Dissertation thesis review

The dissertation thesis titled „**Dynamic Stochastic Modeling Methods for Optimization of Environmental Measurements**", submitted by **Obiora Sam Ezeora**, summarizes authors research in the field of energy-efficient environmental monitoring systems (EMS). The manuscript is organized into seven chapters. First three chapters provide an overview of environmental measurement methods and technology, theoretical and practical premises for sampling techniques, time series data collection and processing, and methods for advanced time-series analysis. The following two chapters illustrate the theoretical background from chapters one to three on two case studies. The last two chapters of the thesis contain the main original contribution of the author. Chapter six introduces and details the adaptive sensing method, an algorithm for optimum sensing interval determination, and last but not least, an event-driven sampling method. The last chapter draws major conclusions and outlines future research directions.

The theoretical background is comprehensive and introduces the area of environmental measurement systems and the open problems in this field very well. The reader gets an overview of methods and means for measurement of environmental variables and various statistical and non-statistical methods. Sadly, out of the many learning and soft computing methods that can be used for time series processing, only recurrent neural networks are mentioned. The use cases apply the introduced statistical methods on data sets obtained by field environmental measurements on two locations in Brazil (i.e. in the tropical rain forest biome) and Canada (boreal forest biome). The analysis, included in chapters four and five, is undoubtedly interesting and illustrates the methods for statistical time series analysis well. It also confirms the intuitive fact that environmental measurements from different biomes yield different properties. However, the importance of these two chapters, comprising of more than 20 pages, for the remainder of the work is rather unclear.
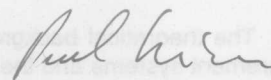
The main contributions of the thesis and authors major research results are described in chapter six. The contribution is threefold. The **adaptive sampling method**, introduced by the author in section 6.1., allows the maximization of the number of measurements under the conditions of limited energy, which is saved by this approach. It takes advantage of ARIMA model of the variable of interest which is created and adaptively updated on the fly. If selected conditions are met, variable measurement (i.e. sensor readings) are replaced by estimates produced by the model. Next, a **method for optimum sampling interval determination** is devised in section 6.2.. It uses stochastic models the variable of interest to find out when it falls outside of the acceptable tolerance range. A time interval shorter than that is said to be an optimum sampling interval. Finally, an **event-driven sampling method** is proposed in section 6.3.. It is based on a statistical estimate of change-points (i.e. values in time-series in which the data falls outside a predetermined range of selected statistical properties). A theoretical energy analysis is performed to support the claim that authors approach reduces the energy consumption of the sensing system.

The methods, proposed by the author, are undoubtedly result of his original research work and have merit. They can be used in the target field of environmental monitoring and improve the energy efficiency of environmental monitoring systems. The reviewed manuscript is, however, far from being a perfect example of a scientific text. Both the language and typographical quality of the thesis are not on a very good level. The author commits many errors and mistakes that make the text hard to follow and understand. The mistakes are too frequent to be all listed, but include all type of language imperfections (word order, missing words – p. 48:

'time series parametric approaches' -> parametric approaches to time series analysis; wrong terms used – sec. 3.2.3.6: 'neutron' -> neuron) and so on. The language imperfections can be attributed to the fact that English is not the author's mother tongue. However, a proper proofreading would certainly help to achieve a better quality of the final text. The number of fonts and typefaces, used in the text, is too high. The quality of figures varies significantly as well. Some of them are authors own work and some of them are, apparently, just screenshots from third-party tools. One would assume that a unified graphical style would be used through a major work such as a dissertation thesis. Finally, some figures are simply unnecessary. Excel screenshots (e.g. fig. 33) are by no means appropriate in an original research report.

The weakest spot of the manuscript is its structure and the ratio of space dedicated to the theoretical background and authors own work. It is not until chapter six (page 103!) that the reader gets to know the description of authors original research and mere nine pages are dedicated to it. The author points the reader to his previously published work ([76] [77]) but the thesis is, as a result, not very self-contained.

However, despite the problems pointed out above, it can be stated that the thesis, in its entirety, describes a solid body of complex original research work conducted by the author and introduces several original concepts with applications in environmental monitoring systems. The author has also already presented his work at 7 international conferences with proceedings published by the IEEE. Therefore, it is my pleasure to **recommend this thesis for defense and Obiora Sam Ezeora for the academic degree of doctor of philosophy (Ph.D)**.

doc. Ing. Pavel Krömer, Ph.D.
Ostrava, 5. 4. 2018