Objective of the project

Human actions recognition and analysis systems have been present in literature and implemented for many years. In this scope, many scientific papers and commercial systems aim at the sign language analysis. This problem is especially important because efficient gesture recognition system of this type aids to interact with deaf and deaf-mute because not many people know how to communicate with person with disable senses. From the other hand full body movements / action recognition was not so much examined. That was due the fact that for many years systems (mostly hardware solutions) that enabled acquisition of gestural data (like motion capture technology) were relatively expensive and could not be easily set up in undedicated environment. In the last few years we can observe a boom on gesture recognition systems that is mostly caused by introduction to market new multimedia devices that uses infra-red projector and camera to generate depth maps (the most popular from this family is Kinect). The close look on methodologies of gestures recognition reveals that even though the problem of movements classification is well known and investigated for many years it is very difficult or nearly impossible to indicate the one leading methodology that deals with this problem and is reliable and in the same time applicable in commercial practice, especially in sport activity recognition and natural (gestural) user interfaces. The aim of this project is to propose and present evaluation of a novel computer methods that satisfies those needs.

The scientific problem aimed to be solved in our project will be following:

- To propose efficient and effective action recognition and analysis methodologies for sport activities, physiotherapy and kinesytherapy. The proposed solution will be scalable method, that will integrate in single scientific framework many approaches capable to analyze both low-quality multimedia tracking data and high-end motion capture data streams.
- To propose and evaluate methods for qualitative and quantitative evaluation of various physical activities.
- To develop real time system that implements above methods.
- To create and publish large open scientific datable for human actions recordings.

The scientific hypotheses of this research are:

- It is possible to create effective and efficient sport (karate) and physiotherapy actions classier with real-time performance using existing and novel pattern recognition, machine learning and signal processing methods.
- With above methods it is possible to perform qualitative and quantitative evaluation of actions ("similarity" to optimal patterns) that can be used in computer couching systems and physiotherapy solutions.
- The results of the researches can be standardized and unified into single syntactic description that can be easily reused in further projects by scientific community.

The basic research to be carried out

The aim of our research project is to create effective and efficient sport, physiotherapy and natural user interface actions classier with real-time performance using existing and novel pattern recognition, machine learning and signal processing methods. In order to solved this scientific problems we will have to validate the proposed methodologies on different real (not generated in laboratory) and "difficult to classify" data sets. Our new approach will be highly scalable supporting different levels of precision of movements' analysis. We will achieve this goal by creating several body kinematic models that will be sufficient to satisfy needs for sport, physiotherapy and natural user interfaces data processing. The starting point for our researches will be a Gesture Description Language classifier which is an original idea of Principal Investigator. The data will be gathered with professional equipment with the aid of sport trainers and doctors of medicine. The results of the researches will be standardized and unified into single syntactic description that can be easily reused in further projects by scientific community. However it is not intended to yield immediate commercial benefits of those implementations. The software will be developed for evaluation purposes only and will lack of elements that would make it commercial products (like user-friendly interface, installation and deployment testing etc.). All of those elements that are required before product can be commercialized are long-drawn activities and we do not reserve time for them in our project schedule. After the project is finished and when new technology will be standardized and fully evaluated we anticipate basing on scientific and popular publications that it quickly becomes very important part of future technology including personal computer sport coaches or natural user interfaces for virtual reality systems. The short term benefits form created technology will be mostly in scientific area.

Reasons for choosing the research topic

There are several very important aspects that should be considered while choosing proper action classification and analysis approach. An optimal choice is a method that provides high recognition rate and in the same time operates on features that are invariant to rigid transform of observed object, has a stable training algorithm and operates in real-time on unsegmented (real-live) data.

All approaches utilizing fully aromatized techniques of human body movement recognition/analysis either require very large training and validation sets (consisting of dozens or hundreds of cases) or have to be manually tuned, which might be very unintuitive even for a skilled system user. The aim of this project is to propose, evaluate and initially implement intuitive standardize framework for sport, physiotherapy and common-live human actions. Our state of the art researches has proved that so far the pattern recognition method for identifying human actions/body movement that satisfies the scientific hypothesis of this research grant has not been proposed. The research grant on this project will give us an opportunity to create effective classifier which introduces body movement recognition technology to wide group of people interested in this field of science.

Basing on scientific and popular publications we anticipate that body movement recognition quickly becomes very important part of future technology including remote controlling of devices, personal computer sport coaches, education and many others. This project aims at establishing Poland a leader position in innovative movement description and recognition technology.

The research in inter-disciplinary group that include experienced computer scientists, sport practitioners and physiotherapist guarantee no only the quality but also uniqueness of results.

Due to growing number of affordable multimedia motion-capture hardware there will be also a growth in a need of body actions recognition solution. However by analyzing application programming interfaces that are sold with even most complicated hardware solution we can notice that very rarely companies include to them action recognition modules. It is the clear signal that there is a big gap between theory and practical solution that can be used in commercial software. In our opinion application of action recognition and evaluation in sport and physiotherapy will be in the next several years among most dynamically developing technologies. With the scientific grant we will be able to make pioneering research in this field and propose solutions with potentially big impact on whole scientific discipline.

We anticipate that the results we publish, initially implemented prototypes and open to use scientific databases quickly becomes among most successful and popular pattern recognition methods in this field. That is because of following factors:

- Up-to date subject of researches.
- Interdisciplinary.
- Interesting and unique activity databases, on which method will be evaluated.
- Potential future application in sport, physiotherapy and kinesytherapy.
- Proved applicability in various scenarios that will be investigated during this research grant.