert System Diagnoses and Treatment." *International Journal of Engineering and Information Systems (IJEAIS)* 1(4): 149-159.
5. Alamawi, W. W., et al. (2016). "Rule based System for Diagnosing Wireless Connection Problems Using SL5 Object." *International Journal of Information Technology and Electrical Engineering* 5(6): 26-33.
6. Al-Dahdooh, R., et al. (2010). "Knowledge management in ESMDA: Expert System for medical diagnostic assistance." *Artificial Intelligence and Machine Learning Journal* 10(1): 31-40.
7. Al-Qumboz, M. N. A., et al. (2019). "Kidney Expert System Diseases and Symptoms." *International Journal of Academic Engineering Research (IJAER)* 3(5): 1-10.
8. Alshawwa, I. A., et al. (2019). "An Expert System for Coconut Diseases Diagnosis." *International Journal of Academic Engineering Research (IJAER)* 3(4): 8-13.
9. Alshawwa, I. A., et al. (2019). "An Expert System for Depression Diagnosis." *International Journal of Academic Health and Medical Research (IAHMR)* 3(4): 20-27.
10. Azaab, S., et al. (2000). "A proposed Expert System for selecting exploratory factor analysis procedures." *Journal of the College of Education* 4(2): 9-26.
11. Baraka, M. H., et al. (2008). "A Proposed Expert System For Guiding Freshman Students In Selecting A Major In Al-Azhar University, Gaza." *Journal of Theoretical & Applied Information Technology* 4(9).
12. Dheir, I. M., et al. (2019). "Knowledge based System for Diabetes Diagnosis Using SL5 Object." *International Journal of Academic Pedagogical Research (IJAPR)* 3(4): 1-10.
13. El Agha, M., et al. (2017). "Polymyalgia Rheumatic Expert System." *International Journal of Engineering and Information Systems (IJEAIS)* 1(4): 125-137.
14. El Kahlout, M. I., et al. (2019). "Silicosis Expert System Diagnosis and Treatment." *International Journal of Academic Information Systems Research (IJAISR)* 3(5): 1-8.
15. El-Hissi, H., et al. (2010). "An Expert System for endocrine diagnosis and treatments using JESS." *Journal of Artificial Intelligence; Scialert* 3(4): 239-251.
16. El-Mashharawi, H. Q., et al. (2019). "An Expert System for Arthritis Diseases Diagnosis Using SL5 Object." *International Journal of Academic Health and Medical Research (IAHMR)* 3(4): 28-35.
17. Elsharif, A. A., et al. (2019). "Hepatitis Expert System Diagnosis Using SL5 Object." *International Journal of Academic Information Systems Research (IJAISR)* 3(4): 10-18.
18. Kashkash, K. A., et al. (2010). "Developing an Expert System for plant disease diagnosis." *Journal of Artificial Intelligence ; Scialert* 3(4): 269-276.
19. Khalil, A. J., et al. (2019). "Apple Trees Knowledge based System." *International Journal of Academic Engineering Research (IJAER)* 3(9): 1-7.
20. Masri, N., et al. (2019). "Survey of Rule-Based Systems." *International Journal of Academic Information Systems Research (IJAISR)* 3(7): 1-23.
21. Mettleq, A. S. A., et al. (2019). "Expert System for the Diagnosis of Seventh Nerve Inflammation (Bell's palsy) Disease." *International Journal of Academic Information Systems Research (IJAISR)* 3(4): 27-35.
22. Mrouf, A., et al. (2017). "Knowledge based System for Long-term Abdominal Pain (Stomach Pain) Diagnosis and Treatment." *International Journal of Engineering and Information Systems (IJEAIS)* 1(4): 71-88.
23. Nabahin, A., et al. (2017). "Expert System for Hair Loss Diagnosis and Treatment." *International Journal of Engineering and Information Systems (IJEAIS)* 1(4): 160-169.