

## COMPLETION REPORT

### **Socially Assistive Robot Exercise Coach for Elderly People**

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This research work presents a socially assistive robot (SAR) system developed for elderly people to help them perform multiple types of arm exercises. The experimental results and the survey have shown a very positive response from the elderly people as well as high accuracy of the proposed optimized Neuro-Fuzzy System for real-time arm gesture detection. In the presented SAR system, a virtual humanoid robot is developed to behave as a physical exercise instructor which is displayed on a large LCD screen in front of patient. The presented robotic exercise coaching system is completely autonomous and doesn't require any human intervention.

An Optimized Neuro-Fuzzy System (NFS) model is used for real-time identification of arm gestures. This NFS model is optimized using both structural optimization and the parametric optimization. Angular transformation scheme is applied to achieve the structural optimization while subtractive clustering approach is used for parametric optimization of the system. Both the optimization schemes resulted in much faster training of NFS model (several minutes) compared to other available techniques.

In the experimental session with 17 elderly volunteers (all of them ageing 60 years and above except for 1), the presented NFS based gesture recognition framework was able to correctly identify most of the gestures during exercise session. For all 17 elderly volunteers, a total of 373 gestures were identified during the experimental setup, out of which only 14 gestures were either not correctly followed by the user or were wrongly identified. The presented Neuro-fuzzy based gesture recognition system provided 96.4% accuracy.

In order get better understanding of their experience and to obtain the feedback during the exercise session, a short survey questionnaire was presented to each of 17 elderly volunteers. The survey was composed of 16 questions split into 6 different categories and was developed based on well-known research works. This survey has shown positive response from elderly in all the 6 categories, while in some categories the response was highly positive.

Overall the presented robotic exercise coaching system has shown very positive feedback from the elderly volunteers and the proposed Optimized Neuro-Fuzzy system has shown very high accuracy in practical setup.

Publication of the Results of Research Project:

Verbal Presentation (Date, Venue, Name of Conference, Title of Presentation, Presenter, etc.)	
<b>Date :</b>	1 ~3 September, 2017
<b>Venue :</b>	Himeji, Hyogo, Japan
<b>Name of Conference :</b>	6th International Conference on Informatics, Electronics & Vision (ICIEV)
<b>Title :</b>	Neuro-Fuzzy Model with Subtractive Clustering Optimization for Arm Gesture Recognition by Angular Representation of Kinect Data
<b>Presenter :</b>	Dr. Takenori Obo
<b>Authors :</b>	Atif Ahmed, Prof. Dr. Loo Chu Kiong and Dr. Obo Takenori
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<b>Date :</b>	25 ~28 August 2016
<b>Venue :</b>	Sapporo, Hokaido, Japan
<b>Name of Conference :</b>	Joint 8th International Conference on Soft Computing and Intelligent Systems and 17th International Symposium on Advanced Intelligent Systems (SCIS&ISIS17)
<b>Title :</b>	Genetic Optimized Fuzzy Extreme Learning Machine Ensembles for Affect Classification
<b>Presenter :</b>	Loo Chu Kiong
<b>Authors :</b>	Wei Shiung Liew, Chu Kiong Loo, Takenori Obo
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<b>Date :</b>	25 ~28 August 2016
<b>Venue :</b>	Sapporo, Hokaido, Japan
<b>Name of Conference :</b>	Joint 8th International Conference on Soft Computing and Intelligent Systems and 17th International Symposium on Advanced Intelligent Systems (SCIS&ISIS17)
<b>Title :</b>	Health Promotion Using Smart Device Interlocked Robot Partners for Elderly People
<b>Presenter :</b>	Loo Chu Kiong
<b>Authors :</b>	Siqi Sun, Takenori Obo, Chu Kiong Loo, Naoyuki Kubota
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Thesis (Name of Journal and its Date, Title and Author of Thesis, etc.)	
<b>Title of Thesis :</b>	A Robotic Exercise Coaching System using Neuro-Fuzzy Model & Subtractive Clustering Optimization for arm gesture recognition with Angular Representation of Kinect Sensor Data
<b>Author of Thesis :</b>	Atif Ahmed [Post-Graduate Student at University Malaya]
<b>Principal Supervisor :</b>	Prof Dr. Loo Chu Kiong
<b>Title of Journal</b>	<ul style="list-style-type: none"><li>• Takenori Obo, Chu Kiong Loo, Manjeevan Seera, Takahiro Takeda, Naoyuki Kubota: Arm motion analysis using genetic algorithm for rehabilitation and healthcare. Appl. Soft Comput. 52: 81-92 (2017)</li><li>• Takenori Obo, Chu Kiong Loo, Manjeevan Seera, Naoyuki Kubota: Hybrid evolutionary neuro-fuzzy approach based on mutual adaptation for human gesture recognition. Appl. Soft Comput. 42: 377-389 (2016)</li></ul>