Medical patient appointments management using smart software system in UAE

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Abstract – **Taking an appointment means go to the medical center, asking about the suitable doctor for your case, spend a lot of time, or make a phone call, or take an appointment with general doctor, after that let he/she decide to which specialists you have to go; it is very long, and boring process. The main aim of this research is supporting Smart Cities Approach in UAE by designing and implementing system and mobile application "Mwa3edk" to add new concepts for the process of taking appointments with doctors in hospitals and medical clinics by transferring this process into the online world technology. This system will be able to connect a huge number of hospitals and clinics with users over UAE; and enable people to look for doctors in different locations and take appointments that suite them. In addition, users can describe their symptoms then the application will give them recommendations according to what they described using the embedded artificial intelligent method, this will help users to avoid one step, where they can take appointment directly with a specialized doctor instead of meeting the general doctor first.**

Keywords – Booking Appointment, Central Data Base, Expert System, Healthcare Mobile Application

I. INTRODUCTION

People are demanding more for new technology that would help in making their normal life easier. In other words, technology became one of the most important tools in our daily life. So, scientists, researchers, doctors and even students are trying to add more value to our life by developing new systems and one of them is the online appointment system which is a useful tool that can reduce costs, time and efforts; this issue can give people the freedom to choose suitable appointments with the desired doctor in a suitable time and location.

Online appointments are growing more by the growth of technology and internet; therefore, we need more researches and harder work to keep up with the rapid changes and developments. Healthcare sector is one the most important sectors that needs more attention due to the high sensitivity so, developing such systems is very complicated and must be more accurate with very high confidentiality.

Many online systems are available in the international markets (but not in UAE), most of them can display list of doctors (specialties), available slots, notify the patients on cancellations or postponed slots, processes location, and many other functions. In this research we are trying to implement and adopt all important features and functions depending on our needs in UAE, in order to add important function for a simple consultation and selecting doctor using Artificial Intelligent technology, as expert system for taking an appointment with most suitable specialist for particular case depending on providing correct information be patient.

A. Aims and Objectives

Online systems and mobile applications are covering all our life sectors and services; we are trying in this research to participate in increasing quality of healthcare sectors, and supporting Smart Cities Approach, by following issues:

- Support our new life style in Smart Cities, where everything depends on the internet.
- Saving time and effort in searching for a doctor, or medical centers.
- Taking an appointment.
- To help special needs people in taking appointments.

II. RELEATED WORKS

Online appointment systems were developed by people who saw the advantages of internet and decided to get the maximum benefits from it. In a matter of fact, developers focused on the problems of the normal appointment process so they can design applications and websites that would be

solutions for these problems. Although not all these systems are the same, there are common features and some differences between them. The following are three systems that were developed by different people in different places around the globe:

A. Midcus[1]

This system was developed by a group of five developers; they had the idea of making the process of taking appointments easier for patients and focused on reducing the effort that a patient should make to take an appointment with a doctor. "The main idea of this work is to provide ease and comfort to patients and it also resolves the problems that the patients face while making an appointment"[1]. In a matter of fact, this system provides a number of functions that help patients such as reminders for appointments, location of hospital or clinic and notifications regarding any change that might happen to the appointment such as cancellation or time changes.

B. MR.Doc[2]

This system was found after a group of five developers realized the problems of the normal process of taking appointments with doctors and decided to find solutions by providing a system that supports taking appointments by making it an online automated process. "Life is becoming too busy to get medical appointments in person and to maintain a proper health care"[2]. Therefore, a system with easy steps

and some useful features such as reminders, location and notifications would be a great tool to help all people in facilitating the process of taking appointments.

C. Online Polyclinic[3]

This system was found and developed by Maryam Tufail (2018) in Pakistan. To be more accurate, it is the first of its kind in Pakistan, so, the developer of this system tried to make the system as much easy as possible in which everyone can understand it and use it easily. Tufail (2018) mentioned in her article: "The reason behind creating this system was the "trend of private medical clinics" and manual medical file keeping system in Pakistan"[3]. In other words, developing such system would support the entire process and make it more efficient by reducing time, money and efforts. For this moment, the system contains simple functions such as online booking and simple notifications, however, the developer is planning to add more features to the system in the future.

D. Overall view

As mentioned before, not all systems are alike but they all have been developed for the same reason which is to facilitate the process of taking appointments with doctors. However, every system has its own way of functioning and Mwa3edk has some features that are not available in any of the previous systems as shown in the next table.

TABLE I.   TABLE1: OVERALL VIEW OF RELATED SYSTEMS

Systems / Features	Online booking	Reminders	Location	Notifications	Recurring appointments	Automated consultancy (ES)
Mwa3edk	√	√	√	√	√	√
Online polyclinic	√	X	X	√	X	X
Midcus	√	√	√	√	X	X
MR.Doc	√	X	√	√	X	X

Recurring appointments and automated consultancy are two important features that make the application special and differentiate it among other applications. Recurring appointments help people who have continuance appointments in which they can take the next appointment directly and automatically after finishing from the first one without the need of asking for an appointment. On the other hand, automated consultancy can help people in choosing the right doctor by asking for a consultancy from the expert system that will give them an advice about the right specialty doctor after the patient type his/her symptoms. These two features differentiate the application and give it a competitive advantage among others.

III.   PROPOSAL SYSTEM

The proposed system consists of three parts: Mobile application, Web Site, and Central Data Base; the central database must be connected to all clinics and hospitals registered to this system, website shall control and manage this database, and coordinate it with mobile application, the third part, mobile application, it used by user as interface between user's requisites and clinics and hospitals according to predefined methods and algorithms. The general structure of the system is shown in Fig1.

A. General Structure of the proposal system

The general view and structure of the proposed system (shown in Fig.1) consists of three main subsystems: Mobile application, Website, and Central Database.
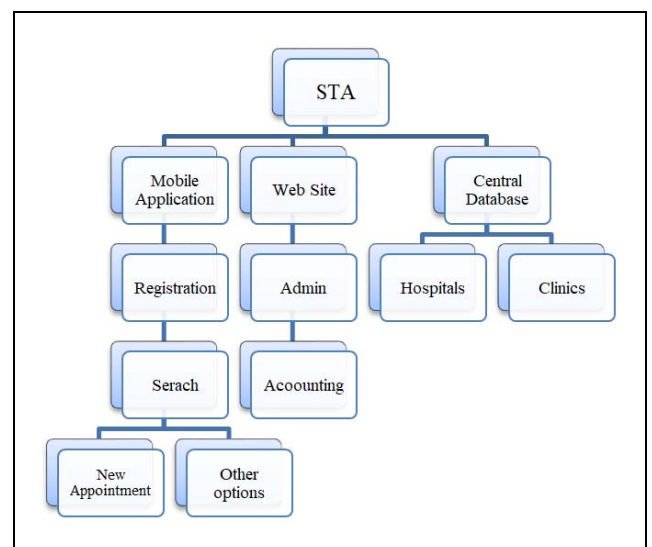

Fig. 1.   Fig. 1: General structure of the proposed system

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1) Mobile Application

Mobile application for this system has the following functions:

- Registration a new user
- Login
- Search for a doctor according to two types of search:
    - By description of the disease using Embedded Expert System.
    - By doctor name
    - By hospital or clinic name.
- Booking appointment
- Editing appointment
- Other options: rating, feedback…

2) Website

C# is used to implement this system, for website C# ASP is the main tool we are using to build it, it's very powerful tool [6]. The website consists of: Main (home) page, Administrator page, and Accounting Page. Website Admin have a full permission to manage the Central Database. Accounting page is very important for this project, because it needs to establish some agreement with medical centers, Insurance companies, and banks to management the financial issues.

3) Central Database (CDB)

MySql is used to design and implement Central Database System; it will be linked to Databases used in hospitals and clinics, to user mobile application, and to website where the administration part is installed. No any type of integration needed to be established with other systems, because it will be managed by the System Admin and can be updated by each node (hospital or clinic) connected to this system. CDB includes: User, Doctors, Insurance Companies, Hospital and Clinic records.

B. Embedded Expert System (EES)

Many types of EES were developed and used as an embedded systems, for example in 2018 one of very important EES was used to present an investigation into the development of an intelligent mobile-enabled expert system to perform an automatic detection of tuberculosis disease in real-time, it was implemented as an efficient image processing platform[6]. Another system was developed to collaboration with medical and computer experts, the ontology-based Medical Report Mapping Process to support the transformation of unstructured reports into a structured representation [7].

This paper presents an EES developed to solve simple diagnostic medical problem in a health care domain, at the level of human intelligence and doctor's expertise; with high performance and reliable response to patient queries. It capable to:

- Give advising for suitable doctor and hospital according to patient symptoms.
- Provide a simple diagnostic.
- Give alternative suggestions to patient problem.

This new option can provide a good guidance and orientation for patient's case in early stage before going to the hospital or clinic, off course it can be not very well recommended step for serious diseases, but it is helpful for simple type of diseases, general view of ESS shown in Fig. 2.
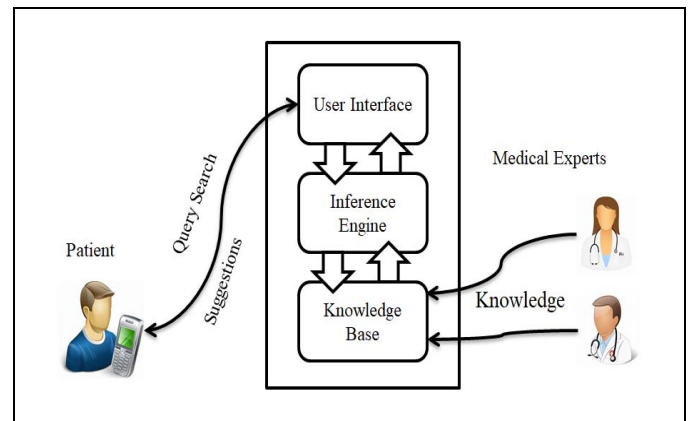

Fig. 2. Fig. 2: Embedded Expert System for STA.

1) Preparing Knowledge Base and Inference Engine

This phase of the proposed system was the big challenge for us, our specialization as accounting, and software engineering do not allow us to collect proper medical data, and information to build required knowledge base. We started many meeting with our colleagues from Pharmacy College to be able to formulate suitable questions to be used in the next stage in interviews with doctors in hospitals to collect their experiences to combine them with available data, and information as knowledge base in suitable form of facts and rules. For example Table2 and Fig.3 show the process of preparing and representation knowledge base for diabetes [5].

TABLE II. TABLE2: DIABETES SYMPTOMS [5]

Common Symptoms	Facts	Disease	Decision
Feeling thirsty	Fact1	Diabetes	Decision1
Urinating often	Fact2		
Feeling very hungry - even though you are eating	Fact3		
Blurry vision	Fact4		
Cuts/bruises that are slow to heal	Fact5		
Weight loss - even though	Fact6	Diabetes	Decision2

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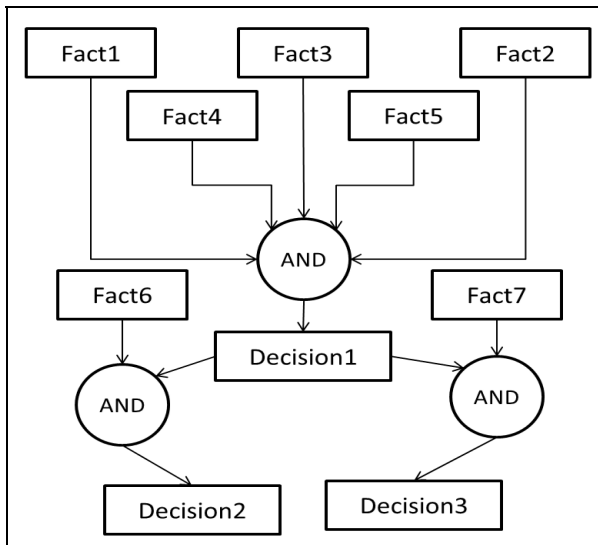| you are eating more		type1	
Tingling, pain, or numbness in the hands/feet	Fact7	Diabetes type 2	Decision3

Fig. 3.   Fig.3: Graphical Diabetes Knowledge representation

Using ideas, and concepts provided by Artificial Intelligent Experts for developing Expert System Shell [8], and Medical expert project [9], the ESS was implemented and integrated to Android platform using xamarin C# with Visual studio. The following code in Fig. 4 shows an example of creating Inference engine

```
RuleInferenceEngine Test = new RuleInferenceEngine();
Rule rule = new Rule("Diabetes");
rule.AddAntecedent(new IsClause("Feeling", "thirsty"));
rule.AddAntecedent(new IsClause(" Feeling ", "very hungry "));
rule.AddAntecedent(new IsClause(" vision ", " Blurry "));
 rule.setConsequent(new IsClause(" Urinating ", "Often"));
rule.setConsequent(new IsClause(" Weight ", "Loss"));
rule.setConsequent(new IsClause(" numbness ", "hands "));
rule.setConsequent(new IsClause(" numbness ", "feet"));
Test.AddRule(rule);
```

Fig. 4.   Fig. 4: An example of Inference Engine Code

Completing building of the KB, and Inference Engine, the EES is ready to give successful Knowledge Acquisition, and achieve the above mentioned capabilities.

2)   User interface

The user interface for this part of proposed system will be included in main system interface as part of Graphical User Interface (GUI). Some of the GUI is shown in Fig. 5.
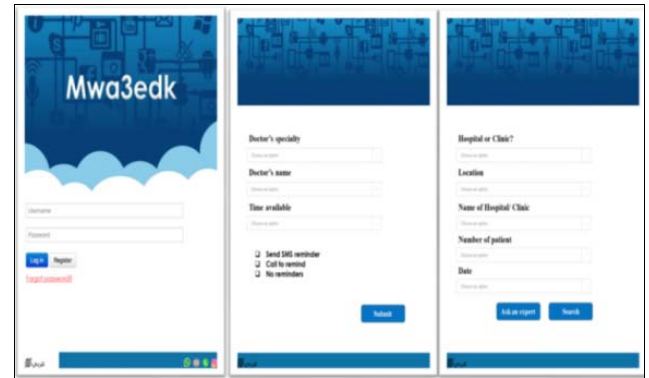

Fig. 5.   Fig. 5: Part of GUI

C.   How it works

The user must create an account using official information (Emirates ID); after that he/she can ask query direct to CDB, according to the data saved in the CDB, the answer will be sent back to the user see Fig. 6. Using this simple process the proposed system is working; keeping hospitals and clinic's data isolated and protected from unauthorized access.
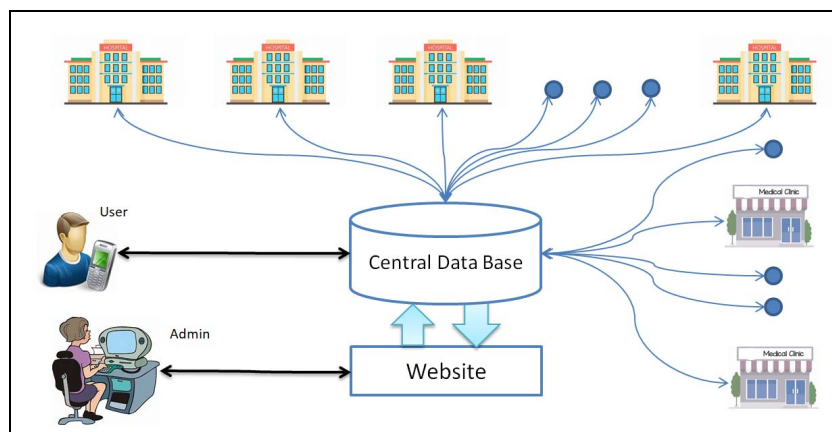

Fig. 6.   Fig. 6: How STA works

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All patient information must be saved in local data base (in hospital and clinics), the main role of website and CDB is coordination between users and hospitals by taking user's query then search local databases to find the suitable answer depending on criteria and specific algorithm show in Fig.7.
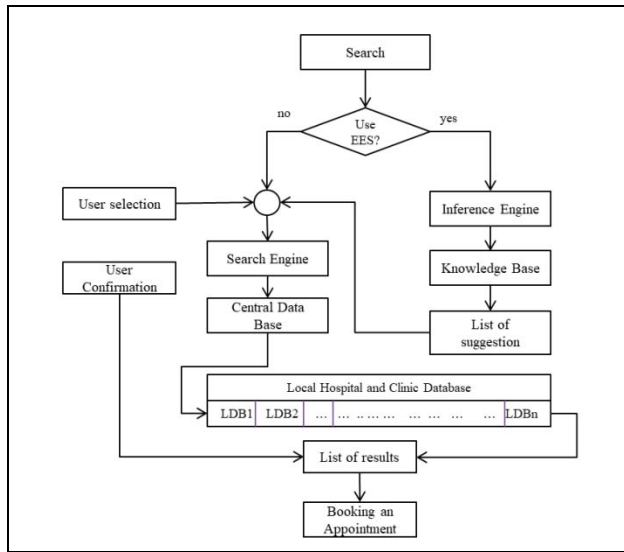

Fig. 7.   Fig. 7: Algorithm of the proposed system.

IV.   RESULTS

Prototype of the proposed system has been implemented, and delivered to a group of users for testing purposes. As a result by surveyed users, and participating in UAEU Innovators and Entrepreneurs Platform 2019, and get awarding in The Seventh United Arab Emirates Undergraduate Research Competition 2019. This system was evaluated by testing it against 50 test cases (with deferent disease symptoms) in three rounds; for first round the result of Inference Engine (IE) in deducting a correct solution was about 75%, but after modifying the algorithm and IE code in

V.   CONCLUSION

It is a fact that people are demanding for new technology in UAE especially for health sector, so, in this research we proposed a new system that facilitates the process of taking appointments easily without getting worried about privacy due to the high confidentiality of the system; there is no direct connection between user and central database, patient information is secure and protected. The user can ask the system to get recommendations for selecting suitable doctor for particular case using the AI part (EES). Furthermore, Mwa3edk will not be limited to appointments only but it will be connected to pharmacies and labs in a step of adding further features to the system in the future.

REFERENCES

[1]. Khalid, M., Singh, S., Singh, K., Jeevitha, J., & Anand , P. (n.d.). Medicus: A Doctor Appointment Booking System. International Journal of Computing and Technology, 5(4), 48–52.

[2]. Malik, S., Bibi, N., Khan, S., Sultana, R., & Abdul Rauf, S. (2016). Mr. Doc: A Doctor Appointment Application System. International Journal of Computer Science and Information Security, 14(12), 452–460.

[3]. TUFAIL, M. A. R. Y. A. M. (2018). Tampere University of Applied Sciences, Master's Degree in Information Technology.

[4]. Kyambille, G. G., & Kalegele, K. (2015). Enhancing Patient Appointments Scheduling that Uses Mobile Technology. International

the second, and third rounds the enhancement of correct solution and providing suggestion was more than 90%.
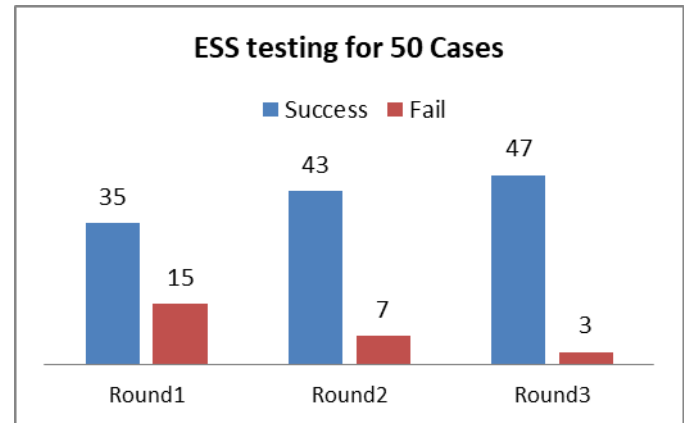

Fig. 8.   Fig.8: Applying 50 Cases through 3 rounds

Fig.9 provides the result of the survey about using expert systems in medical matters such as: obtaining a diagnosis of illness through simple disease symptoms. The survey was distributed among 100 persons (students, and faculty members).
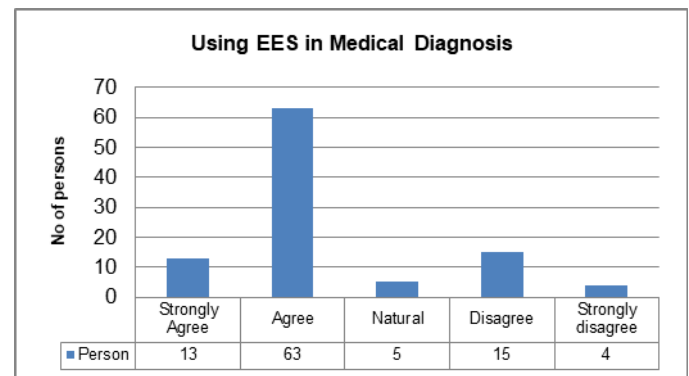

Fig. 9.   Fig.9: Statistical survey result

Journal of Computer Science and Information Security, 13(11), 21–27.

[5]. (2018, August 29). Type 1 Diabetes - Symptoms. Retrieved from http://www.diabetes.org/diabetes-basics/symptoms.

[6]. Shabut, A. M., Tania, M. H., Lwin, K. T., Evans, B. A., Yusof, N. A., Abu-Hassan, K. J., & Hossain, M. (2018). An intelligent mobile-enabled expert system for tuberculosis disease diagnosis in real time. Expert Systems with Applications, 114, 65–77. doi: 10.1016/j.eswa.2018.07.014.

[7]. Oliva, J. T., Lee, H. D., Spolaôr, N., Takaki, W. S. R., Coy, C. S. R., Fagundes, J. J., & Wu, F. C. (2019). A computational system based on ontologies to automate the mapping process of medical reports into structured databases. Expert Systems with Applications, 115, 37–56. doi: 10.1016/j.eswa.2018.08.004.

[8]. chen0040. (2017, May 20). chen0040/cs-expert-system-shell. Retrieved from https://github.com/chen0040/cs-expert-system-shell.

[9]. (2016, July 20). Medical expert system ,C# .NET project ideas. Retrieved from https://www.kashipara.com/project/idea/c-net/medical-expert-system-_907.html.

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