Virtual Coach with IMU for Stroke Patient Rehabilitation

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Background
The U.S is predicted to experience a shortage of Registered Nurses that is expected to become worse as Baby Boomers age and the need for health care grows. In a 2012’s American medical journal, a shortage of the registered nurses is expected to grow in the country between 2009 and 2030. This indicated more and more patients have to take care of themselves.

In which case, how to make the most of the self-nursing and how to give those who don’t have nurses professional suggestions from the doctors becomes an urgent and valuable problem to solve.

Virtual Coach System
Virtual Coach system integrated with professional knowledge inside the system could be one of the solutions to the nursing shortage problem, since this system could be installed inside every patient’s home and give patients advice on their daily rehabilitation process in the meantime.

Virtual Coach system with Kinect and emotion recognition is a rehabilitation system designed in the Prof Asim and Prof Dan’s lab. This system is a demo designed for helping stroke patient rehabilitation process with automatic scoring functions and emotion recognition which will take care of the patients’ emotion during the exercise.

Tremor Problem
Suffering from lesions in the cerebellum resulting from stroke, cerebellar tremor appears commonly in the stroke patients. Cerebellar tremor is a slow tremor of the extremities that occurs at the end of a purposeful movement, such as trying to press a button or touching a finger to the tip of one’s nose. When patients are doing normal rehabilitation exercise, they are also experiencing the cerebellar tremor. However, the Virtual Coach system we have right now cannot detect this kind of tremor. In which case, the doctors cannot remotely monitor or give advice on the tremor problem.

Solution to the Tremor Problem
We propose to integrate an Inertial Measurement Unit(IMU) into the original Kinect based Virtual Coach system to give a tremor score on patient’s exercise repetition. Through this, we could enable the new VC with IMU system to offer a new dimension of information on the cerebellum tremor problem.

The IMU related system working process are shown in the right. And the tremor score computing algorithm are shown below.

What is our IMU?
The IMU we are using is YEI 3-space Sensor™ Bluetooth which integrates a miniature, high-precision, high reliability, Attribute and Heading Reference System(AHRS) with a 2.4GHz Bluetooth v2.0+EDR Class 1 interface and a rechargeable lithium-polymer battery solution into a single low-cost and end-use-ready unit.

Precision Parameters:
- Accelerometer sensitivity: 0.00024g/digit
- Gyro sensitivity: 0.00875º/sec/digit
- Compass sensitivity: 5 mGa/digit

Result
- Comparison 1: Good exercise with and without Tremor
- Comparison 2: Bad exercise with and without Tremor

Future Application
Tremor Score for normal people
- Tremor is an unintentional, rhythmic muscle movement involving to-and-fro movements (oscillations) of one or more parts of the body. It will not just affect stroke patients but also normal people.
- Our tremor detecting block with IMU could be used to help gain better knowledge on this health problem and help those who already suffered from the problem to know precisely about their tremor status.

Fitness Assisting Device
- Tremor could also appear when people are doing very heavy exercise which could be used to specify the quality of the exercise for gym enthusiasts.