

Role of Expert Systems in Digital Mammogram Processing

Mohammed Khalid Kaleem

B-Tech, ME(Canada), Adilabad, AP, India

Abstract

Expert system is essentially a software with expertise or specialization in a particular field. It provides answers and solutions to people in making decisions under uncertain conditions. Expert systems have a wide application in various fields. One such field is the medicinal field. Cancer a deadly disease could be easily diagnosed with the help of an expert system. This study discusses about the application of expert systems in one of the most present advanced technologies in x-ray mammography known as digital mammography in allowing more accurate and faster stereo tactic biopsy.

Keywords

Mammogram Processing, Expert Systems, Digital Mammogram, Role of Expert Systems.

I. Introduction to expert systems

Artificial Intelligence is a branch of computer science that focuses on recreating the portions of human brain that makes decisions, with the help of software. In short, a machine that takes decisions can be built using Artificial Intelligence. Expert system is a product of Artificial Intelligence. Expert system is nothing but software with expertise or specialization in a particular field. It provides answers and solutions to people in making decisions under uncertain conditions.

Expert systems have a wide application in various fields. One such field is the medicinal field. Cancer a deadly disease could be easily diagnosed with the help of an expert system. It is used to detect cancer caused in various parts of human body especially prostate and breast. A large number of health organizations are making use of fuzzy expert systems in detecting breast cancer and prostate cancer.

A medical expert system in order to detect cancer has to be first fed with information from experts, in our case doctors. The information collected from various doctors are gathered, stores and fed into the computer system through program..

II. Introduction To Digital Mammography

One of the most present advanced technologies in x-ray mammography is digital mammography. Digital mammography is related to standard mammography where the x-rays are used to produce brief images of breast. Digital mammography uses the same system for mammography as conventional mammography, but the system is supplied with a computer or a digital receptor instead of a cassette film. Many studies have explained that digital mammography is as sharp and correct as standard mammography [1].

Digital mammography allows more accurate and faster stereotactic biopsy. This result in short times of examination and improves the convenience and comfort of patient significantly since the patient and the time remain still as shorter. With digital mammography, images are developed digitally and it was displayed immediately on the monitor. Digital systems have been approved by the United States FDA for using the breast biopsy [2]. Traditional stereotactic biopsy requires a film of mammogram to be exposed, obtained and then reviewed, which increases greatly the time before the breast biopsy has been finished. The below Fig. shows the contrast transfer of digital mammography :

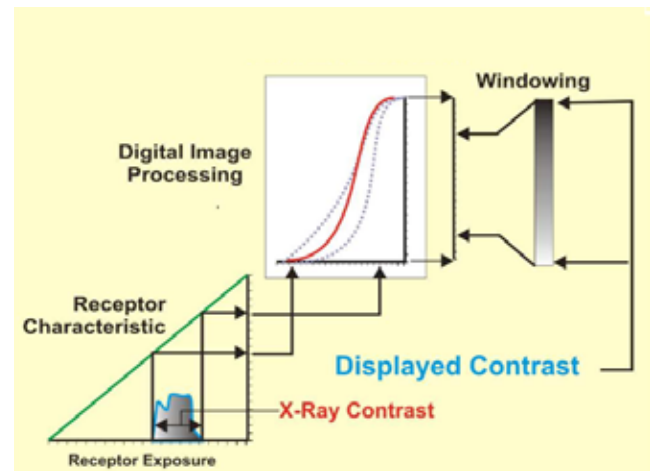


Fig.1: Contrast Transfer of Digital Mammography

Source: Website, Sprawls.org

In addition to digital mammography, the FDA has approved a digital mammography of full field system to diagnose and screen for breast cancer. With the continual improvements, the digital mammography of full field systems may replace eventually with traditional mammography.

The images are recorded on film using a cassette of X-ray in standard mammography. The film which is recorded is viewed by a physician using a frame and then it is stored in a jacket facility's documents. In digital mammography, the image of breast is seized using a special X-ray detector, which converts the image into a digital picture and the physician reviews the images in the computerized monitor. In digital mammography, a digital detector is added to replace the cassette of film of the conventional system. Due to the detective quantum efficiency or high detective efficiency of the detector, the potential to capture the image is up to 90% of the breast image or the original signal information. Digital mammography operates at high speeds significantly and facilitates the independent mammograms interpretation by 2 radiologists and supports the regional telemammography networks development which was designed to underserved and reach isolated populations [3].

Digital mammography use panels of electronic detector for capturing the X-ray images of the breast as a collection of discrete electronic charges. After the X-ray passes through the tissue undergoing imaging, it encounters the layer of scintillator of the detector to convert the X-rays into light. Next, the light signals encounter's the photodiode layer of detector where the signals are converted into electronic charges. Electronic charges are converted to signals of voltage and it is transferred to a monitor for display of image and to a computer for image storage and analysis [4]. The digital mammogram is then stored on a monitor. With digital mammography, the brightness, orientation, contrast and magnification of the image may be changed after the examination is finished and helps the radiologist to view the images of certain areas more clearly. The below Fig. shows the Digital mammography:

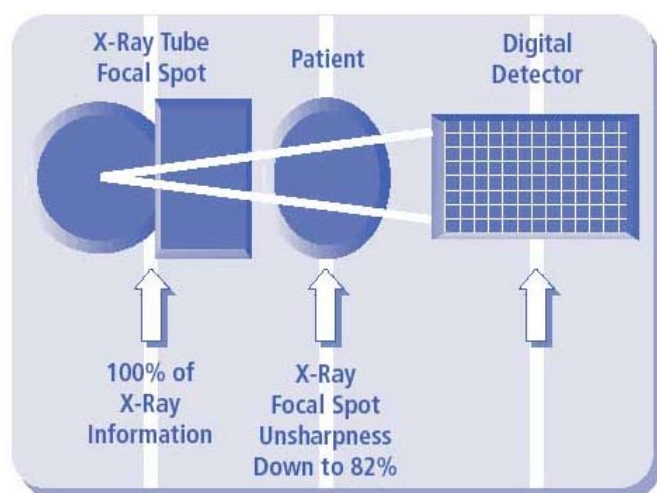


Fig. 2: Digital Mammography
Source: Website, Atp.gist.gov

The studies of standard film mammography and digital mammography shows that film mammography is comparable to digital mammography in terms of detecting breast cancer. Digital mammography expects to improve more quickly than standard film mammography. Small studies show that digital mammography may provide extra benefits, such as low doses of radiation and high sensitivity to abnormalities [5].

III. Role of expert system in medicine

In the last decade the technology has improved a lot and the AI has entered our world with the widest use of technology. ES is not only helping us, but also acting as a human being with full of knowledge and gives us advice in those areas, where it is impossible to have many of the humans to do the same thing. ES are able to perform the high quality task which is very much expensive even though it is not performed by humans. ES is used widely applied everywhere in the society. It serves people by giving a basic advice on a specific problem for performing very hard physical tasks. The main purpose of the ES is to provide a solution for a problem when it is needed and sometimes in a matter of seconds. Because of this use the performance has increased in the business, government, science and the others fields. ES due to their knowledge can take accurate and quick decisions and can provide assistance and support to all professionals.

AI in medicine is based on the construction of AI programs that perform the diagnosis and make some therapy recommendations. The medical applications are developed based on their programming methods, which are purely statistical and probabilistic methods. AI programs are based on symbolic model of disease entities and their relationship between patient and clinical findings. Today, the importance of diagnosis is a task requiring remote support in routine clinical situations which receives equal emphasis on other clinical tasks.

In medical ES the patient's details and their symptoms are the input, and the probable diagnoses which was recommended for the treatments or drugs prescribed are the system output. Some patients will feel happier by typing the medical information into a computer than discussing it with a human doctor but some others would prefer the 'human' touch. There have been several expert systems for the development of expert systems in medicine and to assist the physicians in making a medical diagnosis. Recently

several expert system programs focus on drug suggestion. Some physicians make use of the guidance of expert system for drug suggestion, drug therapy monitoring and drug formulary selection. There are many cases of pharmacy that AI can have an impact on. The challenges now presently faced in pharmaceutical field could be overcome with the help of expert systems someday the usage of expert system can become a reality in pharmacy.

IV. Areas of application of expert systems in medicine

In addition to determining what an object is, we are also interested in determining its pose, i.e., its position and orientation with respect to the viewer. For instance, in an industrial manipulation task, the robot arm cannot pick up an object until the pose is known. In the case of rigid objects, whether three dimensional or two dimensional, this problem has a simple and well defined solution based on the alignment.

A. Clinical Care

The clinical care for a particular patient proceeds in various phases such as the diagnosis before therapy or prevention of disease before the onset of disease or rehabilitation of the patient after therapy. The analysis of the human systems has permitted to identify both the decision elements and their potential decisions to at least 10 distinct phases of clinical care such as:

- Predicting the disease.
- Preventing to avoid the disease.
- Pure attention to the health of the patient.
- Health counseling to the patient.
- Analyzing the cause for the preventive measure.
- Providing rehabilitation for the patient.
- Motivating the patient that their health is fine.
- Protecting the patient from dangers.
- Providing advocacy for the patient.
- Pathologic care of the present.

From the above it is clear that the diagnosis is only problem in clinical medicine. Today, in medical ES are mainly applied for the following types of clinical tasks.

- Generation of warnings and reminders:
In real-time situations, an ES attached to a computer gives warning about the changes in a patient's condition. Otherwise they scan the lab test results and then send the reminders or warnings.
 - Predicting the Diagnostic Assistance:
When a patient's case is a rare one or the person making the diagnosis is inexperienced, an ES helps the patient to diagnose the problems based on their report data.
 - Therapy critiquing and planning:
ES are used to look for some inconsistencies and omissions in the present treatment plan and formulate a treatment based upon a patient's specific condition and their accepted treatment guidelines [Hendler J A, 1998].
 - Education of the ES:
ES are used to give training and practice for the physicians and the students on various medical tasks.
- Problems and Benefits:

Because of the increased use of ES in medicine, the expert systems

become stressed that the development of the system for medical applications has to face some basic problems such as:

- The medical tasks are much more difficult because there are differences between an individual patient and the unavailability of the clinical data.
- The range of the possible errors is very small because of the ethical considerations and the malpractice risks.
- Providing fund for the capital expenses are supplied shortly. On the other side the factors which favor the increased dissemination of ES technology are:
- Cost effectiveness of the medicine.
- Improving the health quality of the patient.
- Agents for information retrieval:

The software agents are used to search and retrieve the information. For example for an agent to understand about its user preferences and their needs, it has to have some medical knowledge to assess the importance and the utility of which it finds.

- Image recognition and interpretation:

Many medical pictures can be interpreted automatically, from empty X-rays by the complex images like AG, Computer Tomography and Magnetic Resonance Imaging scans. This is a value in mass-screenings. For example, the system can scan the abnormal images for human being.

V. Expert system architecture

The following Fig. shows an image of an expert system used in medicine.

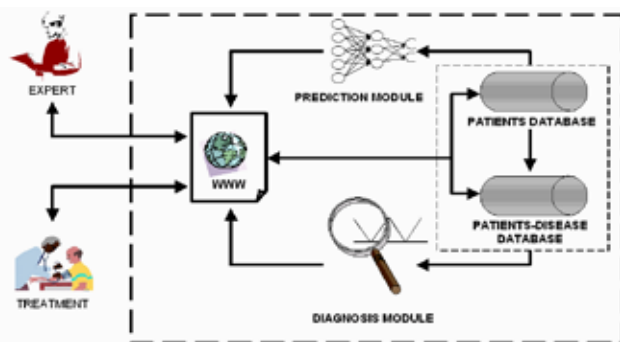


Fig. 3: Expert system used in medicine

Source: Website, pharmainfo.net

VI. Advantages of expert systems in medicine

The advantages of an expert system over a doctor are:

- The huge amount of database for knowledge is added and kept up-to-date and it can also store more knowledge than an ordinary human being.
- The system will not forget
- The system will not get the facts incorrect.
- The ES survives forever and there will be no loss of knowledge when the doctor retires from his work.
- The system can access some special knowledge that the doctor itself may not know.

VII. Goals of expert systems in cancer detection

In the recent years, the methods of AI have been used largely in different areas including the medical applications. In the medicine area, many ES were designed.

The goals of the ES in Cancer Detection are:

- It reduces the misinformation and the fear through cancer education and information
- It increases the awareness of cancer prevention, detection and early screening strategies.
- It increases the knowledge of healthy lifestyle choices which

may reduce the cancer risk.

- It describes the sources of information and support.

VIII. Expert systems for digital mammography

Expert Systems are developed with the help of a collection of software packages and tools which are used to develop the expert systems. Expert System provides a high potential payoff for reducing the downside risk. It can capture and preserve for irreplaceable human expertise. ES provides the expertise needed at a number of locations at the same time and the environment that is dangerous to human health.

The cost of Digital mammography expert system is approximately 2.5 to 5 times as much as standard film mammography systems. While the procedural time is saved by using digital mammography over standard film mammography which justifies the facilities of cost that perform thousands of mammograms each year, and the study determine whether the cost of digital mammography is justifiable in terms of its benefits in detecting breast cancer. The below Fig. shows the operation of digital mammography system:

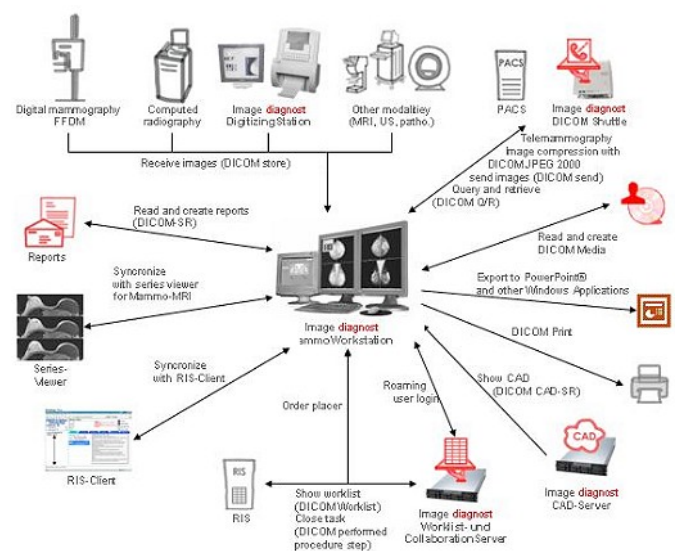


Fig. 4: Operation of Digital Mammography System

Source: Website, Imagediagnost.de

From the perspective of patient digital mammogram is the same as a standard film-based mammogram in that compression of breast and radiation is important to create clear breast images. The time needed to place the patient is the same for both the methods. However, conventional film mammography requires more minutes to develop the film while digital mammography provides the image on the monitor in less than a minute after the data/exposure acquisition. Thus, the digital mammography provides a small exam for the woman and allows the digital mammography with possible facilities to conduct several mammograms per day. Digital mammography can be evaluated to correct for over or under exposure after the examination is finished by eliminating the need for some women to undergo repeat mammograms before leaving the digital mammogram facility.

IX. Advantages of digital mammography systems

The advantages of digital mammograms are:

- Digital mammograms are quicker than film mammograms, because there is no film to develop. The obtained image can be sent immediately to the radiologist for viewing. If the image is unclear, then the image can be retaken. This helps to reduce the callbacks of mammogram and stress on

patients.

- Digital mammography uses low radiation than traditional film mammography, by reducing their lifetime exposure to X-rays.
- Digital Mammography improves the contrast between non-dense and dense tissue of breast.
- Digital mammography uses quicker acquisition of image.
- Digital mammography examines the image in a short time.
- Digital mammography can store the image easily.
- Physician of the Digital mammography evaluates the images of breast for sharp and correct detection of breast cancer.
- Digital mammography has the ability to correct the over-exposure of films without having to repeat the digital mammograms.
- Digital mammography transmittal images over network or phone lines are taken for consultation with the physicians.

In future, digital mammography may provide many benefits over standard film mammography.

X. Disadvantages of digital mammography systems

While digital mammography is quite developing, it still has extra problems to undergo before it replaces the conventional mammography. Digital mammography must:

- Provide high brief resolution.
- Become less expensive.
- Provide a method to compare the images of digital mammogram efficiently with the existing films of mammography in monitors.

References

- [1] Feign S A, "Current status of screening mammography?", 2002.
- [2] Johnson P, "Mammographic referral patterns for breast imaging", Pear Tree Press, 2006.
- [3] Reid M, "Advances in breast imaging", 2005.
- [4] Smith R A, "Guidelines for the early detection of cancer", 2004.
- [5] Wendy P, "Imaging of the breast for the detection", Physics Publishing, 1999.
- [6] Pisano E D, "Digital mammography", 2005.
- [7] Bruising J H, "Digital Mammography: An Updat", 2006.
- [8] Goldsmith S J, "Evaluation of cancer patients", 2003. Newsfeed G, Detection and evaluation of breast abnormalities, 2004.
- [9] Sickles E A, "Annual screening of mammography for women", 1998.



Mohammed Khalid Kaleem has received B.Tech degree in Computer Science & Information Technology from J.N.T.U, Hyderabad, India in 2003, and also Post Graduate (MEng) in Wireless Communication from Canada in 2007. He was a Lecturer with Department of Electrical Engineering in King Saud University, Saudi Arabia from 2008-10 respectively. His research interests include Image Processing, Data Mining, Artificial Intelligence, Cloud Computing and Cryptography.