



Fellow	<Rakesh/ Shrestha>
Host Organisation	<Research Institute of Sweden (RISE) >
Scientific coordinator	<Sima / Sinaei>



## I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

During my ERCIM fellowship, I worked at Research Institute of Sweden (RISE) in the division of Digital System at Industrial System department. I was mainly involved in Distributed Artificial Intelligent System (DAIS) project. It is one of the important projects of RISE in which my participation was to fulfil the requirements of the industry partners in detecting anomalies in the smart grid system, as well as documenting each task performed. My main task on the project consisted of using Machine Learning and AI techniques to improve industrial activities. Another important task in these projects was the interaction with different partners in the industry.

The DAIS is a pan European project involving 11 countries from Europe and 47 partners that bring faster, more secure, and energy-efficient data processing solutions through the development of edge AI software and hardware components. DAIS approach is to develop intelligent, and trustworthy systems for industrial applications to provide comprehensive cost and energy-efficient solutions. In this project, my research has been focused on anomaly detection in federated learning setup in smart grid system. The federated learning (FL) systems is a distributed machine learning technique that acts as a promising solution for addressing the issues of communication costs, data privacy, and low latency.

The objective of my work is to ensure secure and reliable communication for resource constrained IoT devices installed at the smart grid system that aggregate useful data for the cloud/edge ML analytics. The anomaly detection using federated learning techniques help to optimize the process and provide valuable results in safety and time-critical applications for the cloud and edge computing. The anomaly detection -based on autoencoders assist in detecting anomalies in the first place and prevents the smart grid systems from attackers.

The work was composed of investigating the open challenges, and gaps using distributed FL for anomaly detection, verification and validating of develop methods together with Swedish industrial partners.



## II – PUBLICATION(S) DURING YOUR FELLOWSHIP

### Publications

1. **Rakesh Shrestha**, Ashutosh Mishra, Rojeena Bajracharya, Sima Sinaei, and Shiho Kim. "6G Network for Connecting CPS and Industrial IoT (IIoT)." In *Cyber-Physical Systems for Industrial Transformation*, pp. 17-38. CRC Press, 2023.
2. Mohammadi Mohammadreza, Roberto Allocca, David Eklund, **Rakesh Shrestha** and Sima Sinaei, Privacy-preserving Federated Learning System for Fatigue Detection, IEEE International Conference on Cyber Security and Resilience (IEEE CSR) Conference, Hybrid Conference, July 31 (Mon) – August 2 (Wed), 2023.
3. Jayaraman, Ramkumar, Baskar Manickam, Suresh Annamalai, Manoj Kumar, Ashutosh Mishra, and **Rakesh Shrestha**. "Effective Resource Allocation Technique to Improve QoS in 5G Wireless Network." *Electronics* 12, no. 2 (2023): 451.
4. Mats Eriksson, Lars-Göran Magnusson, Niclas Ericsson, **Rakesh Shrestha\***, "The need for Edge to Cloud Orchestration and Optimization in Industrial IoT Systems.", *Electronics Journal*, 2023. (*Major Revision*)  
[\*Corresponding Author]

### To be Submitted:

1. **Rakesh Shrestha**, Mohammadreza Mohammadi, Sima Sinaei, et Anomaly Detection based on LSTM and Autoencoders using Federated Learning in Smart Electric Grid, *Journal of Parallel and Distributed Computing*, Elsevier. (*Journal*)
2. Mohammadreza Mohammadi, **Rakesh Shrestha**, Sima Sinaei, et. Al. Smart Grid System Anomaly Detection Using LSTM Autoencoder: Federated Learning Approach. (*Conference*)

## III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

**Conference:** The 15th International Conference on Management of Digital Ecosystems (MEDES) Conference, Crete, Greece, 5-7 MAY, 2023

**Conference:** RISE Department Conference held at Stora Brännbo, Sigtuna, 3-4 MAY, 2023



- The focus of the department conference was to attend invited talk from SAAB (industry), network and connect within the department, workshops based upon real life challenges from different partners, and time to socialize in a more relaxed setting.

**Conference:** DAIS Open Day- Use case market, Electrum, Kista, Stockholm, 24-28 April, 2023

- Attended face-to-face meetings with DAIS partners from different EU countries and presented two talks on the project results as well as presented one poster in DAIS open use case market.

## IV – RESEARCH EXCHANGE PROGRAMME (REP)

**Duration:** 27th Feb to 3rd March, 2023 (1 week )

**Research Group:** Centrum Wiskunde & Informatica (CWI), Netherlands

**Scientific Contact:** Prof. Marten van Dijk, and Dr. Chenglu Jin (point of contact).

**Description:** The research exchange program (REP) includes

- Giving a presentation about my current research in anomaly detection system based on autoencoders using Federated learning at CWI with a detailed discussion on our work for detecting anomalies in smart grid system.
- Technical discussions with the group members on the research activities at the CWI institute group and possible future collaborations.
- In addition, I got a chance to meet Prof. Chrysa Papagianni from Multiscale Network System at University of Amsterdam and discuss about possible future collaborations.