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iAsistent in Differential Diagnostic

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Abstract

Nowadays, when the world population is growing and when the number of diseases is increasing the need for good doctors is bigger than the last two-three years. Time! The time factor is the most important thing when dealing with human life and their chance to survival. Knowing these needs the author of this paper imagined and starts creating a software tool capable in decreasing the time consumed in differential-diagnostic process, in finding the patient medical history and in searching medical relevant articles and information. Within this system a virtual entity, an intelligent virtual assistant, is to be used in order to help the physician in differential diagnostic process.

Introduction

Medical field – a field in which things fallow an exponential growth. New diseases or mutations of existing ones are discovered every day. In order to keep track with this growth and mutations we have to be up to date with all. In order to facilitate this process and to save time, the iMDD (Intelligent Medical Differential Diagnostic – identified, in article, also through iMDD) system was designed and implemented.

A short description of the iMDD system will be: iMDD is a collaborative platform through which the physicians can easily interact one with each other, without any spatial frontiers. The platform is like a central point of medical knowledge and a tool that facilitates the medical information access and the differential diagnostic process through collaborative tools (mails, chat, whiteboard, etc).

As part of iMDD design is a virtual, intelligent, entity – an assistant – that will help the physician in the diagnostic process. The functionality and the design of this assistant (identified in article also through i.A – intelligent Assistant) is to be presented further on article.

Continued on the article you will find information about the medical context that helped in designing and implementing the system, a summary description about the system itself, the role of artificial intelligence in medicine, the iAssistant structure and functionalities.

Medical Context

In common modern usage, diagnosis is the identification of a disease by investigation of its signs, symptoms and other manifestations. In medical terminology, however, the precise meaning of the word is obscured by the many ways in which it is used: clinical diagnosis, laboratory diagnosis, physical diagnosis, anatomical diagnosis, bacteriological diagnosis, x-ray diagnosis, electrocardiography diagnosis. In each of these cases the word diagnosis connotes an appreciation of

the meaning of observations made by particular methods, but it does not necessarily signify the identification of a disease by these means.

Procedures involved in diagnosis

Diagnosis involves two procedures: 1) collecting the facts and 2) analyzing the facts. Errors in diagnosis may be due to imperfect performance of either of these procedures. When the factual data are inadequate or incorrect, or when they have been misinterpreted, the analysis, though faultless in itself, will lead to an erroneous conclusion. On the other hand, even when the collections of facts has been complete and accurate, and the data have been correctly interpreted, the conclusion may be in error because of faulty analysis.

The diagnostic process is frequently very complex. The number of facts that can be collected in a detailed medical history and in a thorough physical examination is almost limitless. The laboratory tests, x-ray studies and specialized technical procedures that can be employed are numerous and costly. Therefore every question that physician asks in obtaining the medical history, every maneuver that he carries out in the physical examination, and every laboratory test or other procedure that he orders should be thoughtfully selected with a view to eliminating some of the possible diagnoses and guiding the search expeditiously to ward a specific disease. Unselective ordering of tests – the blunderbuss approach – is often confusing, costly, and redundant and is an inadequate substitute for sequential diagnostic analysis; it is to be condemned unless the patient is so ill that time will not permit orderly diagnostic progress.

Steps in Diagnosis

In brief, the successive steps leading toward the diagnosis are the following:

1. Collecting the facts:
   - Clinical history
   - Physical examination
   - Ancillary examinations
   - Observations of the course of the illness

2. Analyzing the facts:
   - Critically evaluate the collected data
   - List reliable findings in order of apparent importance
   - Select one or preferably two or three central features
   - List diseases in which these central features are encountered
   - Reach final diagnosis by selecting from the listed diseases either the single disease that best explains all the facts or if this is not possible, several diseases, each of which best explains some facts.
   - Review all the evidence – both positive and negative – with the final diagnosis in mind.

Through the iMDD system components and tools, some of these steps are sustained and supported in an easy, intuitive and friendly user interface.

In the next article section, the steps that are supported and assisted by the system are to be described.

Collecting the facts

The facts used in differential diagnosis come from four sources:

1. Clinical history
   - supported by the iMDD system with the help of an integrated EMR tool (Electronic Medical Record) for patients and with the help of medical knowledge database for diseases.
2. Physical examination
   - the examination is to be assisted, in real time, by the intelligent virtual entity, iA.
3. Ancillary examinations involving special techniques and laboratory methods
   - these methods will be also sustained and assisted by the iA and by the system itself. The system will be providing all the necessary information regarding the methods and techniques.
4. Observations of the course of the illness
   - the iA will keep track of the course of the illness by reading, interpreting and storing history of the information provided by the live sustain devices.

Interpreting and Analyzing the Facts

The physician who is called upon to analyze the facts may find himself in a position of a drama critic who is asked to render an opinion about a play after having been permitted to see only the third of four facts. He may be able to learn something about the first two acts from other relatively unobservant and technically inexperience members of the audience who actually saw those acts. The fourth act however has yet to be performed. The wise critic would of course, withhold his opinion unless he was permitted to see play through from beginning to end. The physician, however, despite his limited view, may not arbitrarily withhold his opinion. He is dealing with matters of life and death, and he has been trained to render his opinion at any stage of the play.

The physician must therefore begin his analysis of the facts not only by determining their reliability and intrinsic significance but by considering their relations to the patient's total illness. For example, a negative agglutination test for a specific organism may be of no significance early in the illness but assumes great significance at a later stage. Critical evaluation of various physical findings and laboratory tests requires knowledge of the natural history of diseases as well as of the manifestations that are to be evaluated. From the evidence that he has observed, the physician selects the important manifestations and records them as the symptoms and signs of the diseases. These are the raw data to be used in the subsequent clinical analysis. Before the physician begins his analysis, he must decide which facts to consider, how to designate them, how to verify them, and in what form to record them. These are the steps that convert bedside observations into useful clinical data. Objectivity and consistency must be exercised in each of these steps.

iMDD – the system

The iMDD is:

- an accurate and time saving differential diagnosis tool that reminds you instantly of diagnostic possibilities and minimizes medical errors;
- designed to make your practice safer, enhance the quality of care, reduce misdiagnosis and billing errors, and save time - especially in diagnosing complicated cases;
- the ultimate differential diagnosis tool for a busy physician.

iMDD will provide

- a real time assistance in differential diagnostic process
- full and complete patient medical history
- a mature medical customized search engine
- virtual whitetable for easy, real time, brainstorming processes
- disease history, symptoms and possible treatments
- capability in self patient monitoring and condition notifications

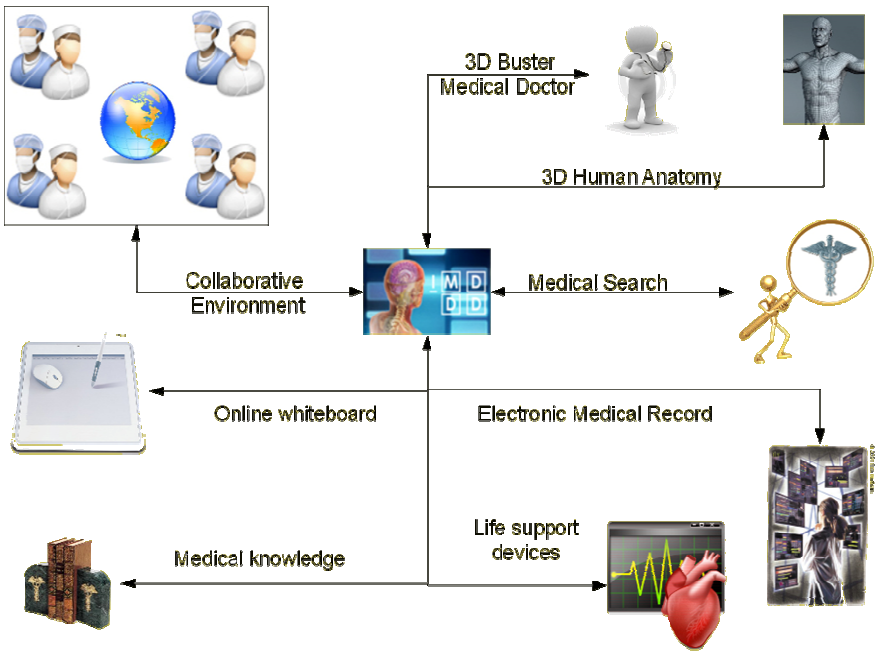

Fig. 1 – iMDD System - Components

Artificial intelligence in medicine

Diagnostic run against the clock is the most important thing to remember in the diagnostically process and e very well knows fact by the physician. The AI technology give a hand of help to the modern physician who is confronting with a growing amount of work and patients and the only think he doesn't have is the precious time.

Artificial intelligence in medicine is a new research area that combines sophisticated representational and computing techniques with the insights of expert physicians to produce tools for improving health care.

Medicine is a field in which technology is much needed. Increasing expectations of the highest quality health care and the rapid growth of ever more detailed medical knowledge leave the physician without adequate time to devote to each case and struggling to keep up with the newest developments in his field.

Due to lack of time, most medical decisions must be based on rapid judgments of the case relying on the physician's unaided memory. Only in rare situations can a literature search or other extended investigation be undertaken to assure the doctor (and the patient) that the latest knowledge is brought to bear on any particular case.

We view computers as an intellectual, deductive instrument, which can be integrated into the structure of the medical care system. The idea that these machines can replace the many traditional activities of the physician is probably. Advocators for artificial intelligence research envisions that physicians and the computer will engage in frequent dialogue, the computer continuously taking note of history, physical findings, laboratory data, and the like, alerting the physician to the most probable diagnoses and suggesting the appropriate, safest course of action

Machine learning systems can be used to develop the knowledge bases used by expert systems or intelligent agents. Given a set of clinical cases that act as examples, a machine learning system can produce a systematic description of those clinical features that uniquely characterize the clinical conditions. This knowledge can be expressed in the form of simple rules, or often as a decision tree.

Some systems require the existence of an electronic medical record system to supply their data, and most institutions and practices do not yet have all their working data available electronically. Others suffer from poor human interface design and so do not get used even if they are of benefit. Much of the reluctance to use systems simply arose because expert systems did not fit naturally into the process of care, and as a result using them required additional effort from already busy individuals. Computer illiteracy of healthcare workers is also a problem with artificial intelligent systems. If a system is perceived as beneficial to those using it, then it will be used. If not, it will probably be rejected.

Expert systems can apply to different clinical tasks, such as:

Generating alerts and reminders. In so-called real-time situations, an expert system attached to a monitor can warn of changes in a patient's condition. In less acute circumstances, it might scan laboratory test results or drug orders and send reminders or warnings through an e-mail system.

Diagnostic assistance. When a patient's case is complex, rare or the person making the diagnosis is simply inexperienced, an expert system can help come up with likely diagnoses based on patient data.

Therapy critiquing and planning. Systems can either look for inconsistencies, errors and omissions in an existing treatment plan, or can be used to formulate a treatment based upon a patient's specific condition and accepted treatment guidelines.

Agents for information retrieval. Software 'agents' can be sent to search for and retrieve information, for example on the Internet that is considered relevant to a particular problem. The agent contains knowledge about its user's preferences and needs, and may also need to have medical knowledge to be able to assess the importance and utility of what it finds.

Image recognition and interpretation. Many medical images can now be automatically interpreted, from plane X-rays through to more complex images like angiograms, CT and MRI scans. This is of value in mass-screenings, for example, when the system can flag potentially abnormal images for detailed human attention.

iAssistant – Intelligent Assistant

iA is an rational agent, an virtual entity – materialized with a 3D human body, that will assist, in real time, the physician in differential diagnostic processes. Being a part of the iMDD system, the assistant will also interact and access all the tools, knowledge repositories from it.

In order to fulfill the decision assistance the iA will use a decision analysis expert system.

The decision analysis process “involves a careful study of the possible actions and outcomes as well as the preferences placed on each outcome**.** It is traditional in decision analysis to talk about two roles: the decision maker states preferences between outcomes, and the decision analyst enumerates the possible actions and outcomes and elicits preferences from the decision maker to determine the best course of action.” [4] (page 509)

The decision analysis expert system must:
- "Determine the scope of the problem"
- "Lay out the topology"
- "Assign probabilities"
- "Assign utilities"
- "Enter available evidence"
- "Evaluate the diagram"
- "Obtain new evidence"
- "Perform sensitivity analysis" [4] (page 510).

The assistant, which is a rational agent, will have as environment the hospital, the patient and the web (for medical information searching) and as goal the patient health and to minimize the costs and time consumed in diagnostic process.

The iA will learn how to read and analyze any medical relevant images, like X-Rays or MRI, and the condition given by the life keeping devices. Also it will percepts the patient symptoms, answers and findings.

By accessing the specialize medical search engine, the iA will know to search for any relevant information regarding a given case.

Being sustained by the decision analysis expert system, the assistant will generate questions, indicate tests and treatments. Besides this, the system will generate alerts for patient critical conditions.

The assistant will interact with the physician through speech recognition and narration characteristics. So, in other words, any produced information will be narrated while displayed on the screen. The speech recognition module it is used for vocal commands; this characteristic is to be added in order to eliminate the time spend for typewriting and the pc dependencies.

Conclusions

The iA – intelligent Assistant – is a rational agent that will help and assist the physician during the differential diagnostic process. Being an agent, the iA will have all the common agent functionalities and characteristics.

The agent will be materialized with a 3D human body, with speech recognition and narration capabilities, and integrated with the iMDD system.

The iMDD system is a collaborative platform which provides a central point of medical knowledge and supports the differential diagnostic process.

The next steps are to design and build the 3D model, establish the agent learning techniques, to implement a decision analysis system – or to integrate an existing one, and to implement the agent itself.

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