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A novel Expert System for Diagnosis of Fetal Alcohol Syndrome using Close Range Photogrammetry

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A novel Expert System for Diagnosis of Fetal Alcohol Syndrome using Close Range Photogrammetry

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Abstract

Remaining necessary information will be received from the patient along with the output of last stage applies to expert system. Decision making in expert system is based on fuzzy method which is done in two stages. In the stage of extracting data from image, according to provided samples, the operator can choose the key points manually. However, due to the dependence of this method to the operator, it is recommended to the user to select image processing the accuracy and validity of input parameters extraction and accelerate the effective of the whole process.

In this paper, we have tried to present an expert system to diagnose fetal alcohol syndrome in which we are able to diagnose the diagnose without the need for an expert. In this method according to the input image, the parameters for diagnose of eye deformities extracted and will be sent to the expert system as input.

Keywords

Disease diagnosis, Expert system, Integrated system, Medical image, fetal alcohol syndrome.

1. Introduction

September 9th is recognizing as reminiscence of fetal alcohol syndrome. On this day, many countries follow ways to control and prevent this disease, but most active countries in this field are countries with the excess use of alcohol and there is special culture, which has little control of personal behavior of women and men so special form of irresponsible behavior specially in families.

Usually, the most active countries are Germany, USA, England, New Zealand, Sweden, Canada and Austria. Annually 40 thousands infant all over the word born with this syndrome who suffer from fatal brain damage and forms of facial physical of face and body. This syndrome is more prevalent than Down syndrome and most of connate physical and brain disorders and among every one hundred birth one infant born with this syndrome.

In the image-based medical diagnosis instruments, interpretation of acquired images is an important step. Usually, interpretation process is carried out by human experts who do it based upon their knowledge and experience. According to developments within the field of intelligent systems, using the capabilities of these systems can improve the interpretation process of medical images. One of the systems can be used for intelligent interpretation of medical images is expert system. Expert system is capable of decision making using human expert's knowledge and is used as an intelligent decision making unit in a medical device recently, some investigations have been carried out in the field of integration of medical imaging and expert system capabilities for disease diagnosis.

According to the measurement capabilities of close range photogrammetry as a data-acquisition method and expert system abilities as an intelligent decision making

system, the main idea behind the research is to suggest an image based medical diagnosis method by integration of these systems which can be useful in clinical environments for non-expert operators.

2. Symptoms of fetal alcohol syndrome

Distinctive facial appearance including little eyes, thin upper lips, flatness of cheekbones, lightweight birth, mal, weakness in the development of fine motor ability, inability to understand concepts such as time and money, heart defects, deformity of the joints, limbs and fingers, slow physical development, vision and hearing problems, microcephaly, mental retardation, developmental delay, unusual behavior, such as: lack of concentration, hyperactivity.

Some of these factors as the facial phenotype which include little eyes and thin upper lips is measureable with photogrammetry and other items are measureable observation of the patient's condition or inquiry.

2-1- Expert system

Expert systems are computer programs designed to emulate the work of experts in specific domains of knowledge. An expert system stores the knowledge and uses it to make a decision.

An expert system has four main elements as follows.

- Knowledge-based (KB).
- Inference engine.
- Explanatory interface.
- Knowledge acquisition module.

Knowledge base is the most important part of an expert system and as mentioned in [19], power of an expert system depends on its knowledge base. The knowledge after acquisition in a specific domain is stored and represented in the knowledge base as rules. The rules are used as the representation of knowledge in the knowledge base. The inference engine analyses and interprets the stored knowledge. Explanatory interface is the part of an expert system which user can interact with the system, enter questions about a problem and get the responses from the system. Knowledge acquisition module allows the user to enter new knowledge to the knowledge base and develop its knowledge domain. Fig.1 illustrates relations between elements of an expert system.

Medical expert system is a common type of intelligent systems in medical applications. The knowledge of a medical expert system is usually defined in a limited specific domain. So, as a medical expert, a medical expert system can make a decision about limited domain of diseases.

3. Integration of close range photogrammetry and expert system for medical applications

The suggested system needs 3 main sections in order to have an acceptable responsibility during a disease diagnosis process. These sections are:

- Data acquisition section for getting required data from affected area.
- Data processing section.
- Decision maker section.

In order to increase the system capability, avoid any user error and diagnose a disease instantaneously, these sections should be integrated. Interoperability is an important factor which should be considered as the integration of these sections. Interoperability is the ability of two or more hardware or software components to directly cooperate or communicate despite of their differences in programming language, interface and execution platform.

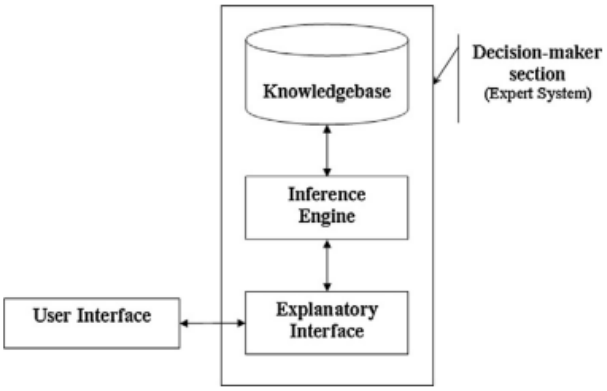

Fig. 1. Main structure of an expert system.[6]

VB can be applied for implementing the interface system. In the following sections, the method of choosing appropriate tools for implementing each part of the integrated system has been explained.

3-1- Data acquisition section

In order to choose an appropriate technique for implementation of the data acquisition section, four following factors should be considered:

– Using the system should be simple enough for nonexpert operators at clinical environments.
– The system should be affordable.
– The system should be safe for patients and has no side effect on the human body.
– The system should be capable of reconstructing the 3D model with high accuracy and precision.

According to the advantages of close range photogrammetry which were explained in previous sections, close range photogrammetry can be used for implementation of the data acquisition section in the integrated system.

3-2 Decision-making section

The disease diagnosis section needs a system which could detect input data, play the role of a medical expert and fulfill several expectations such as:

- Containing enough rules to support decision making process.
- Doing complicated inferences using simple rules.
- Supporting fuzzy rules.
- Answering user questions and explaining the results

One of the useful systems in this field is expert system which is interesting for researchers in medical applications and can be utilized as the decision maker section in this research. For implementation of the decision maker section, three tools include:

- Artificial intelligence programming language
- Expert system shell.
- Expert system developing environment

Can be used, Artificial intelligence programming language is more flexible than the other implementation tools. So, it is a good choice for implementation of the decision maker section. Main architecture of the suggested system is shown in Fig. 2.

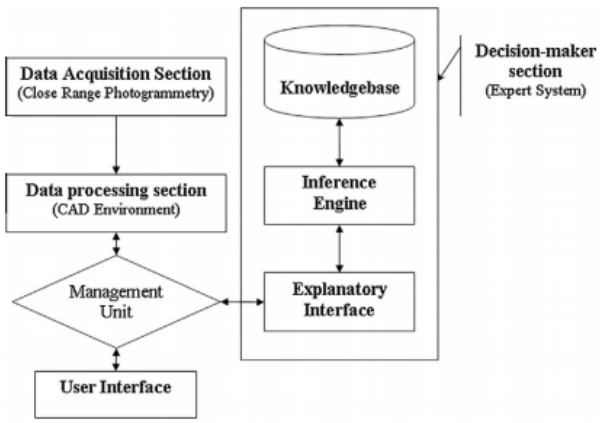

Fig. 2. Main architecture of the suggested system.[6]

4. Implementation and evaluation of the integrated system

As discussed in the previous sections, the suggested system is a medical diagnosis system. Its application is disease diagnosis and proposing some comments to cure the disease. This system is applicable to different types of medical problems chosen according to imaging system characteristics. In data acquisition section of the system, imaging operation is carried out in a visible part of the electromagnetic spectrum. So, the integrated system can be used for the diseases whose symptoms are visible or appear as deformations out of body and around the affected area. A group of disease with such characteristic is deformity. Deformity is a type of disease in which a part of the patient's body changes from its healthy and natural form and in some cases it can cause physical and visible changes out of the body.

One of this anomalies is fetal alcohol syndrome which is offered for implementation and assessment in this study. Fetal alcohol syndrome can involve some of these anomalies:

Eye measurement

1. palpebral fissure length
2. outer canthal distance
3. inner canthal distance
4. Interpupillary distance

And also thin of upper lip

Moreover than external symptoms, this disease involves group of mood disorders such as pertinacity and aggression. Also existing information from birth time can be affective such as ambiance of head and birth time weight, also epilepsy can be one of symptoms.

4-1- Taking information from patient

Taking information can be done in two ways: Part of information can be earn by inquiry and some part draw out from photos.

The first step is to implement the data acquisition section of the system for generating 3D model of the selected organ (foot). The most important hardware in this step is an appropriate camera for capturing needed images. A non-metric digital camera was used to capture the images. The camera specifications are introduced in Table 1 Data acquisition process can be summarized in the four following steps:

1. Camera calibration.
2. Catching proper photos
3. Draw out needed information from photos
4. Receive other information from patient

Camera calibration:

Result of the camera calibration process is shown in Table 2.

Catching pictures

Catching pictures must be enough precise and according to photo 3 which is caught from proper direction.

Drawing out proper information

The first step is drawing out necessary information from photos which contains following parameters:

- palpebral fissure length
- outer canthal distance
- inner canthal distance
- Interpupillary distance

These parameter can be seen in fig 5.

In second step, the output of processing information which is earned from first step gathered with earned information from patient which is received from user interface include the following

- Birth weight

- Head circumference at birth
- A history of epilepsy attack
- Pertinacity
- Moodiness
- Thin upper lip

Table1. Specifications of the digital camera used to capture the images

Camera specifications	
Name	Canon
Model	SX230 HS
Format size	6.1976 × 4.6482
Focal length	5 mm

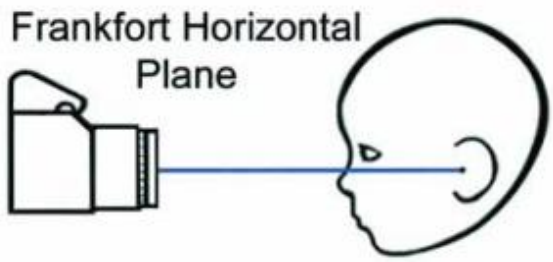

Fig3. Proper form of catching photo [2]

Fig4. Sample Image

Table2. Result of camera calibration process.

Parameter	Value	Deviation
F – focal length	5.136029 mm	6.6e−004 mm
Xp – principal point *x*	3.006705 mm	7.3e−004 mm
Yp – principal point *y*	2.254518 mm	8.3e−004 mm
*K*1 – radial distortion 1	1.164e−003	2.0e−005
*K*2 – radial distortion 2	−7.818e−006	1.6e−006
*K*3 – radial distortion 3	0.000e + 000	
*P*1 – decentering distortion 1	1.467e−003	9.7e−006
*P*2 – decentering distortion 2	−6.603e−004	1.1e−005

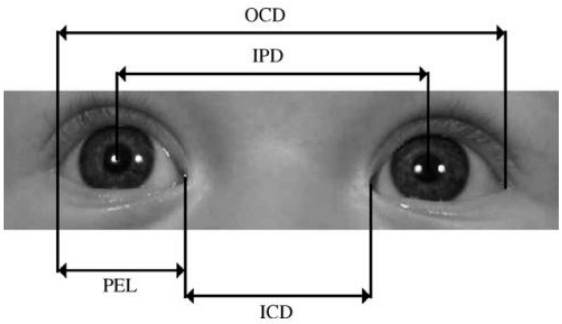

Figure 5. Necessary spots for drawing out information [4]

4-3- Decision making process

The main sources for developing knowledge base of the expert system are the knowledge and experience of human experts and published sources.

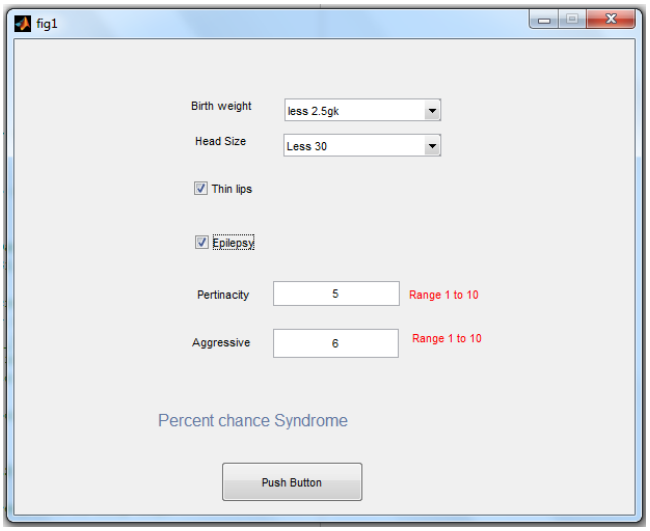

Fig6. User interface and fuzzy information about a patient

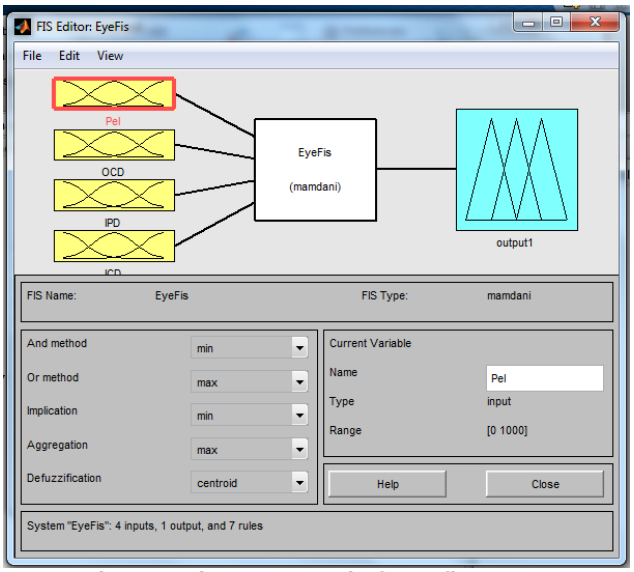

Fig7. Used parameters in fuzzy first step

Its focus is on describing the representation of the cognitive elements which define goal generation and decision-making. It is a reliable method for extracting human knowledge because it is based on the observations or an interview. Thorough knowledge engineering process, useful and basic knowledge was extracted and became ready to represent as rules in the form of

"If <cause>, then <effect>"

In this study, method of fuzzy deduction is used in two steps for decision making based on saved fuzzy knowledge in the knowledge base.

First step is a set of Fuzzy values (with four member) which performs a fuzzy process as figure 7 and in second output step, fuzzy deduction process is set of fuzzy value (with seven member) which performs fuzzy action.

In first step in regarding to existing rules, incompetency and physical problem with the eye is diagnosed and the output from this step is used as a one of the inputs of next step. In second step other information receives from the user and the final decision making is will perform.

5. Conclusion

Integration of image based measurement methods and expert system are a good approach for developing and utilizing artificial intelligence and intelligent systems in medical applications.

Automatic image processing techniques can help increase the accuracy of the system parameters and thus the output for this program.

Designed system in this study is a semiautomatic intelligence diagnosis and can be used for diseases that have visible symptoms.

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