Research on Cross-slot Interference Suppression Method for Railway Cluster Communication System

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Abstract: Aiming at the problem of poor signal reception in traditional railway trunking communication system, the research on cross-slot interference suppression method based on railway trunking communication system is carried out. The research on different suppression methods is combined with its advantages. The interference analysis of the cross-slots, and then the solution of the cross-slot interference suppression based on the isolation band is designed. By comparing the form of the test, it is tested that 5,000 signals are input simultaneously under the same railway communication system, and the designed system receives the signal to provide a solution for the further development of the communication industry.

1. Introduction

In the railway trunking communication system, the key resource allocation method for wireless networks is mainly duplex mode. In the real-time mobile communication of railway clusters, the resource management focuses on frequency division duplexing and time division duplexing. Two independent communication channels do not interfere with each other, and the upper and lower communication links are allocated to the same channel, and are allocated to different time zones during allocation, and the upper and lower two are satisfied by the effective isolation between time differences. The demand for resources between channels enables the cross-asymmetric communication needs of different railway cluster communications. The conversion between the upper and lower communication channels is divided into a specified point conversion and a non-fixed point conversion. Channel switching between non-fixed points can meet the adaptability of real-time conversion between two communication channels. However, in this way, there is a crossover of communication in the path operation, and the intersecting time slots may seriously affect the quality of communication, resulting in communication blocking or communication inconsistency between two independent channels. In order to take advantage of the dual-channel communication of the railway trunking communication system, the upper and lower dual communication channels are allocated rational dynamic data, and a reasonable method is designed to reduce the interference of the railway trunking communication system and optimize the communication quality.

2. Research on Cross-slot Interference Suppression Method for Railway Cluster Communication System

2.1 Design of railway trunking communication system cross-slot suppression method

The time slot interference when the railway cluster communication crosses is embodied as when a base station uses any one communication channel to transmit data on one time slot. During the same time point, another vacant channel is transmitting information in the same period. There will be corresponding interference between the two stations due to temporal conflicts. It appears as a mutual signal disorder between the two base stations and the mobile station[1]. Reducing cross-slot interference between communication systems has become the most important issue in optimizing railway cluster communications. By setting a simple isolation break band, when the break band is crossed, the communication of the data is cut off, although the interference can be suppressed, but there are many system intersections of the cluster communication, and there is a large loss and waste of the communication channel. Alternatively, the center of the two stations may be taken as the center of the two sets of circles when intersecting, and the corresponding area range is drawn, and the overlapping area between the two round faces is circled, and the area is used as the intersection time period, and the distance is avoided as much as possible. At the intersection, data communication is performed by using two circular non-intersection areas, which can avoid the influence of channel communication generated by the cross-slot, but this method is easy to cause corresponding signal interference for the remaining communication units at the non-intersection, resulting in crossover. The transmission data of the time slot period is empty, resulting in an increase in data transmission pressure for the remaining time periods[2]. Or set the real-time transfer of the switching point. When there is a crossover of the channel, randomly convert any channel at the time of the crossover. Although the waste of resource allocation is avoided, there is a random influence on the communication line planning of the railway trunking communication system, and it is difficult to achieve perfect planning. Combining the above-mentioned multiple suppression time slots to the communication system interference method, designing a set multi-mode advantage, the resource can realize the method for reducing interference by optimizing the application, and realizing the stable transmission of signals between the base station station and the mobile station, To avoid the disorder of the cross-slot of the cluster communication, and the range of the isolation band is relatively small, and to maximize the utilization of resources, the following analysis of the interference of the interval stations in the cross-slots, and then propose an implementable solution.

2.2 Interference analysis of interval stations in cross-slots

The time slot interference factor of the inter-station station of the railway trunking communication system changes in real time with the change of the distance of the mobile station. There is a certain relationship between the time slot interference and the displacement of the mobile station interval. When the two communication channels are crossed, in order to reduce the interference of the signal, the station distance of the interval station can be increased, and the information transmission distance in the fixed time period can be opened, thereby avoiding the signal disorder caused by the short distance and reducing the interference to the interval station. The transmitting power of the signal transmitting device increases the power of the signal in operation to reduce the power of the interfering signal, thereby achieving the purpose of improving the signal-to-noise ratio[3].

2.3 Cross-slot mobile inter-station interference solution based on isolation band

In order to suppress the interference of the cross-slots of the railway cluster system to the data transmission, the output of the FM data is intermittently spaced for the access of the user transmission signals in different time periods, and the unused FM signals are all emitted under the same power. In turn, the interval between the signals received by the two mobile stations can be made poor, and the difference is approximated as the measured spacing[4]. When detecting the mobile station transmitting intensity of the collected signal, the power difference between the power of the receiving signal transmitting station and the nearest mobile station is less than the fixed limit value idB, it is regarded as the user has entered the corresponding isolation band. In this case, the user's channel needs to be transferred to other non-interleaved time slots in time. In this way, the time slot interference caused by the cross-slots of the railway cluster communication users can be suppressed.

First, the starting coordinates between the two mobile stations are set to (0, 0), (2r, 0), and the mobile station is in real-time motion state. By setting the moving real-time coordinates to (x, y), the distance between the two-point base stations in the movement can be calculated using Equation 1 below.

$$d_1 = \sqrt{x^2 + y^2}$$
$$d_2 = \sqrt{(x-2r)^2 + y^2} \quad (1)$$

As in the above formula, d represents the distance between two points, real-time positioning of the moving distance of the two points, According to the corresponding coordinates, the distance is calculated by using the fixed point on the circle to the fixed formula on both sides. The process map of the specific isolation area range is shown in Fig.1.

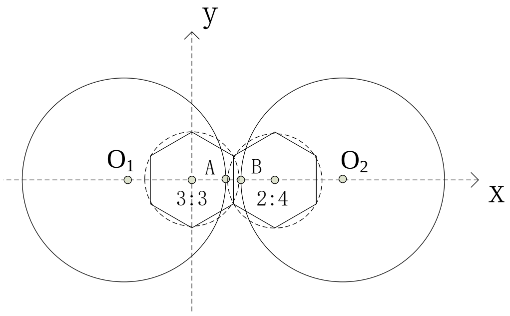

Figure 1 Schematic diagram of user isolation range

As shown in Figure 1 above, O1 and O2 are the centers of the two base station circles, and the two points A and B are the intersection boundary points. The 3:3 and 2:4 are the coordinates of the base station in the user's movement, and the normal use of the signal transmitting device is set. The power is P_t, and the frequency modulation signals received between the two adjacent mobile stations received by the user during use are set to P_{d1} and P_{d2}, By the ideal distribution mode for the two channel models, the amount of signal wear and the distance of transmission in the data transmission path are as shown in Equation 2.

$$P_t - P_d = a + 20\lg d \quad (2)$$

In the above formula, a is the amount of attenuation in transmission, plus 20 times the logarithm of the distance, expressed as the difference between the available powers, and the unit of calculation is uniformly set to dBm. During the implementation of the on-site monitoring process, the measured power transmitted by the mobile station transmits signals, and the difference between the signal strengths is equal to the fixed limit value. The specific formula is as follows.

$$P_{d1} - P_{d2} = 20\lg d_1 + 20\lg d_2 = i \quad (3)$$

In the above formula, by calculating the logarithm between the distances, the power difference between the two base station transmitting devices can be approximated, and d_1 and d_2 are simultaneously substituted into the above formula. The power of the signal receiving base station of the downlink communication channel can be calculated twice, and the signal differential value of the basic FM power is fixed with a certain limit value[5]. The following formula group is obtained.

$$[x - \frac{2r}{1-10^i}]^2 + y^2 = [\frac{2r10^i}{1-10^i}]^2$$
$$[x - \frac{2r}{1-10^{-\frac{i}{10}}}]^2 + y^2 = [\frac{2r10^{-\frac{i}{20}}}{1-10^{-\frac{i}{10}}}]^2 \quad (4)$$

In the above formula group, the two formulas respectively represent the two circles in Fig. 1. When the user is located at the solid line position on the circle, the working power of the FM signal transmitting device in the moving interval can be detected. The device frequency strength of the transmitting device with the recently moved base station is equal to the fixed rating, and the calculation unit is set in dB. When the user continues to operate on the railway, the range of the isolation band is gradually entered. In Fig.1, the signal intensity of the two circular and non-dashed portions is weaker than the portion where the dotted line intersects the circle. During this period of time, although the coverage area of the isolation band is small, it is relatively far from the signal transmitting device. The coverage of the independent bands for this time period is divided as shown in Fig.2.

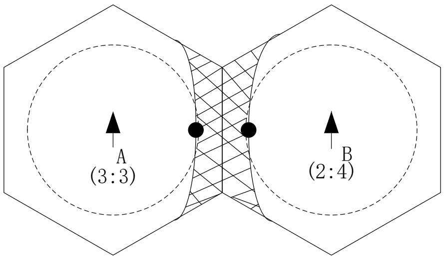

Fig.2 User isolation band division range

As shown in Fig.2 above, after the range adjustment of the signal used by the user, there is no interference of the cross-slot in the shaded part, only when the user is at the center of the circle A, B, There is controllable signal interference, and the receiving strength of the signal can be adjusted by continuously adjusting the distance between the points A and B to satisfy the design of the method based on the cross-slot interference suppression of the railway trunking communication system.

3. Comparative experimental analysis

In order to verify the practicability of the article design method, the number of signals received by the base station in the railway operation is simultaneously detected multiple times. Firstly, 5000 signal data is set to transmit information at the same time in a fixed time. The traditional cross-slot suppression method is used to receive and identify the signal. The cross-slot interference suppression method based on the railway trunking communication system designed by the article is used to perform the re-detection of the same steps. The experiments are all carried out in the same base station. A total of three data comparisons are performed, and the normal group and the experimental group are set, and the feedback data is provided. The analysis is performed as shown in Table 1 below.

Table.1 Comparison test data

Experimental group	The first time Number of signal recognition	The second time Number of signal recognition	The third time Number of signal recognition
Ordinary	3326	3015	3659
Experiment	4389	4573	4417

By comparing the two methods for the comparison of the number of signal identifications, we can conclude that under the same railway trunking communication system, after multiple comparisons of data, the article designed the cross-slot interference suppression based on the railway trunking communication system. The method has a higher recognition number of signals than the conventional method, and is increased by about 10%.

4. Conclusion

This paper studies the cross-slot interference suppression method of the railway trunking communication system, and calculates the relationship between the power and the distance of the signal transmitting equipment by setting the isolation band. Compared with other methods, the article design method is aimed at a smaller range of use. And the loss in the data transportation is high. In the future, the application of this method still needs continuous optimization, which will provide support for the optimization of the railway communication industry in the future.

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