Fingerprint positioning based on WiFi in coal mines has received much attention because of the widespread application of WiFi. Fingerprinting techniques have developed rapidly due to the efforts of many researchers. However, the off-line construction of the radio fingerprint database is a tedious and time-consuming process. When the underground environments change, it may be necessary to update the signal received signal strength indication (RSSI) of all reference points, which will affect the normal working of personnel positioning system. To solve this problem, an adaptive construction and update method based on a quantum-behaved particle swarm optimization—user-location trajectory feedback (QPSO–ULTF) for a radio fingerprint database is proposed. The principle of ULTF is that the mobile terminal records and uploads the related dataset in the process of user’s walking, and it forms the user-location track with RSSI through the analysis and processing of the positioning system server. QPSO algorithm is used for the optimal radio fingerprint match between the RSSI of the access point (AP) contained in the dataset of user-location track and the calibration samples to achieve the adaptive generation and update of the radio fingerprint samples. The experimental results show that the radio fingerprint database generated by the QPSO–ULTF is similar to the traditional radio fingerprint database in the statistical distribution characteristics of the signal received signal strength (RSS) at each reference point. Therefore, the adaptive radio fingerprint database can replace the traditional radio fingerprint database. The comparable results of well-known traditional positioning methods demonstrate that the radio fingerprint database generated or updated by the QPSO–ULTF has a good positioning effect, which can ensure the normal operation of personnel positioning system.

In view of the tedious construction and maintenance of the underground WLAN radio fingerprint database, this paper
proposes an adaptive construction and update method of the radio fingerprint database based on the quantum-behaved particle swarm optimization–user-location trajectory feedback (QPSO–ULTF) algorithm. The concept map is shown in Figure 1. As the miners walk through an underground tunnel, the ULTF algorithm records their relevant positions and RSS data with the technical advantages of a mobile terminal. In the process of creating a radio fingerprint database, each user-location point has its corresponding candidate reference points. The calibration samples belonging to these candidate reference points are used as a scale, and the QPSO algorithm is used to adaptively adjust the RSS data feedback by the user-location track. In the process of updating the radio fingerprint database, the RSS data of filtered user-location track points is used as a scale, and the QPSO algorithm is used to update the calibration samples of corresponding reference points. The secondary construction of the radio fingerprint samples is then used to complete the update of the radio fingerprint database. In general, the radio fingerprint database can be updated in a relatively low-frequency period of time when the miners enter or leave the location area, so as to minimize the impact of the update process on the normal operation of the location fingerprint positioning system. The experiments and analysis show that the QPSO–ULTF can effectively replace the traditional manual acquisition process in the construction and update of the radio fingerprint database. It can also adaptively complete the maintenance of the radio fingerprint database without affecting the normal operation of the positioning system. Furthermore, it reduces resource consumption and makes the system more robust.

Figure 1. Concept map of adaptive construction and update method based on the quantum-behaved particle swarm optimization–user-location trajectory (QPSO–ULTF) algorithm.

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**Keywords**

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