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Fuzzy System for Diagnosis and Treatment of Kidney Diseases

S. R. Mulik[1], B. T. Jadhav[2]

[1]Yashwantrao Mohite Institute of Management, Bharati Vidyapeeth Deemed University
Karad, Maharashtra, India

[2]Yashwantrao Chavan College of Science, Shivaji University, Kolhapur
Satara, Maharashtra, India

Abstract: ***Medical diagnosis and treatment is very vague and complex decision task. A large number of symptoms contribute in the decision, making it complex. Also the decision factors are fuzzy in nature. A small mistake in the interpretation of the severity of the symptoms may lead to major mistake in the treatment decision resulting into serious complications. Fuzzy logic is a widely used theory to deal with this fuzziness [1]. This paper does focus on the design of fuzzy expert system for the diagnosis and treatment of kidney diseases. The paper is composed of four sections. Section I gives overview of kidney disease and some of the software's available for its diagnosis. We describe the design of the developed fuzzy system FSDTKD in Section II. Section III does discuss the applications and advantages of the developed system. The paper concludes in Section IV with summarization and further directions to extend the work.***

Keywords: Diagnosis, Treatment, Kidney Disease, Vagueness, Fuzzy Logic, Expert System

1. Introduction

Kidney disease is very complex disease having higher rate of mortality. There are several causes of kidney disease. Diseases such as high blood pressure or diabetes lead to kidney disease [2]. Also, kidney disease itself results in a number of complications. All these factors must be considered for the diagnosis and treatment of kidney diseases. Also, large number of disorders is associated with kidneys. Most of them show similar symptoms and it is difficult to differentiate and diagnose them correctly. General physicians or practicing doctors often seek an expert's advice to arrive at accurate diagnosis and to plan appropriate treatment. In remote areas where human experts are not easily available, physicians always find it difficult to get expert advice. Accurate and timely diagnosis is essential to reduce the mortality rate and improve the quality of life. Computerized expert system based on expert's knowledge and experience may prove to be helpful in such circumstances [3]. Some of the software systems available for diagnosis and treatment of kidney disease include 'Fuzzy Cognitive Map software tool for treatment management of uncomplicated Urinary Tract Infection (FCM-uUTI)' whichgives a decision on antibiotics' suggestion for uncomplicated UTI treatment [4], 'PerkinElmer Spectrum Two FTIR' which is useful for analysis of kidney stones and identification of their chemical composition, fuzzy application for biofeedback control of ultrafiltration during hemodialysis[5]and 'KidneyAPPetite' that simplify daily nutrients and fluid tracking for chronic kidney disease or dialysis patients.

Most of the above softwares are dedicated to particular disease and have certain limitations. Hence we feel the need of integrated system that can treat multiple kidney diseases. We have developed the integrated fuzzy system "Fuzzy System for Diagnosis and Treatment of Kidney Disease (FSDTKD)".

2. Fuzzy System for Diagnosis and Treatment of Kidney Diseases (FSDTKD)

Fuzzy system named as FSDTKD is developed for the treatment of kidney diseases according to the severity of disease. Nine kidney diseases namely Nephrotic Syndrome, Renal Tubular Acidosis, Hyponatremia, Kidney Stone, Urinary Tract Infection, Kidney Cancer, Renal Anemia, Calculation of Kidney Transplant Allocation Score and Cytomegalovirus are considered in the present system. FSDTKD is a single user application. It will be used by doctor or his assistant only. This section describes the design of the system, software tools used for the development and implementation of the system, and the input/output interfaces of the system. Figure 1 shows overview of the system.

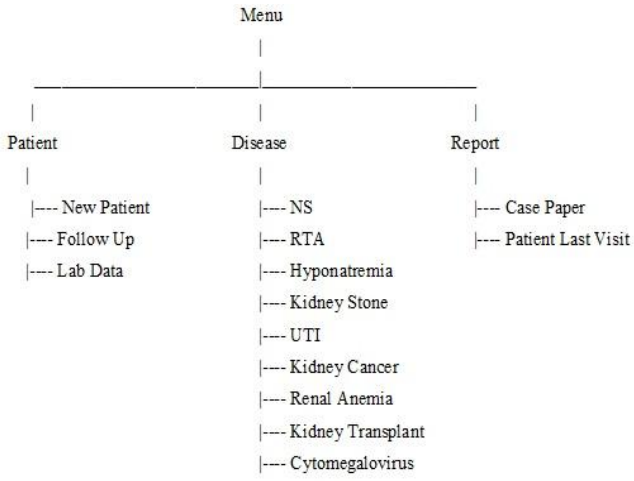

Figure 1: Overview Diagram of System

A. Software Tools Used for the Development of the System

Fuzzy system is developed in Matlab using GUIDE to create GUI interface. The database MS-Access 2003 is

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used as a back end. The reports are generated in html format using Matlab Report Generator.

B. Design and Development of System

The design of the system comprises of following:

- Design of I/p interface
- Design of Database and Fuzzy Rulebase
- Design of Reports

C. Input and Output Interfaces

The system comprises of three modules and user interfaces required for them are designed. The modules are as follows.

1. Patient
2. Disease
3. Report

Snap shots of the input/output interfaces are shown below.

1: Input Interfaces

- **Login Interface:**

Login interface is shown in Figure 2. It allows the user to start the system. Unauthorized user does not have access to the system.

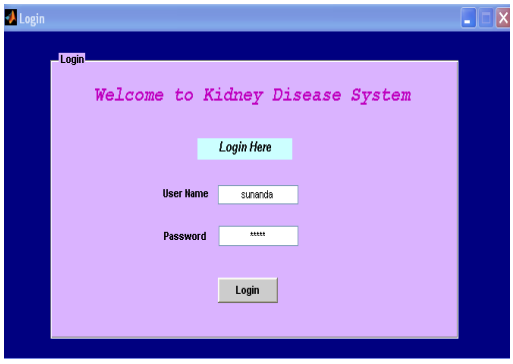

Figure 2: FSDTKD Login Interface

- **Menu Access Interface:**

After successful login, menu screen appears that allows access to different system modules. Menu interface is shown in Figure 3

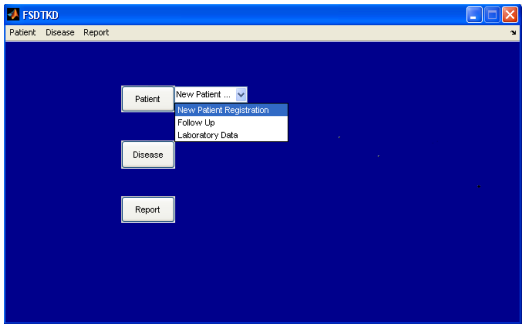

Figure 3: FSDTKD Menu Interface

- **New Patient Registration Interface:**

The interface shown in Figure 4 is used to register new patient which lets you enter personal and illness information of the patient.

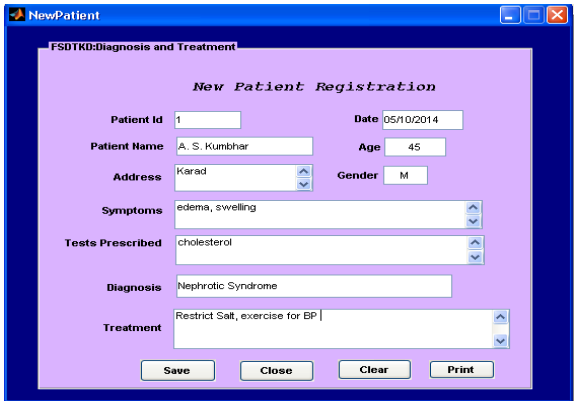

Figure 4: New Patient Registration Interface

- **Follow Up Interface:**

Patient Follow Up interface shown in Figure 5 is used to store patient's follow up information.

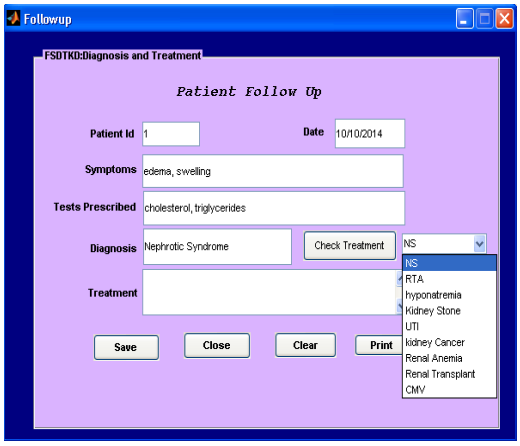

Figure 5: Patient Follow Up Interface

- **Laboratory Data Interface:**

Figure 6shows the interface to input pathological data of the patient. Through this interface, we can enter and store results of blood and urine tests that the patient undergoes.

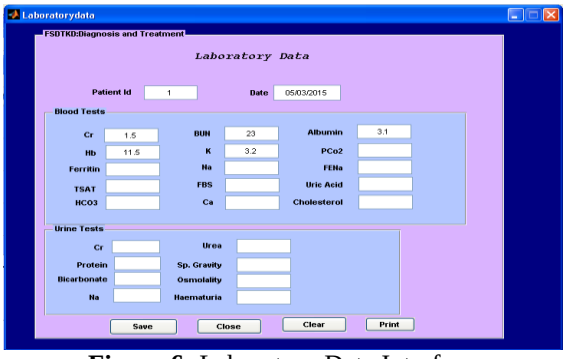

Figure 6: Laboratory Data Interface

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Diagnosis / Treatment Interface (DTI):

Diagnosis and treatment interfaces are designed for each of the above nine diseases. These interfaces get the disease specific information of the patient and suggest treatment plans.Figure7and Figure 8 show sample interfaces for Nephrotic Syndrome (NS)disease and for calculation of Kidney Transplant Allocation Score (KTAS) respectively.

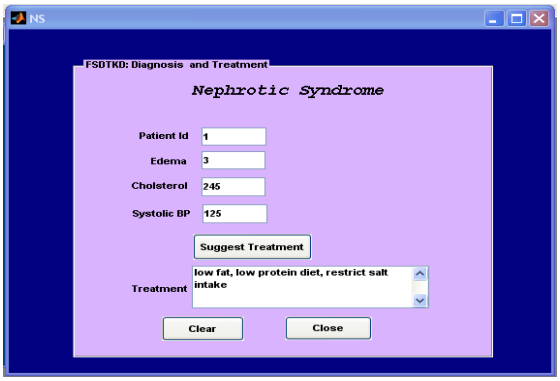

Figure 7: Diagnosis / Treatment Interface: NS

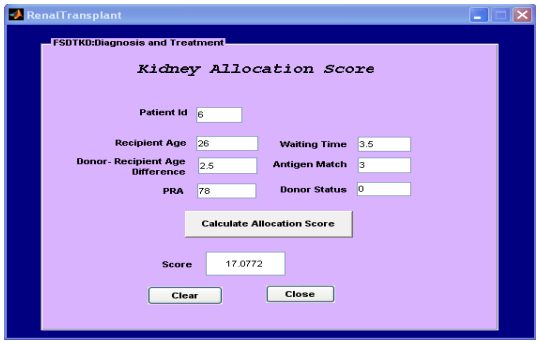

Figure 8: KTAS Calculation Interface

2. Output Interfaces

Output interfaces are used to generate reports useful for the doctors. Using these interfaces, reports such as case paper report, last follow up report and laboratory data report can be generated. Figure 9 shows Last Follow-upreport generation Interface. This interface generates the report of last visit of the patient detailing his symptoms, tests prescribed and treatment suggested to him. Sample report generated is shown in Figure 10.

Figure 9: Last Followup Report Generation Screen

Figure 10: Patient Last Visit Report

C. Implementation of FSDTKD

FSDTKD is a single user windows application. It is used by doctor or his assistant. The system has been presented to doctors and doctors are satisfied with its performance and user friendliness.

D. Software Requirements to Run the FSDTKD Tool

i) Matlab R2008a
ii) Microsoft Access 2003

3. Applications and Advantages of FSDTKD

This section describes various applications and advantages of developed system. The system serves many different purposes few of which are discussed below.

1. System can be useful for doctors to arrive at proper treatment decision.
2. It can be used as an educational aid for the medical students.
3. In remote areas where medical experts are not easily available, this tool can help the general physicians in medical decision making.
4. The tool can be helpful to hospital administrative staff to maintain patient database.
5. It can be used in pathology labs to store pathology data of the patient.

The developed fuzzy system has many advantages as listed below.

1. The FSDTKD model has simple graphical menu drive interface where user can move quickly through the system making it more user friendly.
2. The system is easy to use and cost effective. Data entry and report generation screens are simple and easy to understand. Thus with a little training, doctors and support staff can easily operate it.
3. It is useful to store the patient database for later use.
4. The system generates the essential reports useful for the doctor such as report of last follow up of the patient.
5. The tool is useful to physician for decision making.
6. The model can be used as an educational aid for medical students.
7. Tool can be easily upgraded by adding kidney diseases that are currently not considered.
8. Tool can be easily updated as per the requirements of doctors and changes in the treatment guidelines over time.

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4. Conclusion

Fuzzy system FSDTKD is developed to aid the physicians in medical decision making. The system is presented to the doctors. It has satisfactory level of accuracy and may prove to be helpful to the physicians for the selection of appropriate treatment option. Accuracy can further be enhanced by adding more decision variables. Also more number of diseases can be added to extend its usability.

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