Review of Dissertation Thesis

Dynamic Stochastic Modeling Methods for Optimization of Environmental Measurements

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Relevance to current needs of the scientific community

This dissertation thesis address a very relevant topic that reflects the current trend in reducing energy consumption in modern self-powered measuring systems. Sophisticated sampling techniques and other well-designed procedures can significantly extend operational lifetime of such measuring systems, save data quality and minimize maintenance cost. Developed methods can be useful not only for environmental measurements, but also in many other application areas such as transport, energy, emergency services, industry etc.

Fulfillment of the main objectives

The main aim of this work is to develop new methods of adaptive and event-triggered sampling, to analyze available data files and to test new approaches in view of their perspective of increasing energy efficiency and maintaining approximation error within reasonable limits. All the aims of this work have been fulfilled.

Appropriateness of the methods

In the introduction chapters, the author discusses relevant existing sampling techniques, presents the architectures of the measurement systems, and formulates problems related to finding an optimal sampling interval. In the “state-of-the-art” part, the author presents current techniques for statistical data analysis including bootstrap, kernel estimation, regression techniques, variogram, state-space models, Box-Jenkins methodology, heteroscedasticity models, artificial neural network approaches and stochastic dynamic models. Real sets of environmental data were collected in the forest canopy in the central part of Brazil and in the residential area of Edmonton, Alberta, Canada. These data were used for the development of the methods and for testing. Available data sets were analyzed using standard statistical approaches. Then, new methods for adaptive sampling were developed using the stochastic ARIMA model, which parameters are re-estimated with respect to changes in input data. The method allows for an adaptive increase of the sampling interval and uses model prediction values instead of the measured values. The presented approach was tested using available data files and compared to other statistical approaches.

Another new event-triggered sampling method was developed and discussed. It can be implemented in a software solution that works within limited hardware. The proposed algorithms use statistical changepoint detection methods to modify the sampling interval.

Main practical results

It was claimed that with the available environmental data, the proposed algorithms were able to save up to 45 percent of energy consumption and battery lifetime was extended up to 87 percent. Of course, further testing under realistic conditions is necessary to verify these first positive results.

Publication activities

Achieved new results have been published (with co-authors) at quality international conferences, papers in quality journals are missing.

Specific comments

This thesis describes the new developed methods in the Chapter Six and Chapter Seven, which are presented on pages 103-112 (10 pages in total). Well-known statistical approaches, including very trivial examples, are listed on pages 28-75 (48 pages in total). It was not necessary. A more detailed description and analysis with assessment and other examples should be devoted to developed new approaches.

The text of the thesis does not avoid some inaccuracies, e.g.

Theorem 3.1.2a (page 29) states that members of a given time series are correlated if their autocorrelation coefficient is near zero and uncorrelated if one or more autocorrelation coefficient is significantly non-zero. It is not true.

In the formulas (7), (8) and (10) the symbol x_t is not defined (pages 36-37).

In Table 14 (page 64) criterion AICC should be also computed for p=0 and q=0.

In Figure 36 (page 67) the air temperatures cannot be between 250-450 degrees of Celsius.

Conclusion

The thesis meets the requirements of independent creative scientific work and I recommend the thesis for the presentation with the aim of receiving the Degree of PhD.

Prague, April 9, 2018

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