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A proposed expert system for diagnosing skin cancer

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Abstract
Skin is considered the largest organ of the body, with a total area of about 20 square feet. The skin protects us from microbes and the elements, helps regulate body temperature, and permits the sensations of touch, heat, and cold. For a patient to recover from any illness or weakness that affects the skin, he/she requires an accurate diagnosis of his/her the situation. In this paper will present an expert system that quickly diagnosis patient's condition and propose a suitable solution for the problem. This expert system is designed and implemented in SL5 Object language. This expert system was tested by a group of physician and found to be a useful tool that aids physicians and patients suffering from skin cancer diseases.

Keywords: expert systems, SL5 object, skin cancer disease, diagnosis

1. Introduction
Cancer occurs when normal cells undergo a transformation and grow and multiply without normal controls, as the cells multiply, they form a mass called a tumor. Tumor's are cancerous only if they are malignant, This means that they encroach on and invade neighboring tissues (especially lymph nodes) because of their uncontrolled growth.Tumours may also travel to remote organs via the bloodstream. This process of invading and spreading to other organs is called metastasis. Tumor's overwhelm surrounding tissues by invading their space and taking the oxygen and nutrients they need to survive [1].
Skin cancer is the most common form of cancer in the United States. The two most common types of skin cancer—basal cell and squamous cell carcinomas—are highly curable, but can be disfiguring and costly to treat. Melanoma, the third most common skin cancer, is more dangerous and causes the most deaths. The majority of these three types of skin cancer are caused by overexposure to ultraviolet (UV) light [2].

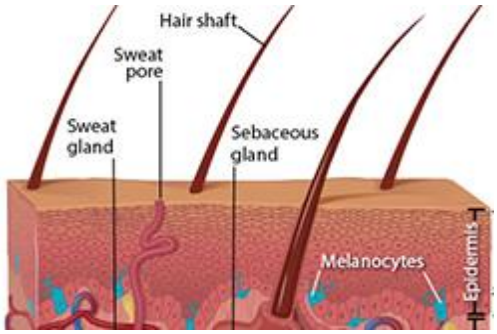

Fig 1: skin cancer

Anyone can get skin cancer, but people with certain characteristics are at greater Risk:
- A lighter natural skin color.
- Skin that burns, freckles, reddens easily, or becomes painful in the sun.
- Blue or green eyes.
- Blond or red hair.
- Certain types and a large number of moles.
- A family history of skin cancer.
- A personal history of skin cancer.

Diagnosis of skin cancer diseases a very important. So they need skin physician with wide experience of skin cancer diseases. For all the aforementioned reasons, we have developed this expert system to help skin physician in diagnosing many of the skin cancer diseases, in order to prescribe the appropriate treatment.
Expert System is a computer application of Artificial Intelligence (AI) [3, 5, 7]; which contains a knowledge base and an inference engine [4]; the main components and details are represented in figure 2.
The proposed Expert System for skin Diseases Diagnosis was implemented using, SL5 Object language which stands for Simpler Level 5 Object [3]. It is a forward chinning reasoning expert system that can make inferences about facts of the world using rules, objects and take appropriate actions as a result. The SL5 Object engine is implemented in Delphi Embarcadero RAD Studio XE6 [9]. SL5 Object executes any Expert System looks like frames. It's easy for the knowledge engineer to build the Expert System and for the end users when they use the system.

2. Expert system
Expert Systems is a branch of the strongest branches of artificial intelligence, which turned to be the most important branch of computer science. Software based on tradition of a human expert behavior in a particular field, by extracting, compiling, analyzing and re-using of information and experience of the human expert in the field and annexed in a system called expert system. So that these systems can address the problems in this area, rather than the people with the expertise and assistance in the transfer of these experiences to other people [10-12].
This smart program takes the rules learned from human experience and use them in the form of the "IF conditions Then results" methods of derivation and reasoning to extract and conclude results, and the resulting match of these conditions with the condition or the facts of what is specific

to the problem, which is intended to find a solution [13-15].
The design of expert systems vary depending on programmers based design, according to the purpose of its creation, however, there are broad lines of the existing terms of components systems agree that the expert system consists of three main parts namely [16-18]:

- **Knowledge Base:** Where the reasoning property alone is not enough to give the computer recipe of intelligence, man Intelligence is capable of reasoning and deducting of his extensive background information, so was the knowledge base is an important part of the expert system, and knowledge can be represented in expert systems in different ways but the most common one is production rules. Here we must not confuse the data and rules of knowledge in an expert system, as the first step is to retrieve stored information while the expert system is thinking and second to use the laws of logic to reach the final results [19-23].
- **Inference Engine:** Inference Engine machine determines when and how to use the facts or rules in the knowledge base. It specifies which rule will be fired and determines whether the solution of the problem is reached or not. It can use knowledge bases of different expert systems [20-22].
- **User Interface:** Through user interface, end user can communicate with the expert system, and enables the user to answer questions and inquiries about the problem easily. Thus the expert system provides solutions and recommendations to the user in a clear and complete way [23-26].

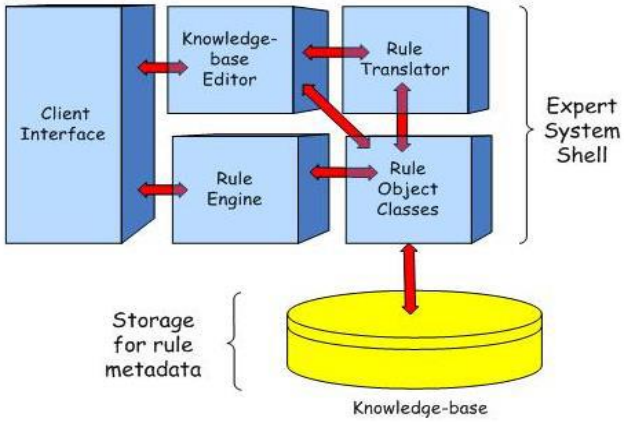

Fig 2: Expert system architecture

To create an expert system: Three important things must be provided [27-30]:

- The Knowledge Engineer who analyzes the problem and write the expert system.
- A human expert who is a specialist in a particular area.
- An expert system language this is suitable for encoding the knowledge collected from the human expert.

Some of the advantages of expert systems are: give steady answers for repetitive decisions, processes and tasks, grasp and keep significant level of knowledge, Ease of use, always remember to ask a question, as a human might not, can work all the time without getting tired, can be used by the user any time [31-35].

3. Materials and methods

The proposed expert system performs diagnosis skin cancer of all stages of the human life starting with newborn to the elderly by asking yes or no questions. The proposed expert system will ask the user to choose the correct answer in each screen. At the end of the dialogue session, the proposed expert system provides the diagnosis and recommendation of the disease to the user. Figure 2 shows a sample dialogue between the expert system and the user. Figure 3 shows how the users get the diagnosis and recommendation.
Figure 3 show the opening screen of the expert system, Figure 5. Shows a sample of questions asked by the expert system, and Figure 6 shows the diagnosis of the skin cancer problem and the recommendation of how to deal with the problem.

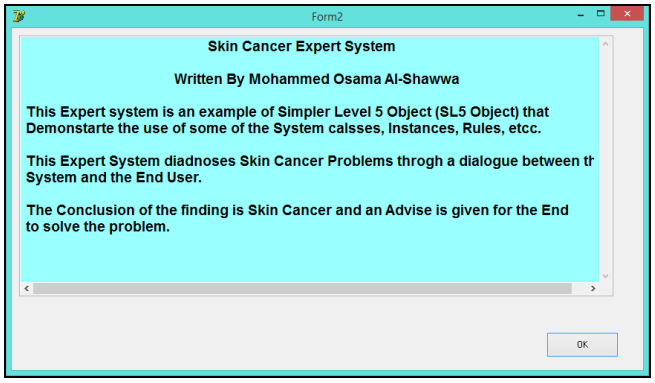

Fig 3: Opening screen of the expert System

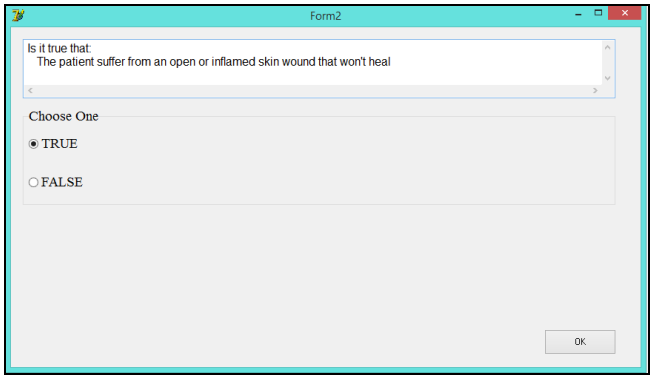

Fig 4: One type of question Asked by the expert System

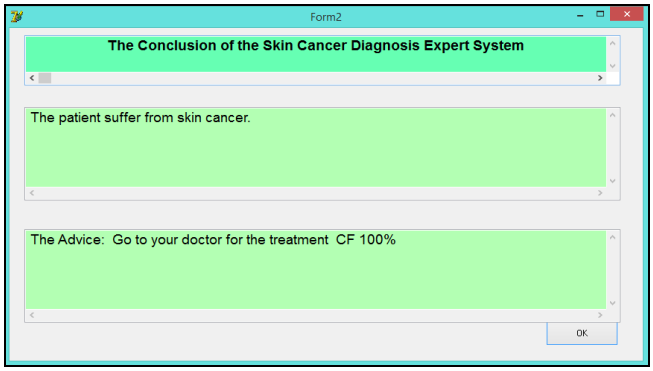

Fig 4: The Conclusion of the expert system

4. Literature review

Here is a summary of expert systems found in the literature:

- A Ruled Based System for Ear Problem Diagnosis and

Treatment [47] was used to classify ear problems into three main sets: a- Inflammation of the inner ear b- Middle ear problems c- External ear problems.

- Lower Back Pain Expert System Diagnosis and Treatment [40] can be used to positively diagnose low back pain concentration.
- A Proposed Expert System for Foot Diseases Diagnosis [59] diagnoses eighteen foot problems of all phases of the human life beginning with baby to the grownup by examining with yes/no questions.
- A Knowledge Based System for Neck Pain Diagnosis [45] can diagnose seven neck diseases of different phases of the human life beginning by asking the user many questions according to their pain symptoms.
- An expert system for shoulder problems using CLIPS [57] can help in diagnosing shoulder problems.
- Expert system urination problems diagnosis [61] can diagnose some of the Urination diseases (Pyelonephritis, Kidney Stone, Bladder infection, Prostatitis, Urethritis, Gonorrhea, Interstitial cystitis, Stress incontinence, Trauma in kidney or bladder).
- A Proposed Rule Based System for Breasts Cancer Diagnosis [49] was developed to help people in preventing and early detecting breast cancer; since it is known that this disease does not have medication or cure yet.
- An Expert System for Endocrine Diagnosis and treatments using JESS [65] was developed to help in diagnosing endocrine glands diseases.
- A Proposed Expert System for Skin Diseases Diagnosis [63] was developed using CLIPS(C Language Integrated Production System) to help user diagnose the following skin diseases (Psoriasis, Eczema, Ichthyosis, Acne, Meningitis, Measles, Scarlet Fever, Warts, Insect Bites and Stings).
- Male Infertility Expert System Diagnoses and Treatment [42] for male infertility diagnosis which helps men to explore everything related to the problems of infertility and infertility diseases such as: Azoospermia, O.T.A syndrome which mean oligo-terato-astheno spermia, Aspermia and Sexual transmitted disease.
- An expert system for diagnosing eye diseases using clips [33] provides the patient with background for suitable diagnosis of a few of the eye diseases.
- An Expert System for Mouth Problems in Infants and Children [45] ask the user to answer the questions about the symptoms of the patient and end up with some information about the disease and some advices telling the user how to deal with the baby.
- Knowledge Management in ESMDA: Expert System for Medical Diagnostic Assistance [36] deals with the design of a prototype expert system that assists patients to diagnose their diseases and offer them the suitable advice.
- Knowledge Based System for Long-term Abdominal Pain (Stomach Pain) Diagnosis and Treatment [56] was made to aid internist physicians in diagnosing numerous of the abdomen diseases for example: gastritis, hiatal hernia, ulcer or heartburn; the proposed expert system offers a summary about abdomen diseases are given, the cause of diseases are drew and the cure of disease when possible is shown up.
- Knowledge Based System for Ankle Diseases Diagnosis [43] recognized seven ankle diseases: Ankle Sprain, Fracture (of Fibula), Rheumatoid Arthritis, Rheumatoid Fever, Gout, and Osteoarthritis (Degenerative Joint) and they developed the expert system for those ankle diseases using SL5 Object Expert System Language.
- An Expert System for Diagnosing Shortness of Breath in Infants and Children [34] for diagnosing infants and children patients with twelve various shortness of breath in infants and children diseases.
- Polymyalgia Rheumatic Expert System [64] outlined an expert system for classification criteria for PMR, recent advances of diagnostic and therapeutic procedures.
- Expert System for Chest Pain in Infants and Children [50] to assist doctors, parents, and care giver in diagnosing chest pain in infants and children.
- Rickets Expert System Diagnoses and Treatment [39] assist doctors to discover everything connected to the problems of rickets.
- Expert System for Hair Loss Diagnosis and Treatment [62] for diagnosing eleven diverse hair loss diseases of the human stages from childhood to adults by asking questions with a Yes or No answer.
- Expert System for Problems of Teeth and Gums [37] assist people with teeth and gums problems to diagnose their problems and receive a recommendation for the treatment. This knowledge based system was developed using SL5 Object language.
- Ear Diseases Diagnosis Expert System Using SL5 Object [31] swiftly diagnoses patient's condition and proposes a appropriate answer for the problem.
- An expert system for feeding problems in infants and children [35] to diagnose feeding problems in infants and children.
- Detecting Health Problems Related to Addiction of Video Game Playing Using an Expert System [38] to assist users in getting the correct diagnosis of the health problem of video game addictions that range from (Musculoskeletal issues, Vision problems and Obesity). Furthermore, this expert system delivers information about the problem and tells us how we can solve it.
- An expert system for men genital problems diagnosis and treatment [44] to assist men diagnose their genital problems and give them the suitable treatment. Genital problems and injuries usually occur through: recreational activities (such as: Basketball, Football, Hooky, Biking), work-related tasks (such as: contact to irritating chemicals), downhill drop, and sexual activities. SL5 Object expert system language was used to develop this expert system.
- An Expert System for Genital Problems in Infants [51] diagnoses genital problems in infants which is one of the most common problems that need quick intervention in the newly born stage.
- An expert system for nausea and vomiting problems in infants and children [53] to aid users in getting the right diagnosis of problems of nausea and vomiting in infants and children (Gastro-esophageal reflux, Gastroenteritis, Systemic Infection, Bowel obstruction, Tumors, A bleeding disease, tonsillitis, and Hepatitis pharynx). Additionally, this expert system offers information about the disease and how to deal with it.

Even though, there are many expert systems that are developed for diagnosing human problems; there is no specialized expert system for diagnosing Skin Cancer

diseases available free. The proposed expert system was designed and developed specifically to aid doctors in diagnosing Skin Cancer diseases.

5. Knowledge representation

We used the SL5 Object syntax (Rules, facts rules and objects) for representing the collected knowledge of skin cancer diseases.

Here is an example of the representing knowledge:

RULE R5

IF The patient suffer from any change in size or color or shape or texture of a mole or other skin growth
AND The patient suffer from an open or inflamed skin wound that won't heal
AND The patient suffer from a change in an existing mole
AND The patient suffer from a small dark multi coloured spot with irregular borders either elevated or flat that may bleed and form a scab
THEN ASK The patient suffer from a cluster of shiny firm dark bumps

6. System evaluation

As a preliminary evolution, Medical students tested this proposed Expert System and they were satisfied with its performance, efficiency, user interface and ease of use.

7. Conclusion

In this paper, a proposed expert system was presented for helping doctor in diagnosing patient's skin cancer diseases. Podiatric skin cancer diseases patients can get the diagnosis faster and more accurate than the traditional diagnosis. This expert system does not need intensive training to be used; it is easy to use and has user friendly interface. It was developed using SL5 Object Expert System language.

8. Expert system source code

```
! Written Mohammed Osama Al-Shawwa
!
ATTRIBUTE start SIMPLE

ATTRIBUTE The patient suffer from any change in size or color or shape or texture of a mole or other skin growth SIMPLE

ATTRIBUTE The patient suffer from an open or inflamed skin wound that won't heal SIMPLE

ATTRIBUTE The patient suffer from a change in an existing mole SIMPLE

ATTRIBUTE The patient suffer from a small dark multi coloured spot with irregular borders either elevated or flat that may bleed and form a scab SIMPLE

ATTRIBUTE The patient suffer from a cluster of shiny firm dark bumps SIMPLE

ATTRIBUTE The patient suffer from a mole larger than a pencil eraser SIMPLE

INSTANCE the domain ISA domain
WITH start: = TRUE

INSTANCE the application ISA application
 WITH title display: = introduction
 WITH conclusion display: = Conc

INSTANCE introduction ISA display
 WITH wait: = TRUE
 WITH delay changes: = FALSE
 WITH items [1]: = textbox 1

INSTANCE textbox 1 ISA textbox
 WITH location: = 10,10,800,350
 WITH pen color: = 0,0,0
 WITH fill color: = 153,255,255
 WITH justify IS left
 WITH font: = "Arial"
 WITH font style IS bold
 WITH font size: = 14
 WITH text "=

                Skin Cancer Expert System

            Written By Mohammed Osama Al-Shawwa

This Expert system is uses Simpler Level 5 Object (SL5 Object) that
Demonstrate the use of some of the System classes, Instances, Rules, etc.

This Expert System diagnoses Skin Cancer Problems through a dialogue between the
System and the End User.

The Conclusion of the finding is Skin Cancer and an Advise is given for the End User
to solve the problem ".

INSTANCE Conc ISA display
 WITH wait: = TRUE
 WITH delay changes: = FALSE
 WITH items [1]: = title textbox
 WITH items [2]: = problem textbox
 WITH items [3]: = advise textbox

INSTANCE title textbox ISA textbox
 WITH location: = 20,10,800,70
 WITH pen color: = 0,0,0
 WITH fill color: = 102,255,179
 WITH justify IS center
 WITH font: = "Arial"
 WITH font style IS bold
 WITH font size: = 14
 WITH text: = " The Conclusion of the Skin Cancer Diagnosis Expert System"

INSTANCE problem textbox ISA textbox
 WITH location: = 20,110,800,130
 WITH pen color: = 0,0,0
 WITH fill color: = 179,255,179
 WITH justify IS left
 WITH font: = "Arial"
 WITH font size: = 14
 WITH text "--===-- "=
```

INSTANCE advise textbox ISA textbox
WITH location: = 20,280,800,130
WITH pen color: = 0,0,0
WITH fill color: = 179,255,179
WITH justify IS left
WITH font: = "Arial ″
WITH font size: = 14
WITH text ″--===-- ″=

RULE R1
if start Then Ask The patient suffer from any change in size or color or shape or texture of a mole or other skin growth

Rule R2
If the patient suffer from any change in size or color or shape or texture of a mole or other skin growththen ask the patient suffer from an open or inflamed skin wound that won't heal

RULE R3
If the patient suffer from any change in size or color or shape or texture of a mole or other skin growth and The patient suffer from an open or inflamed skin wound that won't heal then ask The patient suffer from a change in an existing mole

RULE R4
If the patient suffer from any change in size or color or shape or texture of a mole or other skin growth and the patient suffer from an open or inflamed skin wound that won't heal and the patient suffer from a change in an existing mole then ask the patient suffer from a small dark multi coloured spot with irregular borders either elevated or flat that may bleed and form a scab

Rule R5
If the patient suffer from any change in size or color or shape or texture of a mole or other skin growth and The patient suffer from an open or inflamed skin wound that won't heal And The patient suffer from a change in an existing mole and The patient suffer from a small dark multi coloured spot with irregular borders either elevated or flat that may bleed and form a scab then ask The patient suffer from a cluster of shiny firm dark bumps

RULE R6
If The patient suffer from any change in size or color or shape or texture of a mole or other skin growth and the patient suffer from an open or inflamed skin wound that won't heal and The patient suffer from a change in an existing mole and The patient suffer from a small dark multi coloured spot with irregular borders either elevated or flat that may bleed and form a scab and The patient suffer from a cluster of shiny firm dark bumps then ask The patient suffer from a mole larger than a pencil eraser

RULE R7
If The patient suffer from any change in size or color or shape or texture of a mole or other skin growth and The patient suffer from an open or inflamed skin wound that won't heal and The patient suffer from a change in an existing mole and The patient suffer from a small dark multi coloured spot with irregular borders either elevated or flat that may bleed and form a scab and The patient suffer from a cluster of shiny firm dark bumps and The patient suffer from a mole larger than a pencil eraser
Then text OF problem textbox: = "The patient suffer from skin cancer ″.
AND text OF advise textbox: = "The Advice: Go to your doctor for the treatment CF 100% ″
ELSE text OF problem textbox: = "The patient does not suffer from skin cancer ″.
AND text OF advise textbox: = "The Advice: Keep the good health ″

END

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