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Research on Low-Energy Information Transmission Based on Wireless Network

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Abstract: In this paper, the topological structure of the vehicle wireless network M2M (Machine to Machine) is used as the experimental research model, and four kinds of light coefficients are set as factors affecting the experimental results, namely, light intensity factor ∈ and α, to represent the light intensity coefficient and influence factor. The remaining energy consumption of mobile terminal equipment was measured respectively, the distance parameter from device to device, the maximum transmission energy consumption, and the correlation coefficient between environmental parameters and energy consumption parameters was analyzed. This paper discusses the impact of different topological structures on the environment, energy saving and emission reduction in the relatively flat terrain area, based on the planning scheme of parking area within the coverage range of base station signal, the transmission capability of vehicles as mobile device nodes within the coverage range of base station signal, and the signal coverage range of base station under different light intensity. As the distance between the base station and the vehicle mobile device node changes, the maximum transmission energy consumption of the mobile device node is obtained. Based on the above factors, the optimal performance optimization parking scheme and the optimal energy consumption optimization transmission scheme are obtained.

Keywords: Wireless network; Transmission capacity; Coverage area; Available energy consumption; Optimization scheme

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1. Introduction

The maximum energy consumption available for communication between two mobile device nodes (D2D) increases with the increase of the distance between the device node and the base station (dist). There are two factors that restrict the transmission energy consumption between the mobile device node and the base station, namely, ∈ (the maximum limit of the transmission process obstacle coefficient) and dist (the distance between the mobile device and the base station). However, the influence coefficient ∈ of the transmission process obstacle changes with the change of light intensity α. When the light coefficient α is constant, the signal transmission ability

gradually weakens with the increase in distance. In a certain area, that is, when the transmission process barrier coefficient is fixed, the better the light intensity is, the better the transmission capacity is. Among the distance base station dist and the transmission process impact factor coefficients, the most important constraints are as follows: From the above, it can be seen that at least two aspects of influence should be considered in energy consumption optimization [1].

2. Parameters and methods

2.1. Experimental parameters

The relevant parameters of the experimental data were adopted from a shared car parking space in Haikou City, Hainan Province. The data for the experiment include the base station (base station of existing shared car parking space supplier), mobile vehicle equipment (shared car Qoros 3, Qoros 5), simulation software used in the experiment (MATLAB R2016a simulation software), and the algorithm is D2D communication technology (Device-to-Device) Communication. The result set (Maximum allowed transmit power, dBm) is C1, C2, C3, C4, C5, C6, respectively. The distance between the mobile communication equipment and the base station is set as dist = 20 m, dist = 80 m, dist = 150 m. The light influencing factors are $\in = 0$ and $\in = 0.5$.

2.2. Experimental methods

2.2.1. Test preparations

On August 1, the mobile devices within the coverage of the base station will check the available initial energy consumption quantitative detection before the test, and then determine the remaining energy consumption of the mobile devices after several rounds of communication, so as to know the energy consumed in the communication process.

2.2.2. Calculation method

On August 1, August 2, and August 3, a total of three days of testing, the measurement time of 11:50, 12:10, and 12:30, three times of average energy consumption is the coefficient value 0, 18:50, 19:10, and 19:30, three times of average energy consumption coefficient 0.5, to determine the remaining energy consumption of mobile equipment.

2.2.3. Determination method

Measurement of light intensity, distance from base station, and energy consumption: After the initial energy is determined, the communication energy consumption is tested three times a week during consecutive 3d sunny days with excellent light intensity, and the results are averaged over three days. Similarly, the communication energy consumption was tested three times in the period of poor lighting conditions, and the results were averaged over three days.

2.3. Data processing

Simulation software MATLAB R2016a was used to analyze and process experimental data. Different values were set to obtain experimental result sets to form curves. Different curves could be calibrated by symbols and compared and analyzed between different marks of the same color.

3. Results and analysis

3.1. Influence of different obstacle coefficients on experimental results

As can be seen from **Figure 1**, when the distance from the base station is constant, the greater the obstacle coefficient, the smaller the maximum transmitted power of the mobile device node. It can be seen that when the distance from the base station is constant, the obstacle factor ∈ has a significant impact on the transmission power cost.

As can be seen from **Figure 2**, with the increase of obstacle coefficient ∈ (cost factor ∈) of each curve, the maximum distance between the mobile device and the base station also becomes smaller; when ∈ = 1, the value of each curve tends to zero, that is, the maximum transmission distance from the base station is zero.

As can be seen from **Figure 3**, as the distance between the mobile device and the base station increases, the influence factor of barriers in the transmission process has the greatest impact on energy consumption. The transmission power of mobile devices also increases gradually. When the distance from the nearest base station is 250 m, the transmission power values under the three curves (that is, different influence factors) are equal.

As can be seen from **Figure 4**, a scheme with ∈ = Area RL and a coverage range of 45 ± 0.5 should be adopted to optimize the energy consumption of signal transmission between the mobile device and the base station.

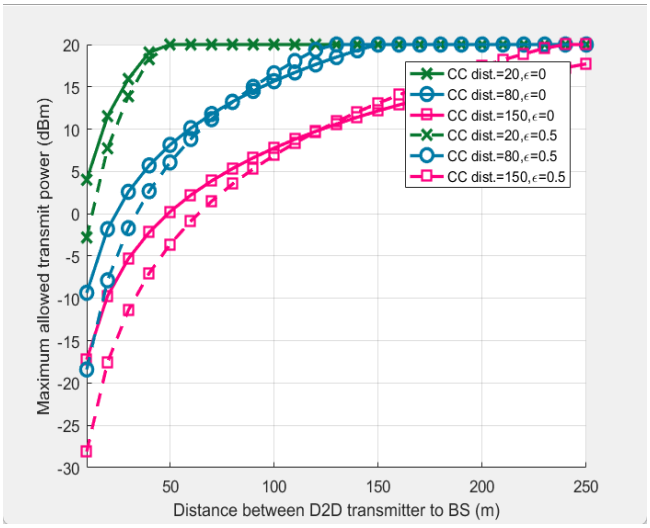

Figure 1. Influence of different barrier coefficients on the maximum transmission power

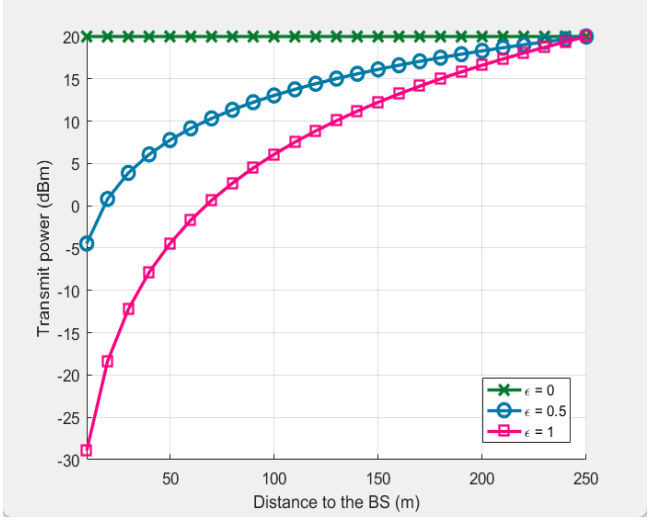

Figure 2. Influence of different light intensities on maximum transmission power

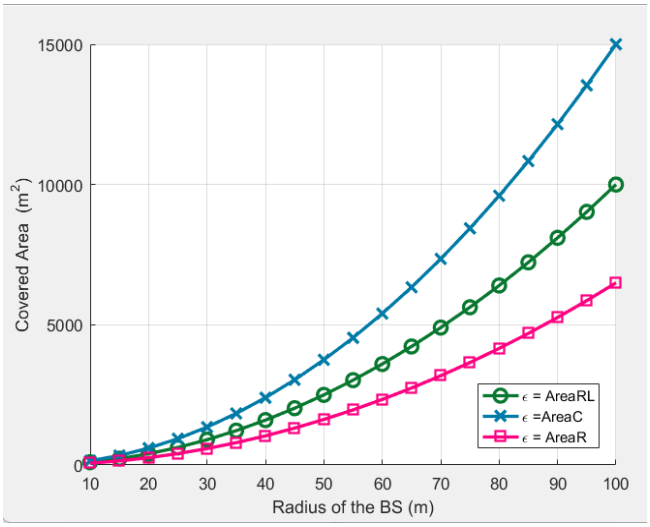

Figure 3. Different influence factors for maximum transmission power

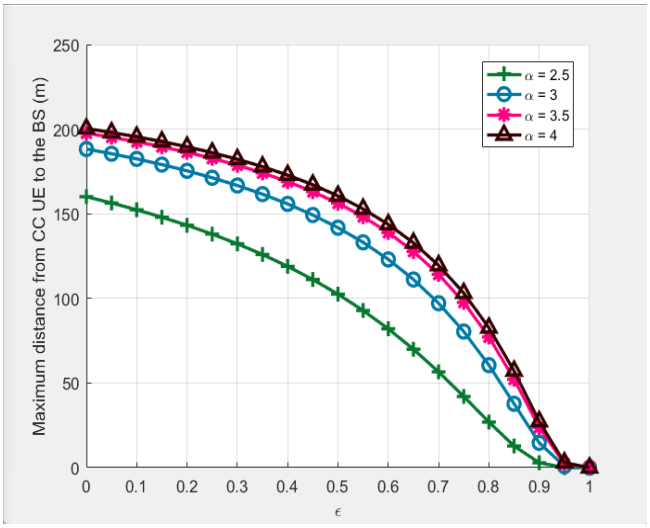

Figure 4. Effect of different base station layouts on signal coverage

3.2. Influence of different weather factors on the energy consumption of mobile devices

The obstacle factor is one of the factors that affect the energy consumption of mobile devices in the communication process of signal transmission of mobile devices. Under the influence of different obstacle factors, the transmission rate, energy consumption, output power, and input power of the three types of mobile devices are significantly different, and the obstacle factors caused by different factors are significantly different.

3.3. Influence of different lighting on the energy consumption of mobile devices

As the light intensity decreases, the energy consumption of the influencing factors in the transmission process will gradually increase. In the same type of mobile devices, different light intensity has a significant impact on the information transmission process of mobile devices; that is, the stronger the light, the faster the transmission rate, and the lower the energy consumption in the transmission process. On the contrary, the light is weak, the

transmission rate is low, and the energy consumption in the transmission process is large.

4. Discussion

In this study, the influence of different light intensities measured under different weather conditions on the transmission rate and energy consumption of different types of mobile devices during the transmission process was determined. The average light intensity in Hainan in summer is more than 1,800 $\mu mol \cdot m^2 \cdot s^{-1}$. It can be seen from the results that although different equipment types have differences in transmission rate and energy consumption, the transmission power is minimum and the energy consumption in the transmission process is maximum when the weather conditions are extremely poor, that is, the weather lighting conditions are the worst. When the light is not strong, the transmission rate is large, and the energy consumption in the transmission process is small. When the weather is clear and sunny, the transmission rate is the fastest and the energy consumption is the lowest, so the light intensity is the main factor affecting the transmission rate and energy consumption between mobile devices [2–5].

Topography is also one of the main factors affecting the transmission rate and energy consumption between mobile devices. During the transmission process of the same device, when mobile device nodes are in the low-lying area, the transmission rate between mobile device nodes is smaller than that of flat land, and the transmission energy consumption also increases, which is also one of the main reasons affecting the transmission rate and transmission energy consumption of nodes in the network [6–8].

5. Conclusion

The results of this study show that different types of mobile device nodes have certain differences in transmission speed and energy consumption. The information transmission rate and energy consumption of the same type of mobile device nodes are mainly affected by the light intensity, weather conditions, and terrain of the region, and secondly, the layout of the base station and the network coverage model are also related. That is, the terrain is relatively flat and the light intensity is good, and the network coverage is carried out in a rectangular way [9,10].

Disclosure statement

The authors declare no conflict of interest.

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