SZ-GESA
A Geodesical Efficient Self-Deployment Algorithm for Steppe Zones

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ABSTRACT

In this article, advanced tools are provided to steppe specialists to guide them in choosing the integrated development policies for steppe and pastoral zones. To this end, the use of adapted mobile wireless sensor networks (WSN) is proposed. Thus, a distributed and localized protocol dealing with the self-deployment problem resulting from mobile sensor random deployment is presented, on a steppe rangeland. This scheme entirely based on a geometric approach dealing with geodesy and steppe zones characteristics, allows mobile sensors moving to optimal positions on these study rangelands. The Geodesic Efficient Self-Deployment Algorithm in Steppe Zones (sz-GESA), so called, in its approach to solve the self-deployment problem for a given geographical rangelands type, showed during simulations a great robustness for the WSN adapted to this kind of zones by allowing optimization of the coverage and to idealize the connectivity. Obtained results are very encouraging and let us think for more research enhancing this developed system more efficiently.

KEYWORDS

Connectivity, Coverage, Deployment, Geodesic, IoT, Pastoral, Steppe, WSN

INTRODUCTION

The scarcity of water in steppe zones, being the major concern of the populations, requires a valorisation of the existing and a huge mobilization to satisfy their needs and those of their environments. From this perspective, two actions take priority: mobilizing surface water and preserving groundwater. A spatial planning policy is therefore essential. However, the implementation of development programs in the steppe zones is hampered by several constraints, of which the most salient are related to the knowledge lack of the physical environment. This knowledge lack is mainly due to a weakness of scientific research to accompany these programs. Organizing records of biological environments underneath databases form allows contributing to ecosystems knowledge and comprehension. Steppe being a biologically very fragile milieu, complex and difficult to manage, so the use of these databases permits the assessment of the agricultural steppe patrimony, its cutting in homogeneous zones, the determination of soil use, a land use and pastoral production mapping, the preparation of development and rangelands organization programs, the husbandry animal promotion, the improvement and production intensification. Natural factors, whose actions and interactions constitute the environment, are those that determine the genesis of an ecosystem. It is therefore normal that the data defining it should be grouped in relation to the fundamental aspects of the climatic, geomorphologic, geological,
hydrological, plant and human environment. This is reflected in part by the acquisition of numerous field surveys, and secondly, by computer processing of these surveys.

The main objective of this research is to provide steppe specialists, taking advantage of the Internet of Things (IoT) opportunities, by tools to guide them in their policy enforcement choices in the integrated development of the steppe and pastoral zones (Robert, 2017). A first result is to create a database combining climate surveys and topographic analysis, spread over few periods with a WSN that helps to the pseudo-mapping of the steppe rangelands from models developed with the collected spatial data. The property to have steppe zones effective coverage comes from the fact that the 32 million hectares of the Algerian steppe are subject to an uncontrollable degradation of their natural resources (HCDS, 2006). These steppe zones receive an annual rainfall of about 28 billion m³, of which about 06 billion represents the run-off fraction, but only a small portion equivalent to 2% is mobilized (HCDS, 2005). Thus, in order to develop and safeguard these rangelands, the rational use of the water resource must imperatively be well studied. Therefore, in the zones of interest (ZI), in this case the steppe rangelands studied, the surface water mobilization zones (MZ), that is to say those where rainwater is mobilized, must be located by the sensor nodes. These latter must move according to protocols based on geometric approaches (taking into account the spatial coordinates: longitude, latitude and altitude) in order to automatically position themselves in the best locations, to provide optimal coverage and connectivity for the mobile WSN (Miao, 2015).

The geometrically distributed and localized protocol in steppe zones thus considered is called Geodesical Efficient Self-deployment Algorithm in Steppe Zones (sz-GESA). This suggested protocol operates at equal time periods such as ESA (Efficient Self-deployment Algorithm) (Khelil, 2016), where at each round the nodes move to new destinations in order to reach the MZ, while maintaining coverage and connectivity (Akewar, 2012). Simulations carried out show the results of this solution in terms of coverage and connectivity rates. Also, vegetation development images and precipitation data can be automatically transmitted to the data processing station at specified times, and involve the adoption of a new tool for steppe specialists. The discerned sz-GESA proposes to cover optimally, after an arbitrary initial distribution of its nodes, and with great connectivity, a steppe rangeland. The latter represents a given steppe zone, geodetically marked, and therefore in real positions and magnitudes. In a first place, using the sensors mobility, their new positions are detected according to the real spatial coordinates, for optimal coverage and maximum connectivity. This deployment will make it possible to study the regeneration dynamics and pastoral production in a long-term fencing rangeland. The sz-GESA transmitted data then eliminates the need for recourse to traditional methods like observation and random sampling (Bengourina, 2010), in this case the construction method of the minimal area, and the qualitative and quantitative vegetation parameters given by statistical treatments and cartographic analyses, in this case remote sensing (Wael, 2009). The main asset of sz-GESA is to allow observations without having to make only sampling statements through time for the first methods and to be much less expensive and more accurate than for the second methods.

In a second place, and since sz-GESA makes it possible to diversify the collected data by collecting data for a wide applications variety, and to recover several hundred thousand measures spread over time, the latter offers the possibility to retrieve the sensor position in the deepest area in altitude. This will be used as a benchmark in order to be able to detect the locations of run-off rainwater fractions. This property comes from the fact that the proposed WSN is mainly characterized by its geometric treatments. Once the new deployment is made from the first one taking into account this new benchmark, this will give main opportunities to study the surface waters mobilization in steppe zones, exploratory little studied so far in these rangelands, which will be very useful for the preservation and exploitation of steppe ecosystems.
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