A Sensing System for Rehabilitation Exercise and Fall Monitoring or System for Home Alert & Rehab (SHARE)

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PROJECT DESCRIPTION:

Motivation & Objectives

Stroke rehabilitation is a time-consuming process that can take up to 6 months for a patient to relearn his missing capabilities. As the rehab exercise should be done daily, home is the most convenient place to do rehab after discharge. However, with limited home-visit from their therapists, patients can hardly effectively monitor their recovery progress or whether their exercise prescription should be adjusted. Adding tele-rehabilitation to the process could mitigate the problem by reducing the time lapse. Still, remote monitoring is not scalable enough to support all the stroke patients. Some forms of automatic performance summarization such as repetition or precision of each exercise session are also important to reduce therapists' workload in the monitoring process and make tele-rehabilitation truly scalable. To practically achieve the goal, the sensing system must meet the balance between its required space, accuracy, ease of use and affordability. In addition, as a stroke patient usually has a high risk of falling, the system could use the same wearable sensing unit as a fall detector.

Methodology

- Kinect and wrist-worn 9-axis IMUs are combined to improve upper limb 3D motion capture especially for information that cannot be extracted from Kinect SDK such as forearm pronation or forearm orientation when it is occluded.
- Normal exercise patterns will be learned from healthy subjects using unsupervised machine learning techniques and the learned model will be used for anomaly/incorrect movement detection in the actual patient's exercise. This system will help therapist in the monitoring process by highlighting the important section in the time-series data and shorten their time spent on providing feedback.
- 3-axis accelerometer and barometer on the user's wrist are used to detect fall. Pattern of specific activities that are likely to generate false alarm will be learned by a similar machine learning technique to exclude some specific false alarms.

Results / Progress

- Sensor node hardware and firmware are built and implemented
- Sensor nodes and Kinect is integrated for 3D motion capture of upper limb
- Autoencoder network is found to be capable of norm modeling and anomaly detection
- A fall detection algorithm is developed with a good balance between detection accuracy, false alarm and battery life

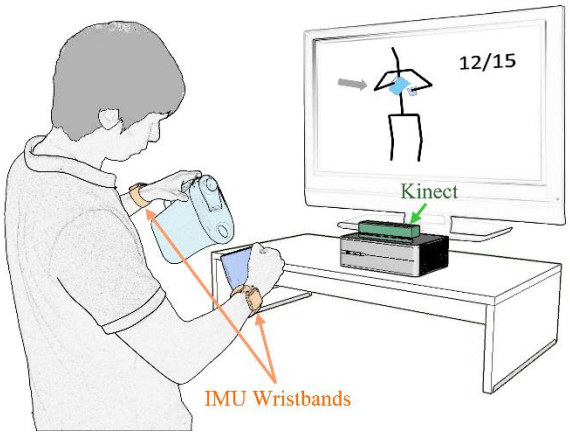

Figure 1: Rehab exercise mode integrates Kinect and wrist-worn sensor to assess upper limb movements

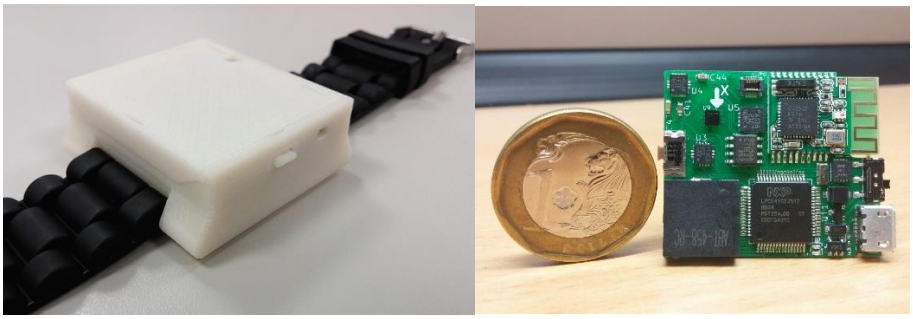

Figure 2: The developed sensor node

GRANT:

$100,000 Centre for Healthcare Assistive & Robotics Technology (CHART) Grant,
June 2016 – November 2017

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PUBLICATIONS:

Refereed Journal (Published/In Press): *Nil*

Refereed Conference (Published/In Press):

P. Jatesiktat and W. T. Ang, "Unsupervised anomalous movement detection using autoencoder reconstruction error," in *Proceedings of AUN/SEED-NET Regional Conference on Computer and Information Engineering 2016*, 2016.