Knowledge Modeling and Reasoning for Radio Jamming Discovery in Grid Radio Monitoring

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Due to the open nature of wireless communications, jamming devices can easily decrease the signal-to-interference-plus-noise ratio (SINR) by using radio jamming to disrupt communications [1]. Therefore, efficient management of spectrum data and acquisition of monitoring knowledge are important research directions in radio monitoring [2]. This paper proposes a gridded radio jamming monitoring knowledge graph model based on spatial-temporal graphs. Its main feature is to convert raw data into graphs, emphasizes the spatial-temporal characteristics in the data, and obtain hidden data structure and topological information.

The proposed method is shown in Figure 1. (a) is the monitoring scene module. The actual monitoring region is divided into 100*100 grids, a car carrying jamming devices moves randomly inside, and monitoring data is generated based on this simulation scenario. (b) is the receiving array module, there is a set of relationships between the radio jamming source and the receiving node within the scan cycle t to indicate connectivity. It is worth noting that the figure only shows the 9 receivers closest to the jamming source $M_{i,j}(n)$ node. (c) is the monitoring matrix module, which records the respective field strengths of the 5*5 monitoring grid area centered on the jamming source location. The monitoring data is structured as a 3-D array $W \in R^{L\times N\times F} = R^{1000\times 25\times 1}$, the scan cycle length L is 1000; the number of monitoring areas N is 25; the number of monitoring values F is 1, where monitoring value is field strength. (d) is the knowledge reasoning module. Taking the jamming source movement trajectory reasoning as an example, according to the monitoring state information of the jamming source recorded in the monitoring matrix, the knowledge reasoning method based on logical rules is used to obtain the movement trajectory of the jamming source between scan cycle t_1 and scan cycle t_2. According to the above method, the knowledge graph of radio jamming monitoring is constructed, new radio jamming monitoring knowledge is obtained by knowledge reasoning based on logical rules, and an experimental system of radio jamming monitoring is developed. The results show that this method performs well in data management and knowledge acquisition of radio jamming monitoring, and it can lay a foundation for the assistant decision-making module in the radio monitoring system. This work was funded by the National Natural Science Foundation of China (Grant Nos. 61963037, 61863035), and Ten Thousand Young Top-notch Talents Program of Yunnan Province (Grant No. YNWR-QNBJ-2018-310).

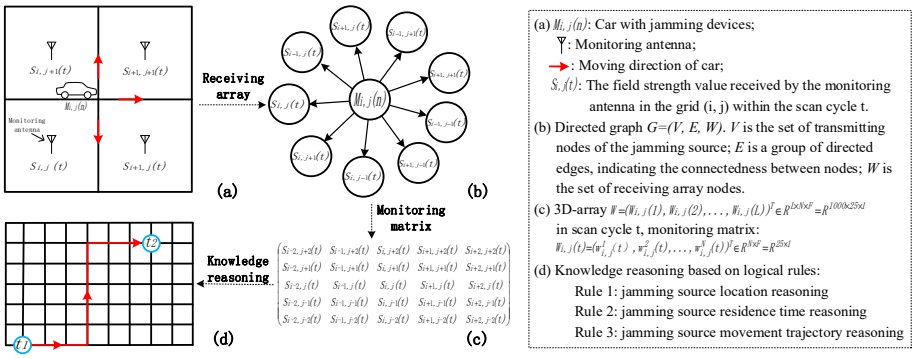

Figure 1. Gridded radio jamming monitoring knowledge graph model based on spatial-temporal graphs.

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