ASSESSMENT BY THESIS SUPERVISOR

PhD Candidate:	M. Sc. Obiora Sam Ezeora
Dissertation topic:	Dynamic Stochastic Modeling Methods for Optimization of Environmental Measurements
Study programme:	Electrical Engineering and Informatics
Training department:	Department of Mathematics and Physics
Supervisor:	prof. Ing. Petr Musílek, Ph.D.
Expert Supervisor:	Mgr. Jana Heckenbergerová, Ph.D.

Characteristics of PhD Candidate

Mr.Ezeora received his BEng degree at the University of Nigeria in 2001. He then obtained M.Sc Degrees in Mechanical Engineering (2005) in Project Management and Operational Development (2010) from the Royal Institute of Technology, KTH, Stockholm, Sweden. These degrees were confirmed as equivalent to corresponding degrees in the Czech Republic.

Since September 2014 he has been PhD Candidate in study programme Electrical Engineering, in part time study regime and Individual Study Plan. He successfully passed all four mandatory exams: Selected Chapters from Applied Mathematics, Selected Chapters from Mathematical Statistics, Continuous Systems Modeling and Simulations and English for Scientists. In May 2016 he passed his State Doctoral Exam. The main research topic in the course of his studies has been Modeling Methods for Optimization of Environmental Measurements. In 2015 and 2016, he contributed to two projects supervised by Dr. Heckenbergerova under the Student Grant System program. He published 7 conference papers as the main author, all indexed in Scopus or WoS databases.

Exams

Selected Chapters from Mathematical Statistics – Doc. Ing. Milan Javurek, CSc.
English for Scientists – PhDr. Jitka Hlouskova, PhD.
Continous Systems Modelling and Simulation, doc. Dušek, 1.10.2015
Selected Chapters from Applied Mathematics, doc. Linda, 26.11.2015
State Doctoral Exam, 16.5.2016

Description of the Dissertation

The aim of the thesis is to propose an algorithm for the control of a solar-powered environmental monitoring system, intended for application in harsh climatic conditions (for example in subarctic areas), where there is no possibility of frequent human intervention. The optimization task has two basic components. The first is determination of the optimal measurement frequency depending on the energy availability and acceptable minimal amount of collected data. The second task is development of an approximation model of the environmental time series that can be used to substitute any missing data, based on their stochastic and deterministic properties.

To address the problems of energy-efficient operation of environmental monitoring system, the candidate developed energy-aware sampling techniques, including adaptive and event-triggered sampling. The first approach determines the optimal sampling interval, while the second method utilizes a new type of event-triggered mechanism to adjust the sampling interval with the changes in measured data. Both algorithms have been developed and all methods demonstrated using real measurements from field campaigns in Brazil and Canada. Obtained results have been thoroughly analyzed from the perspective of approximation error and energy savings. The ensuing models have been validated and evaluated for accuracy. They feature high correlation values and low values of mean square normalized error with respect to actual measurements. The lifetime of device battery has been extended by more than 87% when the sampling interval increases from 15 to 30 seconds. Furthermore, about 45% of energy consumption have been saved in analog-to-digital conversion using the newly proposed algorithm.

Assessment of the Dissertation

The thesis describes different mathematical approaches to time series processing, including examples of their implementation, in Chapter 3. These procedures (predominantly parametric) are then applied to two diverse cases, described in Chapters 4 and 5. The Brazilian data shows the difference between the environmental parameters, each with a different optimal sampling rate. The data from Canada are unique due to the different sampling intervals for the same variable – photosynthetically active radiation (PAR). This analysis provides solid justification for building different prediction models. The main contributions of the thesis are presented in Chapter 6. The candidate has created a new sampling method, using event-trigger methods to separate the day and night modes and, on the basis of the stochastic model, to determine the optimal sampling interval. Overall, the dissertation satisfy all formal standards and meets the requirements for this type of work. Therefore I recommend it for the defense.

prof. Ing. Petr Musílek, PhD.
Supervisor