Blockchain-Based Distributed Cooperative Control Algorithm for WSN Monitoring

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Abstract. The management of heterogeneous distributed sensor networks requires new solutions to address the problem of data quality and false data detection in Wireless Sensor Networks (WSN). In this paper, we present a nonlinear cooperative control algorithm based on game theory and blockchain. Here, a new model is proposed for the automatic processing and management of data in heterogeneous distributed wireless sensor networks stored in a blockchain. We apply our algorithm for improving temperature data quality in indoor surfaces.

Keywords: Wireless Sensors Network · Blockchain · Game theory
Nonlinear models and systems · Data quality · False data detection
Nonlinear cooperative control

1 Introduction

Wireless Sensor Networks have become important in the last years and nowadays are present in practically all the sectors of our society. Their great capacity to gather data may facilitate the construction of smart environments, allowing for a flexible analysis of processes that occur in the environment and the services offered to users [1–9]. Distributed sensor networks and depending on the network topology and sensor neighbourhood are also presented. In our work, coalitions of neighbours are created by using clustering techniques. This distributed and self-organized (overall temperature equilibrium arises from local game interactions between sensors of an initially disordered temperatures system) game is designed to provide reliability and robustness to the data collected by a WSN [10–13]. It identifies sensors gathering defective or inaccurate measurements and detects areas with similar temperatures. This article tackles the problem of WSN data reliability from the point of view of game theory and probability, which is a novelty approach in this field [14–17].

In this paper, we present an algorithm that will ensure the robustness and reliability of the data collected by WSN and stored in a blockchain [18–22]. In our

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approach we apply game theory (GT) to data stored in the blockchain. Our game is distributed and self-organized so that it can work in a WSN regardless of the number of sensors, the architecture of the WSN or the type of sensors to which the game is applied [23–27]. The design of the game fulfills the following needs: it is capable of recognizing the neighborhood in which it is implemented [28–30]. The game also identifies the possible coalitions that can be formed between the neighbors. Finally, the temperature is determined by the winning coalition for the sensor to which the game has been applied. The algorithm also has a high reliability as it uses blockchain to store data and create a log [31,32].

2 Conclusion

This work proposes a distributed and self-organized cooperative algorithm using game theory. The algorithm has been applied to the data collected by a WSN in an indoor surface. The main goal of the game is to improve the robust control of the WSN by consensus temperature monitoring. Furthermore, the submitted work achievements ensure data quality, false data detection (i.e., inaccurate sensors) and temperature data optimization to improve energy efficiency in cooperative WSNs. The most significant results obtained in this work are listed below.

This paper provides a novel, blockchain-based, distributed and self-organized algorithm, which allows to self-correct temperature data collected by the sensors according to their surrounding temperatures. We also address some interesting results and some quite promising industry applications. In our future work, we will extend the game to larger topological manifolds and we will study these manifolds dynamically.

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