ERCIM "ALAIN BENSOUSSAN"
FELLOWSHIP PROGRAMME

ERCIM
European Research Consortium
for Informatics and Mathematics

Scientific Report

First name / Family name	SUNILKUMAR TELAGAM SETTI
Nationality	Indian
Name of the *Host Organisation*	Norwegian University of Science and Technology (NTNU)
First Name / family name of the *Scientific Coordinator*	Øyvind Stavdahl
Period of the fellowship	01/02/2019 to 30/04/2020

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

The main goal of my postdoctoral research is to develop an automated approach for early meal detection that can be used in artificial pancreas for early insulin dosage. During this tenure, we have developed non-invasive sensors based early meal detection approaches. Major activities during my postdoc are as follows:

- Data acquisition: Collect the signals acquired from non-invasive sensors attached to the human body of volunteers.
- Data analysis: Analyse the data and remove the artefacts including powerline interferences, environmental noise in the signals using signal processing techniques.
- Meal onset detection: Develop machine learning-based algorithms for early meal detection using the signals acquired from various sensors.
- Other minor activities: Apart from aforementioned activities, I have also been involved in submission of ethics applications to Regional Ethical Committee (REK), supervision of Master students, and data storage in HUNT Cloud (a local cloud service for clinical data) and writing parts of a Disclosure of Innovation (DOFI) submitted to the NTNU Technology Transfer office.

My first work at NTNU has been focussed towards early meal onset detection using abdominal sounds. Sounds from the abdomen, or gastrointestinal sounds, are normally caused by transport of food, liquids and gas in the intestines during digestion. Of late, many researchers have studied the characteristics of abdominal sounds [1, 2]. However, their main focus is towards the diagnosis of gastric disorders. Further, these works have reported the results corresponding to pre- and postprandial sounds, which did not include the actual time of meal intake. Very little work has been done in the direction of meal detection using abdominal sounds [3,4]. Therefore, we focussed our efforts towards early meal onset detection using abdominal sounds.

Here, we employed abdominal sounds recorded in two healthy volunteers with a condenser microphone. We used the Mel-frequency cepstral coefficients (MFCCs) and wavelet entropy extracted from the abdominal sounds as features. These features are fed to a simple feed forward neural network for discriminating meal from no-meal abdominal sounds.

This approach detected meal onset with an average delay of 4.3 minutes in our limited number of subjects. More importantly, it provided lesser response delay than the state-of-the-art CGM based approach, which achieved a response delay ranging from 30-40 minutes. The preliminary results indicate that the proposed abdominal sound-based approach may provide early meal onset information.

In my second work, we have recorded the signals using various non-invasive sensors including a sound recording device designed by SINTEF and a Littmann electronic stethoscope attached to the human body (the other sensor modalities are confidential). After pre-processing, statistical features are derived from the signals. Finally, these features are given to a support vector machine for detecting meal onset. This approach has provided promising results for meal onset detection (more details of this approach will be provided in the article)

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

1. T. S. Kumar, E. Søiland, Ø. Stavdahl and A. L. Fougner “Pilot Study of Early Meal Onset Detection from Abdominal Sounds,” IEEE International Conference on e-Health and Bioengineering, PP:1-4, Romania, 2019.

Abstract presentation

1. T. S. Kumar, E. Søiland, Ø. Stavdahl and A. L. Fougner “Pilot Study of Exploiting Abdominal Sound for Early Meal Onset Detection,” Advanced Technologies & Treatments for Diabetes (ATTD 2020), PP:1-1, Vol. 13, Madrid, Spain, 2020.

Article under preparation:

1. T. S. Kumar, A. Holten, Ø. Stavdahl and A. L. Fougner “A new approach for meal onset detection” [final title is confidential].

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

1. The 3rd annual conference of Digital Life Norway Research School, Bergen, 2019.
2. IEEE International Conference on e-Health and Bioengineering, Romania, 2019.
3. Advanced Technologies & Treatments for Diabetes (ATTD 2020), Madrid, Spain.
4. Deep learning for image recognition workshop at NTNU, Trondheim.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

During my REP, I have worked (online) with Prof. Panagiotis Tsakalides and Prof. George Tzagkarakis of FORTH institute, Greece. During this, we focussed our efforts in analysis of fMRI data of Lupus and healthy subjects.

References:

[1] F. Campbell, B. Storey, P. Cullen, A. Cuschieri, “Surface vibration analysis (sva): a new non-invasive monitor of gastrointestinal activity”, Gut, vol. 30, no. 1, pp. 39–45, 1989.
[2] C. Garner, H. Ehrenreich, “Non-invasive topographic analysis of intestinal activity in man on the basis of acustic phenomena”, Research in Experimental Medicine, vol. 189, no. 2, pp. 129–140, 1989.
[3] K.A. Al Mamun, N. McFarlane, “Integrated real time bowel sound detector for artificial pancreas systems”, Sensing and Bio-Sensing Research, vol. 7, pp. 84–89, 2016.
[4] K. Kölle, A. L. Fougner, R. Ellingsen, S. M. Carlsen, Ø. Stavdahl, “Feasibility of early meal detection based on abdominal sound”, IEEE Journal of Translational Engineering in Health and Medicine, vol. 24, no. 2, pp. 594–602, 2020.