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Design and Implementation of Health Care Tool that Provides Suggestions and Doctors Appointment

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Abstract: In this paper we propose a computational model based on OWL/SWRL enabled ontologies, which can be used in the development of an automated software tool which help the patients know about their health conditions via patient specific reminders, advice and action items which helps in preventing the development of specific disease like diabetic foot care and Alzheimer's in patients. This tool focus at: (i) patients who would like to manage their illness efficiently by being informed and alerted to the significance of any change(s) they detect in their health condition and (ii) healthcare professionals who can disseminate their knowledge to patients more effectively, and thus prevent the development of disease , which may cause the premature death of patients. The benefits of OWL/SWRL enabled ontologies in our computational model are numerous i.e. range from the power to store, manage and reason effectively upon knowledge and information related to particular disease and prevention through OWL/SWRL computations, to the feasibility of including such computations into software applications, which can be used as a set of Apps on Android devices or on personalized healthcare iClouds. Consequently in the core of our proposal are (a) the OWL ontological model and its constraints which define and store the semantics of symptoms and observations of the changes in patient health and (b) the reasoning process which uses the semantics and the power of ontological matching through SWRL.

Keywords: OWL/SWRL, Alzheimer's, Diabetic foot, Data classification.

I. INTRODUCTION

There have been many initiatives in healthcare systems and professional circles and organizations around the world to raise the awareness about few diseases like diabetic foot (DF) and Alzheimer's [1],[2],[3].

In DF all have agreed that amputation of limbs due to diabetes complications are preventable and that raising awareness of the dangers of developing DF, amongst patients and healthcare professionals, is the way forward in supporting self-management for the preventions of foot complications. Provisions of education and sharing of experiences and sources of information on DF and empowering diabetic patients by giving them the automated and personalized access to relevant information and advice on DF prevention, thus help patients to detect the problem in the early stages and ask for suggestions based on the problems identified. In our modern society, where information and data are generated, processed and accessed from anywhere, as we speak, it is not very difficult for the patients to constantly export and share the results from expertise and allowing people to manage their health knowledge and expectations in a personalized and timely manner.

Alzheimer's disease is one of the most common causes of dementia, affecting around 496,000 people in the UK. The term 'dementia' describes a set of symptoms which can include the following a) loss of memory, b) mood changes, and c) problems with communication and reasoning. These symptoms occur when the brain is damaged by certain diseases and conditions, including Alzheimer's disease. This factsheet outlines the symptoms and risk factors for Alzheimer's disease, and describes what treatments are currently available and to manage their health knowledge and expectations in a personalized and timely manner.

In this paper we investigate possibilities of creating a software tool, which would run as an application on remote devices which the patients can access easily, and support the patient in prevention of particular diseases. Its purpose is to raise awareness of the consequences of neglecting diseases (like feet problems in diabetes) it also helps to open the door to effective sharing of knowledge and information between the healthcare professional circles to patients themselves, who can extend their knowledge and awareness of DF their own personalized way.

This paper is a continuation of our interest in preventive healthcare [4] in which we define, collect, manipulate and share knowledge and information using semantic web technologies, by creating the OWL/SWRL enabled computational models in particular. These are software engineering solutions which require reasoning upon the semantic of the environment where we create all the healthcare applications through which we are able to personalize their use and provide details to the patients or healthcare professionals based on their disease , and thus the essence of such computational models is in creating

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OWL ontologies which helps in describing the semantics of healthcare environments through its concepts: classes, constraints and individuals, which populate ontologies for particular disease in specific and creating a main class that further subdivides each diseases in particular in the subclasses . The reasoning, i.e. inference of the concepts within OWL ontologies through SWRL which enables the decision making in terms of providing advises to the patients on their best possible action which helps them in avoiding the further complications of disease. Therefore the tool should allow the patients to enter the specifications of their respective environment(s) and observations they may have regarding their health issues, and give immediate support in situations where awareness/ complications of disease are important. Computational models in the tool should make provision for a) patient's perception of the purpose of the tool i.e.; to obtain the remainders suggestions and b) healthcare professional interests to maintain the newest, clearest and most efficient knowledge and information which can be shared with patients through the tool such that there are aware about the complications that might occur. From this perspective OWL/SWRL enabled computational solutions are ideal, because it guaranties the correct interpretation and inference of semantic stored in such healthcare environments. Furthermore, our OWL/SWRL enabled computations secure flexible and relatively simple software applications, which do not have to cope with very large volume of knowledge-bases, often associated with formal ontologies from the medical domain. In other words our OWL is a simple OWL repository and hence easy to maintain, but powerful in the following terms of a) securing a correct interpretation of the semantic of a particular situation described by a patient and b) reasoning for the purpose of empowering the patient, i.e. providing patient- specific reminders, advice and action-items for preventing the development of disease .

However, it is important to note that the development of these software tools is becoming one of the most important advances of information technology in healthcare. Therefore the development of Personal Health Information Systems, as a supplement in delivering modern healthcare services is going to be dependent on various software tools. This has already proved to be popular and designed as web- based tool such as WebMED

The paper is organized as follows. In section 2 we address related works by looking at publications which deal with exchange of information and knowledge about the disease in online environments. In section 3 we describe the overall architecture of the system. In section 4 we introduce our OWL ontological model , In section 5 we introduce the process of reasoning, which is based on OWL ontological matching through SWRL. It supports the patients in their management of health issues and understanding any changes they may notice in them. In section 6 we illustrate the proposed computational model in a scenario of a patient reporting changes in their observation and we explain the exact results in terms of ontological individuals which give answers to questions patients may have at that particular moment.

II. RELATED WORK

There are not so many peer reviewed papers which focus on personalized and automated health care tools that provides the suggestions about their health complications and doctor's appointment if required and now we focus only on two diseases i.e.; diabetes foot management, Alzheimer's disease in a single health tool. We also could not find papers which deal solely on the problem of the creating intelligence for software tools which can raise awareness of disease in patients and there is one publication which reviews electronic decision support tools for diabetes care. We extract from it a few interesting references. There are a few publications which focus on telemedicine and telecare which conducted home based treatment of DF and attempts to rely on technologies and pervasive healthcare environments to treat patients with few diseases at any time and at any location.

However, there are many clinical decision support systems for diabetes management and Alzheimer's. The principle of OWL/SWRL enabled computations uses ontologies and produce inference, but we do not have any particular knowledge database or inference engine for computational model. We propose a pure software engineering solution which can raise awareness of disease in the patient. The role of ontologies and reasoning in our solution is to support computations which can be incorporated in the automated tools for personalized maintenance of health in patients. In order to understand both the environment where patients reside and their needs, we use Semantic Web Technologies which enables both the definition of semantics and the reasoning upon its modelling concepts in order to support patients at any moment.

III. SYSTEM ARCHITECTURE

The system architecture is explained with respect to the below figure1. The system architecture is mainly divided into login, screening test generation and appointment generation.

A. Admin Login

This allows the Administrator to Login into the system by using his valid username or password.

B. Create Doctor or Patient Coordinator

This allows the Administrator to create new patient or doctor to use the health management system.

C. Doctor Login

The Login is used by the Doctor in order login into the application by using the valid username and password.

D. Test Generation and Suggestion Creation by Doctor

This is used by the doctor to create questions for the screening test, rate each of the questions, provide suggestions, provides the ranges for diabetics to be high, low or medium.

E. Patient Coordinator Login

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The Patient Coordinator Login is used by the Patient Coordinator in order login into the application by using the valid username and password.

F. View Test's Generated by Patient Coordinator

This is used by the Patient Coordinator in order to view the Diabetics Tests generated by the Doctor.

G. Eligibility Creation by Patient Coordinator

This is used by the Patient Coordinator in order to create the eligibility for the patients who have registered into the health management system for the Diabetics Tests generated by the Doctor.

H. Patient Registration

The Patient Registration Module is used by the patient in order to register itself for using Health Management System

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I. Patient Login

This module is used to allow the user to login into the Health Management system if the user is valid. Otherwise user will stay in the login page.

J. Patient Screening Test

This module is used by the Patient in order to get important notification. In this project this is the place where the Patient receives the password for the screening test which he/she wishes to take.

K. Patient Data Analysis

This module runs the algorithm behind the scenes when the patient takes up the screening test. Based on the analysis of the data the rating will be generated based on the questions answered by the patient.

L. Categorization of Disease level

This module is used to categorize the patient into 3 three categories based on the rating generated after the patient data analysis is completed. The 3 categories are namely Low, Medium or High.

M. Suggestion Creation

This is used by the doctor in order to create the suggestions for the disease. The suggestions are listed to Patient after he takes the test.

N. Appointment Generation

This process is used to generate an appointment for the patient if the patient has high diabetics range and if the patient's wishes to have an appointment with the doctor.

O. View and Approve Appointments by Patient Coordinator

This is used by the patient coordinator in order to approve the request made by the Patients and forward it to doctor

P. View Approved Appointments by Patients

This is used by the doctor in order to view the approved request made by the Patient coordinator and provide treatment to patient and remove after the treatment is completed.

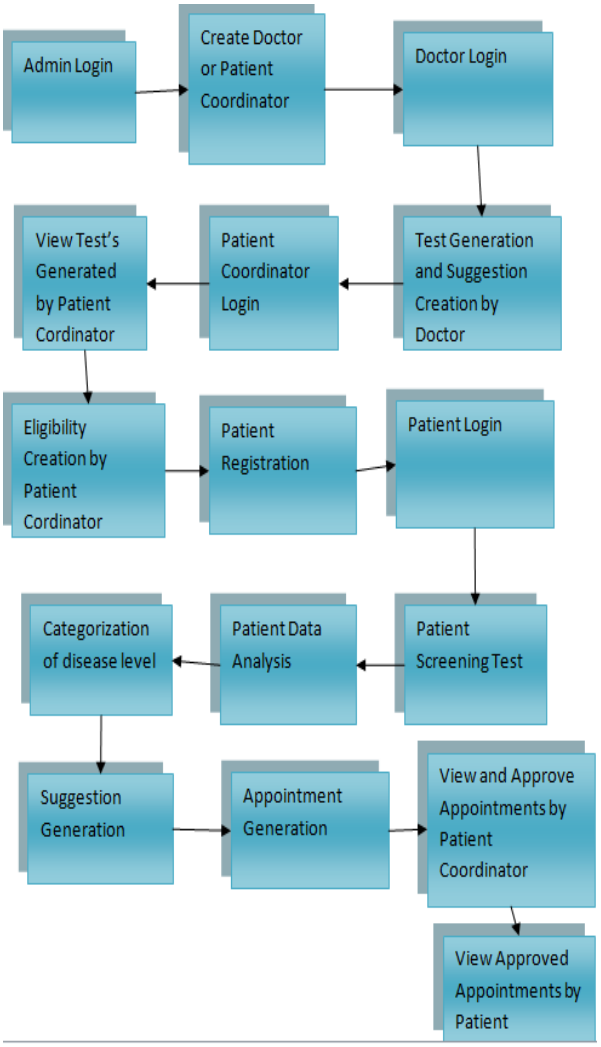

Fig 1. System Architecture

IV. ONTOLOGICAL MODEL

The ontological model, illustrated in Figure 2, gives the Overall idea about the tool i.e. we develop the owl model in general and then extend the main owl tool into multiple sub component modules which are specific for few disease based and in this paper we mainly concentrate on diabetic foot and Alzheimer's disease and explain these to ontological models in details.

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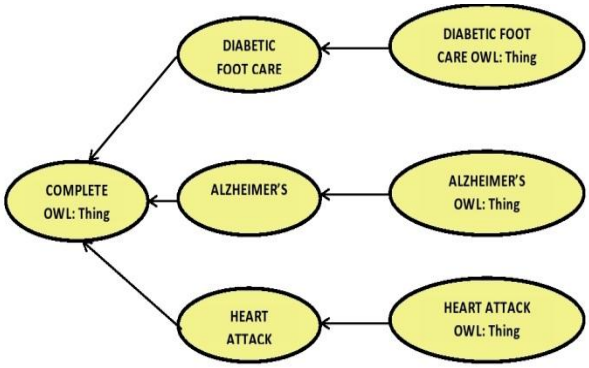

Fig 2. Ontological Model

The ontological model in Figure 3a has three basic class that stores information on patients as individuals (PATIENT), information supplied by a patient and/or healthcare professional which may help us to understand the problem with the patient (via REPORT) and a set of supporting actions i.e.; suggestions that are defined in order to raise awareness of DF (via SUPPORT). The RESULT class contains the details about our reasoning process i.e. our reasoning is performed on various combinations of OWL classes, which are determined through correctly defined constraints and ontological mapping. Hence the role and the purpose of the RESULT class sub hierarchy are dependent on the particular reasoning process we perform upon the ontology and can be explained only when illustrating the instances.

The ontological model, illustrated in Figure 3b, stores the semantics of defining preventive measures for diseases in a patient. It's similar diabetic foot care but instead of FOOT_OBSERVATION and FOOT_REMAINDER we have POTENTIAL_DISEASE and PREVENTIVE_ MEASURES may contain enough concepts, in terms of their individuals and the properties imposed on them, in order to manage all the reasoning upon patients' lifestyles, symptoms they have which may lead to a potential disease in future. Ontology for heart disease is built similarly to the previous model but we have details about heart disease that is HEART_DISEASE_FACTOR instead of diabetic and Alzheimer's details. Hence the simplicity of the main ontological hierarchy does not mean that we cannot store more information related to problem domain within the ontology. Hence we will be able to handle the ontological classes, that basically helps to manage the relationship between the patient symptoms and lifestyle factors that are reported by the patient, and potential diseases associated with them.

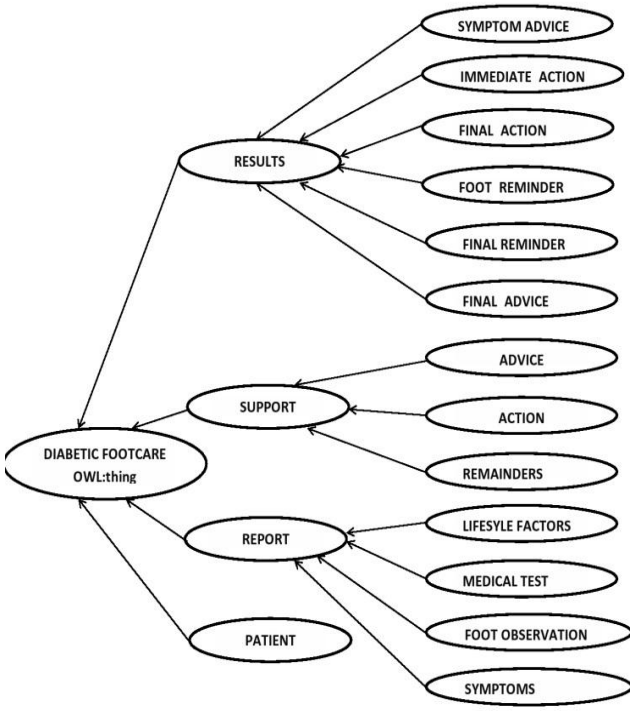

Fig 3a. Ontological Model of Diabetic Foot Care

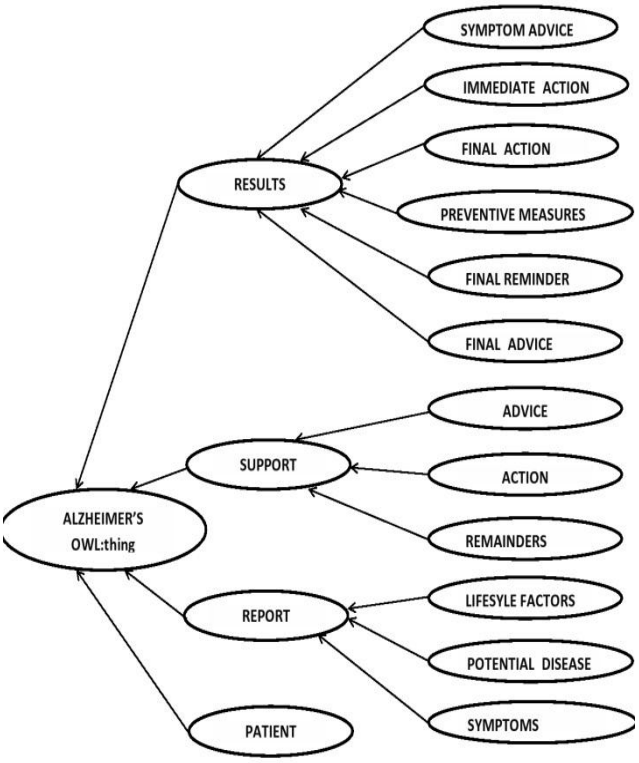

Fig 3b. Ontological Model of Alzheimer's

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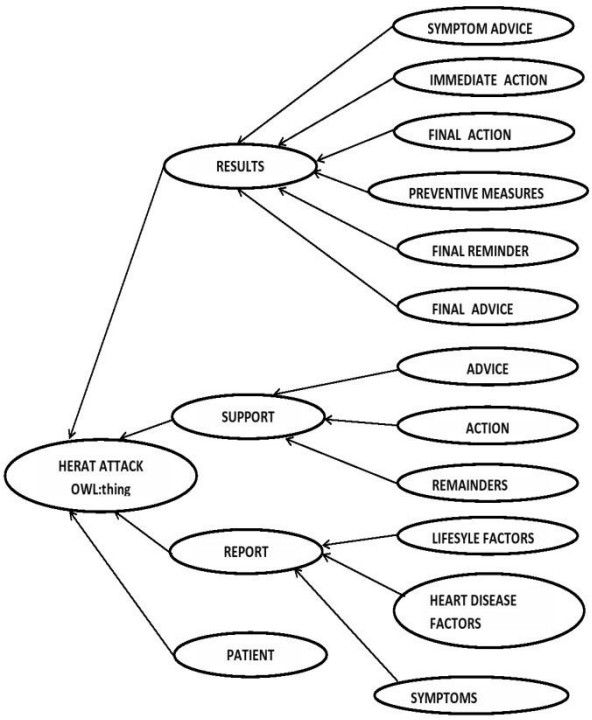

Fig 3c. Ontological Model of Heart disease

V. IMPLEMENTATION

Our computational model from Figures 2 and 3a, 3b, 3c has been implemented through Protégé ontology editing tool and Jess Engine which allows us to run the SWRL through Protégé plug-ins and we are able to run the ontological reasoning through Java application developed in NetBeans integrated development environment, which has access to OWL-API and secures immediate and transparent execution of SWRL rules. Hence the proposed computational model can run in Java environments and will be able to access via any mobile device, the OWL/SWRL enabled computations on any type of network and the server which hosts data and applications. iCloud should be our choice for future implementations.

The rules are framed based on each and every diseases which includes the details like lifestyle factors, observations, obtained by the patient which studies that have been done the doctors with their previous patients, the models are built specifically such that the patient co-ordinator will look upon the details of the specific patient ant the tests will be granted to the patient and he also helps in obtaining appointment with the specific doctors.
To obtain the patient disease level after performing the test we make use of data classification algorithm, in our computational module the value of n is 3 , we classify the patient data level into three level based on the answers that have been provide by the patients and we classify into three distinct types i.e.; low medium and high level of complexity and request for appointment if the patient disease level is high. The Data classification algorithm is as follows,

Input N={1,2,3,4,……,n}, where N is the number of questions in the screening test

C=4 , It's a constant value that has been used in our conceptual model i.e.; the no: of options for provide (1….4) .
Processing:
a) Computation of ranges
L={(max_val (N) * C)};
Range for low level is R_l = (0 to $L/3 - 1$)
Range for Medium level is R_m = ($L/3$ to $L/2 - 1$)
Range for high level is R_h = ($L/2$ to $L - 1$)
b) Computation of disease level
R_o = 0 ,
for each i
for each m
if (m = n)
F_i = 0
F_i = N(i){Ratting value of C(m)}
end if
end for
$R_o = R_o + F_i$
end for
if ($0 < R_o \leq (L/3 - 1)$)
then return R_o , patient disease level is low
End if
Exit
Else if ($L/3 \leq R_o \leq (L/2 - 1)$)
then return R_o , patient disease level is medium
End else if
Exit
else ($L/2 \leq R_o \leq (L - 1)$)
return R_o , patient disease level is high .
Output : R_o rating obtained after computation of disease level.

The implementation of the entire system will be explained with the help of the below figures , figure 4 provides explains the details about login module , through which the patient, doctor, patient co-ordinator and administrator is logged in . once the login part is done each and every member of the system can access their respective models and does their specific work .

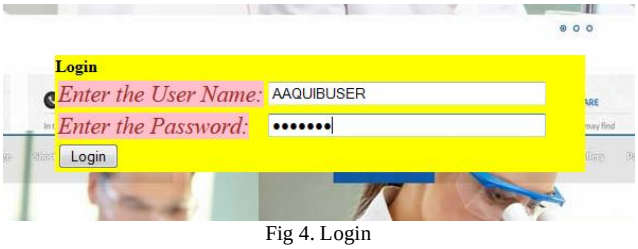

Fig 4. Login

The Doctor will login into the system and write screening test for particular disease and checks for the appointment details and also verifies the details about the critical patients. The doctor can write n number of test and each test must have minimum of four questions and can have maximum of n questions with four options. Each and every question is provided with suggestions that each suggestion is unique for each option as illustrated in the figure 5. Based on the number of questions in each test

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Vol. 3, Issue 6, June 2014

rating is calculated with the help of data classification algorithm and it will be classified into low medium and high ranges as illustrated in figure 6.

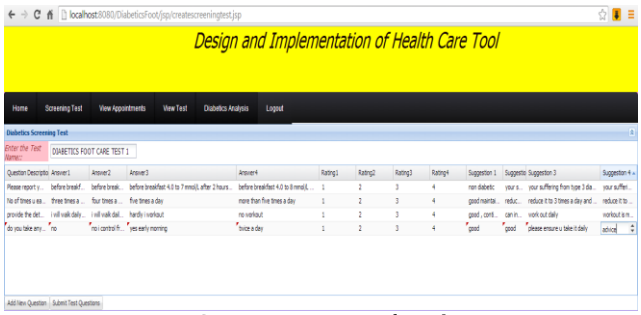

Fig 5.Screening test written from doctor

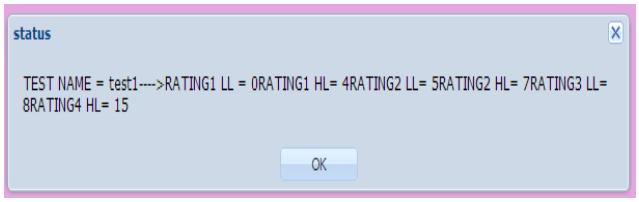

Fig 6. Rating performed for each question

Patient co-ordinator will basically provide eligibility for patients to take screening test and approves appointment with doctor as illustrated in figure 7 , 11.

Fig 7. Patient co-ordinator providing eligibility for patient

Patient will answer the screening test that has assigned to them from the patient co-ordinator figure 8 and then disease level will be calculated based on the data classification (computation of disease level) algorithm and suggestions will be provided for each questions and the overall result and displays the range to which the patient falls figure 9 and also request for the appointment if they fall in high level figure 10 and which will be sent to patient co-ordinator figure 11 and based on the availability of doctor and the level or seriousness appointment will be granted, once the appointment is granted from the patient co-ordinator the patient details will be sent for doctor figure 12 and the patient can view the approved status in dashboard figure 13.

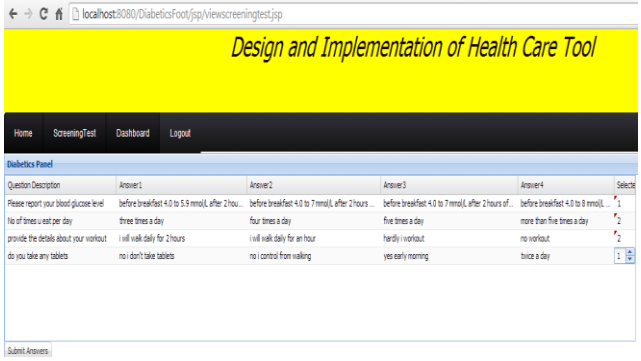

Fig 8. Screening test attended by patient

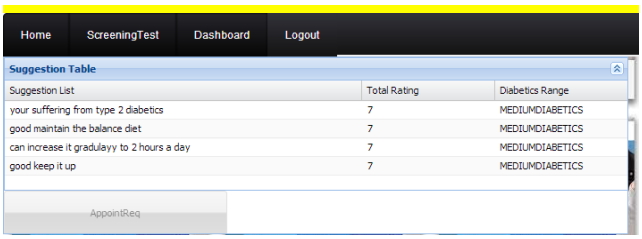

Fig 9. Suggestions provided to patient after screening test

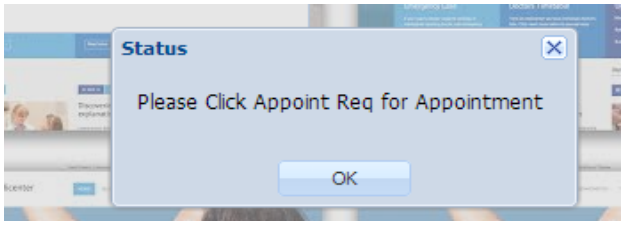

Fig 10.Appointment request if its in high level

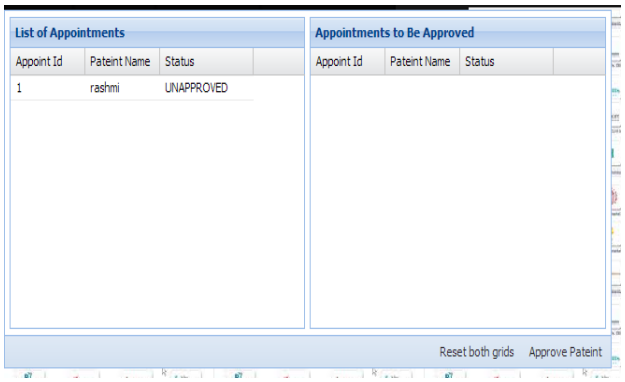

Fig 11. List of appointment sent to patient co-ordinator

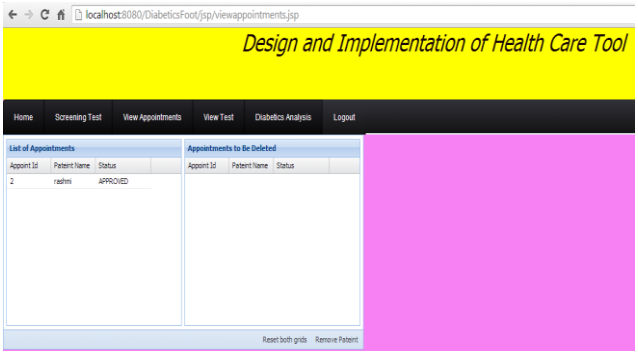

Fig 12. List of appointments assigned to doctor

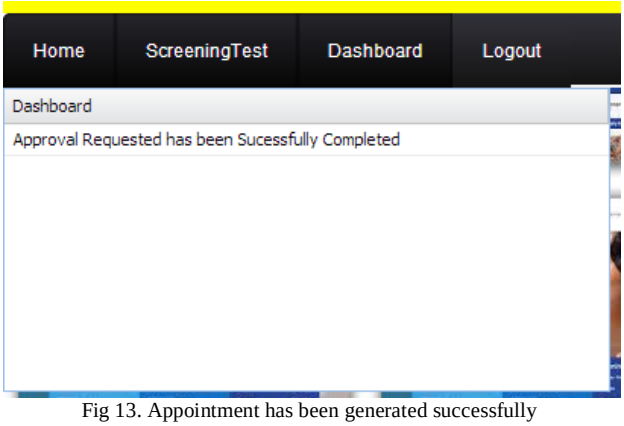

Fig 13. Appointment has been generated successfully

VI. CONCLUSIONS AND FUTURE SCOPE

In this paper we promote a generalised computational model, which can generate an automated software tool for raising awareness of dangers disease in patients and know the particular stages of their disease with the help of the ratings obtained by the result of data classification algorithms and the tools also provides the efficient output in the form of suggestions for each questions answered by the patient and thus help the patient to change their particular lifestyle habits that has been followed the patient. We believe that we have software tool that uses OWL and data classification algorithm and helps us to provide the suggestions and doctor appointment for few diseases. The system architecture explained in this paper can be used for many other healthcare environments where patient observations and symptoms may decide on the type of message(s) we pass to the patients based on the screening test answered by the patients. This paper implements our computational model in the Java application developed in NetBeans integrated development environment to prove the concepts of our proposal. The system so flexible that more it can had n number of doctors and n number of patients , it can also be extended to many other disease which can be observed by the patient and educate the remote patient about the disease and hence we avoid the remote to visit the hospital frequently.

The system can be further enhanced such that an intelligent ontology model is built such that the knowledge based model will assign screening test directly to the patient and provide multiple solutions for particular question in the screening test and thus the patient will get maximum suggestions from single screening test.

REFERENCES

[1] Foot Care, Living with Diabetes, American Diabetes Organization, accessed in May 2012, available at http://www.diabetes.org/living-with- diabetes/complications/foot-complications/foot- care.html

[2] NICE Consults on the Management of Diabetic foot problems, published by the National Health Service, UK, National Institute for Health and Clinical Excellence, 2010, accessed in May 2012, available at http://www.nice.org.uk/newsroom/pressreleases/DiabeticFootProblemsConsultationPressRelease.jsp

[3] Diabetic Foot, World Diabetes Foundation, accessed in May 2012, available at http://www.worlddiabetesfoundation.org/composite1850.htm

[4] S. C. Suh. V. Gurupur, N. Koay, R. Juric, P. Karla "Developing A Preventive Healthcare Tool For Alzheimer's Disease Using Semantic Web Technologies", in Proceedings of the 17th International Conference on System Design and Process Science, SDPS 2012, Berlin, Germany, 10-14 June 2012.