



ERCIM "ALAIN BENSOUSSAN"
FELLOWSHIP PROGRAMME



Scientific Report

First name / Family name

Piyush Swami

Nationality

Indian

Name of the *Host Organisation*

Norwegian University of Science &
Technology (NTNU) – TRONDHEIM

First Name / family name
of the *Scientific Coordinator*
Period of the fellowship

Xiaomeng Su

01/04/2019 to 31/03/2021

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

Introduction:

Patients suffering from musculoskeletal/ orthopaedic problems routinely undergo exercise therapy. However, reduced biofeedback monitoring often result in delaying the rehabilitation process. Literature survey showed that such rehabilitation could be enhanced through exergaming. Since many musculoskeletal diseases have neurological aetiologies, it makes imminent sense to study physiological signals in synchronisation with the biomechanics. This could help in shedding light on the biomarkers and accelerating the rehabilitation trajectory.

Objectives:

The scientific activities targeted:

1. to develop experiment for synchronized physiological and biomechanics monitoring during virtual reality tasks, and

2. to analyse corresponding biomedical signals and gait data for revealing its correlations across different age groups in healthy participants.

Methodology:

The sensors used for the development of the experiment targeted monitoring the brain, heart rate and muscle activities. While the biomechanics reflectors were used for capturing the gait patterns. Data acquisition included eighteen healthy participants across 18-70 years. The analysis procedure involved: removal of powerline interference; bandpass filtering, independent component analysis; channel(s) rejection, baseline correction, filtering and then applying time-frequency domain techniques for analysis.

Results:

The preliminary results proved transmission and reception of markers with cent percent accuracy. Various conditions viz. different displays; variations in movement speeds; etc. exhibited observable changes in the magnitudes of the evoked potentials across the two age groups. However, walking speeds was found to be independent of age which is postulated to be due to body mass indexes. Detailed results will be published in the manuscripts.

Conclusions and Future Scope:

It is established that synchronised experiment involving physiological signals and biomechanics monitoring was successfully developed. This involved analysis of biomedical signals and gait data which foster development of machine learning models and framework for accurate and user-friendly biofeedback applications/devices in training and rehabilitation that can be used in clinical and home settings.

Acknowledgements:

The work was carried out during the ERCIM Fellowship period at the Motion Capture and Visualisation Laboratory in collaboration with the Norwegian Open-AI Laboratory at the Department of Computer Science (IDI), NTNU – Trondheim. Other collaborator at the NTNU include Prof. Beatrix Vereijken, Department of Neuromedicine and Movement Science (INB).

II – PUBLICATIONS DURING YOUR FELLOWSHIP

1. Swami et al., “Latency estimation during event-related potentials for virtual reality and LED displays,”. (Under Preparation).
2. Swami et al., “Simultaneous measurement of physiological and biomechanics data during visuomotor task,”. (Under Preparation).
3. Swami et al., “Correlations between physiological signals during visuomotor task,”. (Under Preparation).
4. Swami et al., “Effect of visuomotor in the brain connectivity,”. (Under Preparation).

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

1. Presented talk titled “Demystifying Automated Diagnosis of Epilepsy using Brain Signals & Introduction to Brain and Biomechanics Experimentation” at the Department of Biomedical Physics, University of Warsaw on 22nd Apr. 2021.
2. Presented ERCIM research work at the Game for Health Technology virtual Seminar on 23rd Nov. 2020.
3. Attended workshop on Gait Data Acquisition & Analysis at the Department of Neuromedicine & Movement Science, NTNU on 4th Mar. 2020.
4. Presented talk titled “Epilepsy diagnosis & Brain and Biomechanics during Exergaming” at Nice, France organised by the Applied Information Technology group, Department of Computer Science, NTNU on 20th Oct. 2019.
5. Attended Annual CATCH-IDI seminar organised by the Department of Computer Science, NTNU in Trondheim from 9th-10th Sep. 2019.
6. Attended Telenor workshop on Deep Learning at the Norwegian Open-AI Laboratory, Department of Computer Science, NTNU from 3rd-5th Sep. 2019.
7. Attended 10+ Norwegian Open AI Laboratory seminars at the Department of Computer Science, NTNU during the fellowship period.
8. Attended Norwegian Artificial Intelligence Symposium at the Department of Computer Science, NTNU – Trondheim on 27th-28th May 2019.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

Underwent REP at:

1. FORTH-ICS (Institute for Computer Science), Greece from 2nd-31st Mar. 2021 under the supervision of Prof. Panagiotis Tsakalides.
2. University of Warsaw in the Department of Biomedical Physics from 3rd Mar. – 15th Apr. 2021 under the supervision of Prof. Jarosław Żygierewicz.

REP with both the above institutes proved to be very beneficial in terms of exchanging new research ideas and establishing collaboration for future work.

Apart from the activities listed in above sections, the fellow:

1. completed course on Norwegian for Foreigners Level 1 (NFUT0104) during the Spring semester in 2020 from instructor Prof. Sissel Vuttudal Robbins;
2. sit-though course on Modern Machine Learning in Practice (TDT05) during Autumn semester in 2019 from instructor Prof. Zhirong Yang;
3. directly involved in the procurement of the instruments for physiological monitoring;
4. directly involved in the recruitment and supervision of two contractual research assistants in this project.