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COMPLEX PROJECT FOR DEVELOPMENT AN EQUIPMENT FOR 3-D PICTURING AND MEASUREMENT OF ATHEROSCLEROTIC PLAQUE MANAGEMENT

MANAGEMENT KOMPLEXNÍHO PROJEKTU NA VYTVOŘENÍ ZAŘÍZENÍ PRO 3-D MODELOVÁNÍ A MĚŘENÍ ATEROSKLEROTICKÉHO PLÁTU

Abstract

This contribution presents management system of a complex grant project focused to the development of the equipment for 3-D picturing of carotid artery. The presented results have been obtained during the soling of research project GA 101/06/0491 supported by the Czech Science Foundation.

Abstrakt

Článek prezentuje systém řízení komplexního projektu zaměřeného na vývoj zařízení pro 3-D zobrazení artérií. Prezentovaných výsledků bylo dosaženo díky podpore Grantové agentury České republiky, při řešení projektu GA 101/06/0491.

1 INTRODUCTION

The ischemic stroke is the third most frequent reason of death and the most frequent reason for disability of our population. Therefore it is becoming a significant social and economic problem. Ischemic strokes participate 85% of all the strokes. The highest risk factors are hypertension, hypercholesterolemia and smoking. The atheromatosis of carotid arteries is the most frequent stroke aetiology factor. This takes part in stroke development by its 30%. This study aims is a development and following test of an equipment for 3-D picturing. To create 3-D picture we have to make three steps. The first step is acquisition, the second one is reconstruction and the third is rendering. We have to work out computer system for measurement 2-D sonograph pictures, for 3-D reconstruction and final creating of all pictures. Than it is necessary to suggest and bring the construction of shoulder keeping ultrasound probe to existence and to solve the mechanisms of movement of probe.

In the last period of the design all the system above mentioned will be tested by repeated measuring on the group of volunteer. The lengths of all the study will last three years. The meaning of the project is based in practical application of the system – the possibility to measure the progression of atherosclerotic plaque in the area of carotid artery preciously and to predict a risk of ischemic stroke.

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2 CURRENT STATE OF PROBLEM

The ischemic stroke is the third most frequent reason of death (mors cause) and the most frequent reason for disability of our population. Therefore it is becoming a significant social and economic problem. Ischemic strokes participate 85% of all the strokes. The highest risk factors are hypertension, hypercholesterolemia and smoking.

3 AIMS OF PROJECT AND DESIGN OF SOLUTION

3.1 Aims of project

The aim of this project is to develop and test the equipment for 3-D ultrasound measuring atherosclerotic plaque in carotid artery bifurcation. To create 3-D picture we have to make three steps:

- to get picture data of 2-D sonograph picture
- reconstruction of these data
- to create final 3-D picture

We expect that our system will be able to correct measure volume of atherosclerotic plaque. It is necessary to 3-D ultrasound measuring atherosclerotic plaque to make computer system for measuring 2-D sonograph picture, for 3-D reconstruction and final processing the picture.

Than it is necessary to suggest and bring the construction of shoulder keeping ultrasound probe to existence and to solve the mechanisms of movement of probe.

In the last period of the design all the system above mentioned will be tested by repeated measuring on the group of volunteers.

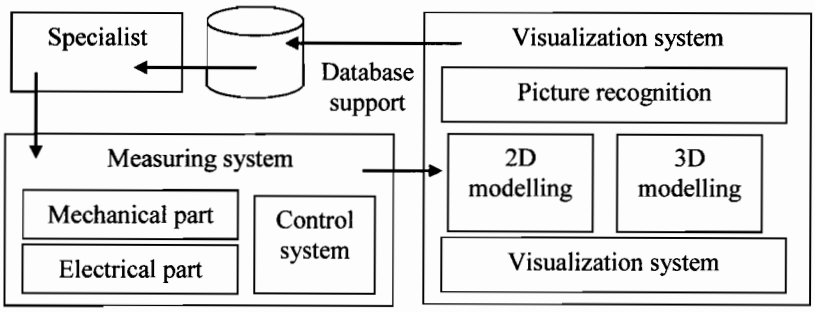

Fig. 1 Developed system main structure

The whole project will last three years and will be divided in to three one- year period.

Period one: 2006 year

1. Suggestion and solving of computer system for measuring ultrasound picture and creating the object in 3-D picture.
2. Establishing graphic working place including connecting it with ultrasound machine.
3. Design of the construction of the shoulder including keeping the probe and mechanism of its movement.

Period two 2007 year

4. Development of the system driving the probe movement
5. Establishing the shoulder and the probe catching including the mechanism of the movement.

6. Solving how to recognise the points of interest of the object in the picture by using ways of artificial intelligence and animation the measuring process.
7. Data and function analysis of data system for measuring evidence and their searching.

Period three 2008 year

8. Testing exam of data system – how to make measurements and their searching.
9. The testing of the system on the group of volunteers which is repeated.
10. Publishing the results on internet and in periodicals

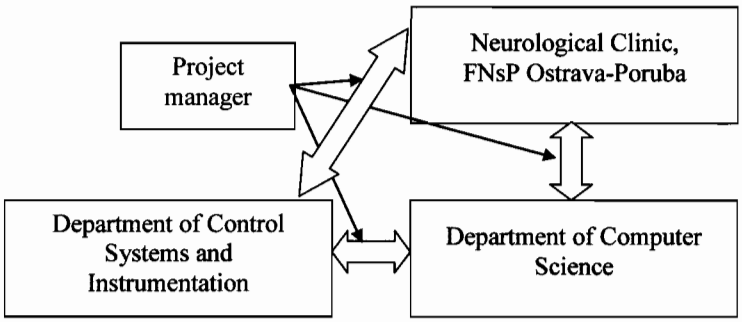

Fig. 2 Project collaboration model

3.2 Probe movement controlling and connection of ultrasound device with graphical workstation

The present state requires a doctor to place the probe into the proper position and to define the beginning and the end of the recording.

To be able to determine the exact position of actually performed ultrasound picture scan, it is necessary to develop a mechanism which could setup the location of the ultrasound probe and send back its position for validation. The worm gearing (ball-screw) with the ultrasound sensor located on it will be probably used for this purpose. The entire mechanism will be attached to bed using bracket. Drive unit will comprise of an engine with transmission or – if the outdoing force allows it – stepping engine. Controlling unit will be based on monolithic processor PIC made by Microchip. Communication between PC and the controlling unit will be provided by RS232 interface or by generation of TTL signals.

Created mechanism will allow setting of the probe location in the dependence on the actual incision scanning. The mechanism and controlling system will be realized at the Department of Control Systems and Instrumentation FS VŠB-TU Ostrava in the period on and period two of the task solving. Control system will be designed with use of many previous experiences [4, 10, 12, 15, 16]

3.3 Retrieval of graphical files for following computer processing

Used computer system contains graphical adapter with input interface for video signal. For graphical files retrieval will be developed special software (single purpose program), which will handle the transfer of selected images from ultrasound probe to BMP format file, which will be stored on hard disk of computer system [1, 2, 3].

3.4 System for measurement and evaluation of ultrasound images

The main goal of the system is to present measured data both in graphical form and in the form of the tables and compositions [8, 9, 11, 13, 14].

2-D Modelling

The main goal of the system is to present measured data both in graphical form and in the form of the tables and compositions.

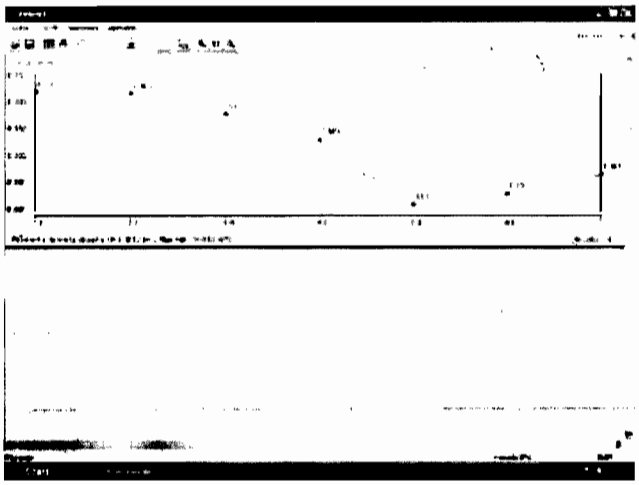

Fig. 3 Output graph

3-D Modelling

For applying the 3-D scene on the monitor of the computer, which has the physical ability to figure only 2-D objects, it is necessary to transform this 3-D scene. For this purpose the projecting is used in the computer graphic. The projecting means to depict the vector $(x',y',z') \rightarrow (x, y)$,). The most famous kinds of the projecting see Fig. 4.

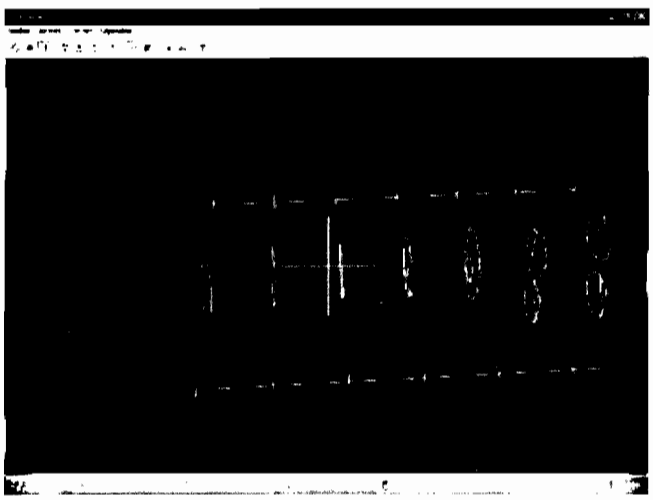

Fig. 4 3-D model

Measuring Process Animation

Object animation is the fundamental projecting mode. It concerns the projection or animation of objects on a certain background which is often made of the measured image.

Deviation Measuring

Provided that the measurement of the object is done utilizing photogrammetric methods, both direct values of the objects of interest and the deviations of those values from chosen mean or original values are of interest to us.

Synthesis of Two Measurements

It is more convenient then to figure the parameters from the actual measuring into one graph together with parameters from the previous measuring, towards which we want to identify changes.

Feature Objects Recognition

The recognition of points of interest at the photograph is used for finding out and consequently defining values for the coordinates X_i, Y_i. The data file is to be the result of these values. For specifying the positions of each points, there are known rows of algorithms and methods.

System Architecture

System will consist of the following modular structure:

- Module – Feature Points and Objects Selection.
- Module – 2D Modeling of the Measurement Process.
- Module – 3D Modeling of the Measurement Process.
- Module – Measurement Process Animation
- Module – Deviation Values Measuring
- Module – Two Measurements Comparing
- Module – Feature Points and Objects Recognition

System for Measurement and Evaluation of Ultrasound Images will be implemented at the Department of Computer Science FEI VŠB TU.

3.5 Data and Functional Analysis of Database System for Measurements Recording and Look Up

Data and functional analysis with the proposal and realization of the database system used for measurements recording and look up will be realized at the Department of Computer Science FEI VŠB TU Ostrava in the period two of the grant task solving.

3.6 Design of Graphical Workstation at Neurological Clinic FNsP in Ostrava

The neurological clinic of FNsP in Ostrava is among the other things equipped with personal computer assigned to paperwork processing which is mostly of medical type. A need of the workstation equipped with high-performance computing system arises out of the demand for diagnostic quality improvement and research of disease progress and its treatment. This workstation will be used for processing of 2-D images acquired from ultrasound measurements. Furthermore it will be used for 3-D reconstruction of observed objects and related computations (determining of position, surface, volume). There will be also statistical computations, animations of measuring process, artificial intelligence tasks (feature objects recognition) and the presentation of reached results made.

4 CONCLUSIONS

By this project a movement of the probe will be solved at first place. By single purpose program will be ensured the transfer of particular images to BMP format. These images will be processed by graphical system.

System composed in this way solves the requests specified by the object measurement in pictures with modern methods. 2-D modelling of the measurement process and the matter of relative rotation of the objects will be solved. Also 3-D object modelling containing all required common

functions (e.g. zoom, rotation, shifting and incisions) and computer animation of objects and pictures will be implemented. Both evaluation of deviations from calculated mean or original parameter values and comparison of two measurements of the same object will be available. The recognition of feature points or objects in the image is important and complex task, because it affects speed and effectively of image data processing. Recognition will also be a component of the system.

In the end of project will be solved functional and data analysis for database system serving for searching and evidence of measurements. System for presentation of achieved results at WWW will be also solved.

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