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WT2.9: University of Bradford, Bradford, Great Britain (UBRA)

Report

Activities performed during the visit

in University of Bradford, Bradford, Great Britain (UBRA)

period: ..08.06.2015...... -...13.06.2015.....

author: …Martin Tabakow………………

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 316097 [ENGINE].

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Personal Information

Mr./Ms. ………………Martin Tabakow……………………………………….., faculty member of ………… Wroclaw University of Technology, Poland ……………………. visited
(name of sending institution, country)

…… University of Bradford, Bradford (UK), School of Electrical Engineering and Computer Science ………. in the period from …08.06.2015……. to ……13.06.2015………………. in

(name of the visited institution, country)

order to carry out research and training activities in the field of…Bioinformatics (exploration and analysis of medical data)...……………………………………………………..

(give the area)

Information about Seminars

The seminar presentation was organized on ……… Thursday (11.06.2015)………..………………….

the date

It was entitled:

Some applications of fuzzy techniques in medical data processing

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Description of scientific activities

(Please describe value added to the ENGINE project i.e. new knowledge, new skills with respect to the objectives of the project, the assigned common area of future cooperation with the partner, plans for common research, projects, publications and how it could be used in the scope of ENGINE)

The main objective of the visit was to present the idea of a research project concerning the development of intelligent prosthetic limbs. The project proposal was entitled as 'Intelligent 3D-Printed Bionic Arm'. We are going to work on the submission of the proposal within the Horizon 2020 framework, dedicated to the above subject. The second goal was to look for new opportunities of research collaboration in the field of histopathology image processing and analysis.

Addressing the first objective, the following activities has been completed:

- Discussion of the possible research challenges and consortium partners, including possible cooperation with business entities. The result of the discussions was the preparation of a document describing the objectives of the project.

Find below, some details:

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Intelligent 3D-Printed Bionic Arm

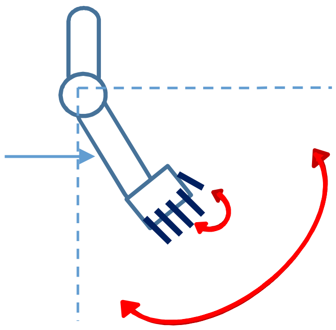
(*brief description of the basic concepts*)

Project objective: Development of 'smart' 3D-printed prosthetic limbs, with adaptation mechanism (for example based on learning procedures), which would provide sufficient functionality for patients, based on surface Electromyography (sEMG) signal analysis. The adaptation mechanism should relate the sEMG signal values to corresponding degree of device action.

Strong assumptions:

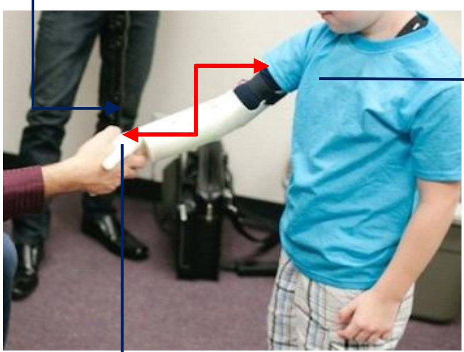
Hardware:

(1) At least four degrees of freedom – work of the palm (catch/release); work of the elbow (stretch/bend)



Assuming, degree of device actions (smooth movements), based on sEMG signal analysis and corresponding control model.

(2) Applying only sEMG sensors,
(3) Minimum number of sEMG sensors,
(4) Cheap hardware elements (control unit – for example: raspberry pi),
(5) All elements of the arm should be 3D printed in order to minimize the production costs,
(6) Feedback information simulated with pressure sensors , in order to provide sensing.



The degree of pressure, should give corresponding degree of ‚shock' impulse (object sensing feeling)

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using pressure sensors (located on the fingers)

The cost of the hardware should be minimized – this is major requirement.

The quality of the arm functionality should depend on the software applied.

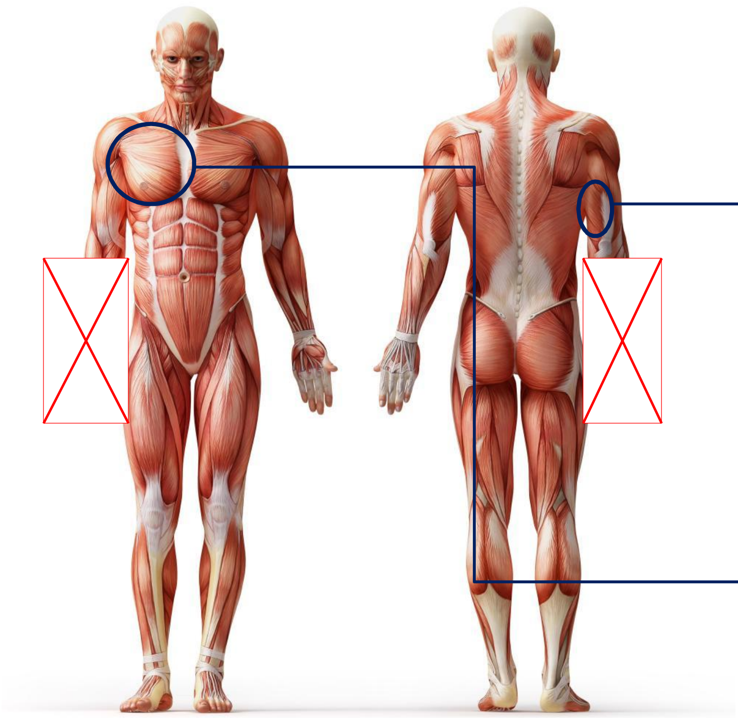
Software:

(1) Proper recognition of the sEMG signal – searching for signal features, that affect the control process,
(2) Investigation of the possible relations between the data gathered from different muscles,
(3) Preparation of adaptive learning mechanism in order to personalise the device,
(4) Preparation of the control module (for example, based on **Fuzzy Sets of Type 2**) ensuring smooth manner of device actions.

Medical issues:

Assuming cooperation with Rehabilitation facility.

(1) Identification of the target group of muscles that can provide sufficient information for control, with respect to the level of amputation,
(2) Preparation of corresponding rehabilitation procedure in order to stimulate the target group of muscles,



The triceps muscle might be used to simulate the palm action.

The proctoralis major muscle might be used to simulate the elbow action.

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(3) Possible surgery support – for example, to connect the biceps muscle with some part of the bionic arm or to extend the remaining bone. Otherwise, the biceps cannot be used in the control process.

Levels of research complexity:

Level 1 - simple: Engineering approach – it is enough to monitor only one muscle with respect to the sEMG and a corresponding threshold value (T). The arm will be controlled in binary mode with trivial control rule – If the sEMG reaches values ≥ T then 'action1' (if the previous action was 'action 2') or 'action 2 ' (if the previous action was 'action 1') .

Level 2 – advanced: Research & Engineering – introducing smoother operations of the arm, by applying fuzzy control (of type 2) for example. The degree of 'arm action' should give better performance in practice, more sensitive to real objects – meaning, there is difference between grabbing egg or glass, than objects made from steel.

Level 3 – advanced: Research & Engineering – we may extend the research level 2, by monitoring of groups of muscles. This should increase the functionality of the arm.

All above subprojects, should involve learning procedures as well as corresponding rehabilitation procedures, in order to adapt the software parameters to a specific patient (to personalize the arm).

Level 4 – high complexity: Research & Engineering, assuming cooperation with appropriate medical facility - electrodes for prosthetic arm permanently implanted into the stump. Therefore, the objective is to achieve almost perfect arm substitute with surgery support.

In the research discussions were involved: Dr Martin Tabakow (Wroclaw University of Technology), Rami Qahwaji, Professor of Visual Computing (Bradford University) , Dr Mhd Saeed Sharif, Research Associate (Bradford University), Raed Abd-Alhameed, Professor of Electromagnetics & Radio-Freqency Engineering (Bradford University). Initial preparation to corresponding state of the art joint research publication was also discussed.

Addressing the second objective, several meetings took place, presenting the possibilities of cooperation within the field of cancer recognition and drug design with the support of computer aided techniques. In the research discussions were involved: Dr Martin Tabakow (Wroclaw University of Technology), Dr Samar Betmouni, Director of Clinical Pathology – Faculty of Life Science (Bradford University), Mohamed El-Tanani, Professor of Molecular Pathology and Cancer Therapeutics (Bradford University), Rami Qahwaji, Professor of Visual

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Computing (Bradford University) , Dr Mhd Saeed Sharif, Research Associate (Bradford University), Dr Krzysztof Poterlowicz, Lecturer in Bioinformatics.

The above meetings and research discussions were related to the seminar presentation of Dr Martin Tabakow, as it described his recent research in Bioinformatics. The presentation was consisted of three parts:

1. 'Recognition of HER-2/neu Breast Cancer Cell Membranes with Fuzzy Rough Sets'

The human epidermal growth factor receptor 2 (HER-2/neu) is a biomarker, recognized as a valuable prognostic and predictive factor for breast cancer. It is very important issue in modern breast cancer diagnosis, to introduce correct identification of the HER-2/neu positive breast cancer patients. This can be done by accurate recognition of HER-2/neu cancer cell membranes that are visualized as 'HER-2/neu overexpressed' on images acquired from corresponding histopathology preparations. In order to segment this structures, a new approach which uses appropriately defined fuzzy set approximations, with respect to corresponding image features was discussed.

2. 'Decision Support System for Histopathological Diagnosis of HER2 Breast Cancer using Pawlak's Information System and Mamadani Type Fuzzy Control'

In this part, the specification of a histopathology decision making support system, based on Pawlak's information system concept and Mamdani type fuzzy control, was discussed. The proposed procedure was applied as a recognition process of HER-2/neu histopathology preparations through microscopy image information analysis. The Pawlak's information system methodology was applied in order to generate decision rules under the considered problem. The so generated rules can be easily transformed into fuzzy rules and exploited in the Mamdani inference model.

3. 'Proposition of Electromyographic Signal Interpretation in the Rehabilitation Process of Patients with Spinal Cord Injuries'

Surface electromyography (sEMG) is one of the examinations within the protocol of neuro-rehabilitation processes, that allow the assessment of possible patient progress with respect to conductivity of neurons and skeletal muscle functionality. The interpretation of sEMG signal is one of the critical issues that should be considered in order to diagnose patients with severe spinal cord injuries. Currently, it is very hard to relate values gathered from sEMG to existing reference scale of patient rehabilitation progress. What more, the

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interpretation of the signal data is very subjective and it is also strongly related to current physical disposition of the patient. Therefore, the objective of the proposed research, was to introduce a mathematical approach which determines the patient's physical condition, based on sEMG data. To achieve this goal, the application of a properly defined fuzzy Sugeno integral was discussed. The proposed aggregation operator allows to combine both: subjective expert knowledge and signal data.

………

Information referring to the intellectual property

(the generally binding low in this area in the visited country and procedures of patenting);

……

Description of the cooperation between universities and industry

(how it is organized in partner's organization, the sources of funding, the opinions about drawbacks and strengths of existing solution).

....

Other activities

.... Presentation of some research projects of students from the Technical University of Wroclaw: '*3D reconstruction of brain structures*' and '*Computer system for Neuronavigation*'

....

REMARK: Apart from this information also a program of the visit and the presentation in electronic version should be given to the project office (please send all of them to Urszula.Markowska-Kaczmar@pwr.wroc.pl). Please respond to the points 1-5 for outgoing visit and points 1-3 for incoming visit. Point 6 is for extra activities that are not put in points 1-5.

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