Research on Satellite Signal Detection Scheme

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Abstract. This paper introduces the characteristics of common source of the satellite signal detection module. At present, the satellite signal detection module usually detects satellite beacon signals, which has high costs and weak anti-interference, and is not suitable for use in a variety of complex environments. In order to overcome the shortcomings in the current mobile satellite communication signal detection scheme, a multi-source signal detection scheme is proposed. This scheme can use different detection sources according to different working environments and working conditions to ensure the smoothness of mobile satellite communication links. This solution is robust, adaptable to various environments, simple in structure, low in cost, and especially suitable for low-cost development of mobile satellite communication equipment.

1. Introduction

With the increase of satellite resources, mobile satellite communications has become the mainstream of future satellite communications [1]. It has the advantages of long communication distance, wide coverage area, wide communication frequency bandwidth, large transmission capacity, high communication quality, and flexible communication links [2,3]. At present, satellite resources in the sky can cover any corner of the earth. In other words, as long as there are satellite communication equipment terminals, they can quickly access the Internet and communicate with the outside world at any corner of the earth. According to the kind of receiving terminal, satellite communications can be divided into fixed satellite communications and mobile satellite communications. Mobile satellite communications can play an outstanding role in deserts, islands, and emergency rescue and other special environments. It is the mainstream of future development of satellite communications. The representative equipment of satellite communication is also known as "SOTM", that is satellite on the move. This paper focuses on the scheme used by the satellite signal detection module in the “SOTM” system [4,5].

Downlink signals of satellite links usually include satellite beacon signals, satellite television signals, and communication carrier signals [6]. These three signals have different characteristics. The program can fully utilize the characteristics of different satellite signals according to different working environments of the satellite signal detection module.

1.1 Satellite Beacon Signals

The beacon signal is a kind of special signal that identifies the satellite. It is usually used by satellite ground monitoring stations to search, track, monitor, and control satellites. From the launch of the satellite, the beacon signal will continue to work until the end of the life of the satellite. Usually there is a beacon signal in each polarization direction. Beacon signals are usually distributed at both ends of the downlink signal band, and Ku-band beacons are usually located near the 12250 MHz and 12750 MHz frequencies. Figure 1 shows the use of a spectrum analyzer to measure the beacon signals of

Asia NO.V. Since the ground receiver contains 11300 MHz local oscillators, the detected beacon signal frequency is 1449.7 MHz(Vertically polarized beacon frequency is 12749.75MHz) [7].

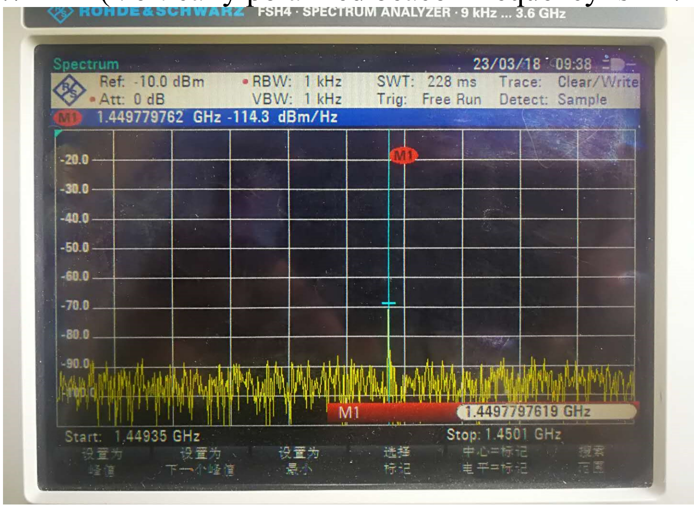

Fig. 1. Beacon signal spectrogram

1.2 Satellite television signals

Satellite TV signals (DVB-S, DVB-S2) have the characteristics of wide frequency band and high intensity. In addition to the audio and video contents, the data stream output after receiving, tuning and demodulating also includes many auxiliary data information. Data information can complete the satellite identification. The data stream is transmitted in packet format. The header identification byte is 0x47. The NIT (Network Information Table) in the data stream provides information about the physical network. The NIT carries network identifier (network ID, NID) information. Each has a unique identifier [8,9]. Since the NID in the NIT is unique, the satellite can be identified by extracting the NID in the data stream. Some of the satellite network identifiers (NIDs) are shown in Table.1.

Table 1. Parts of the satellite NID

Satelite	Direction	NID （Frequncy(GHz)）
Zhongwei No.1	87.5°E	7000（3.869）
Zhongxin No.1	88°E	1121（3.632）
Asia NO.3S	105.5°E	100（12.316）
Xinnuo NO.1	110.5°E	65（12.320）
Asia NO.4	122°E	8888（12.320）
Yatai NO.6	134°E	8022（12.302）
Yatai NO.5	138°E	41029（12.720）

To identify satellites with satellite television signals requires demodulation and decoding of satellite television signals. This requires high hardware requirements, high costs, and is not economical. However, in the phase of satellite tracking, the real-time adjustment of the antenna attitude in real-time can be adjusted according to the variation of satellite TV signal strength, which can ensure the real-time openness of the communication link. Such a scheme is simple in structure and low in cost.

1.3 Communication carrier signals

The bandwidth of the communication carrier signal is between the beacon signal and the satellite television signal, which is typically a few megahertz bandwidth. Different satellites often use different modulation and coding methods. Satellites can be identified according to different modulation and coding methods.

2. Satellite detection and identification scheme

In the course of work, the "SOTM" system will undergo initial capture, tracking, shadowing, and then recapture phases. The state transition is shown in Figure 2

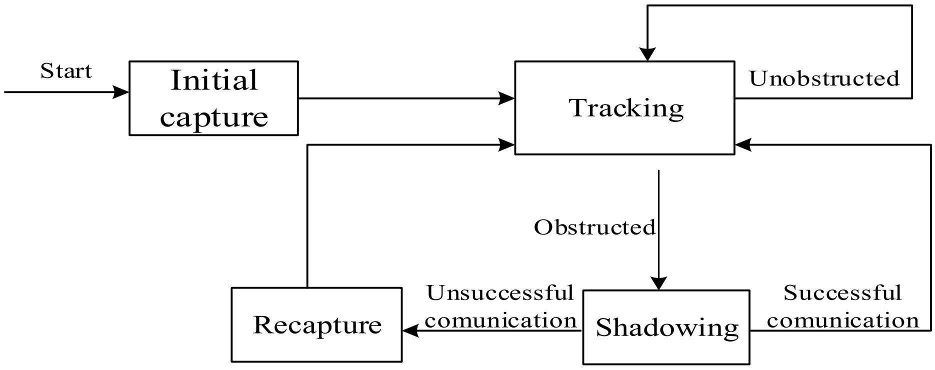

Fig. 2. State transition diagram

This paper synthetically utilizes the characteristics of narrow band and uniqueness of beacon signal, wide frequency band and high intensity of satellite TV signal, and proposes a satellite identification tracking scheme for narrow-band identification satellites and wide-band tracking satellites. It is used for initial acquisition and reacquisition in the "SOTM" system. During the stage of searching for the target satellite, it cannot be determined whether the detected signal is a signal forwarded by the target satellite. By detecting whether the beacon signal is received or not, it is determined whether the “SOTM” system is aimed at the target satellite. In the tracking phase, the carrier posture changes little. The “SOTM” antenna beam has been aligned with the approximate airspace where the target satellite is located. By detecting changes in the strength of the satellite television signal, according to the principle of maximum signal strength, the antenna pointing is fine-tuned so that the antenna beam is accurately aligned with the satellite at all times to ensure the communication chain. The scheme does not require demodulation and decoding of satellite television signals. It only uses the signal strength of satellite television signals as a feedback signal to instruct the measurement and control system to adjust the antenna beam, which reduces the complexity of the system. The structure is simple, the cost is low, the response speed is fast, and it is easy to implement. Hardware structure scheme diagram shown in Figure 3

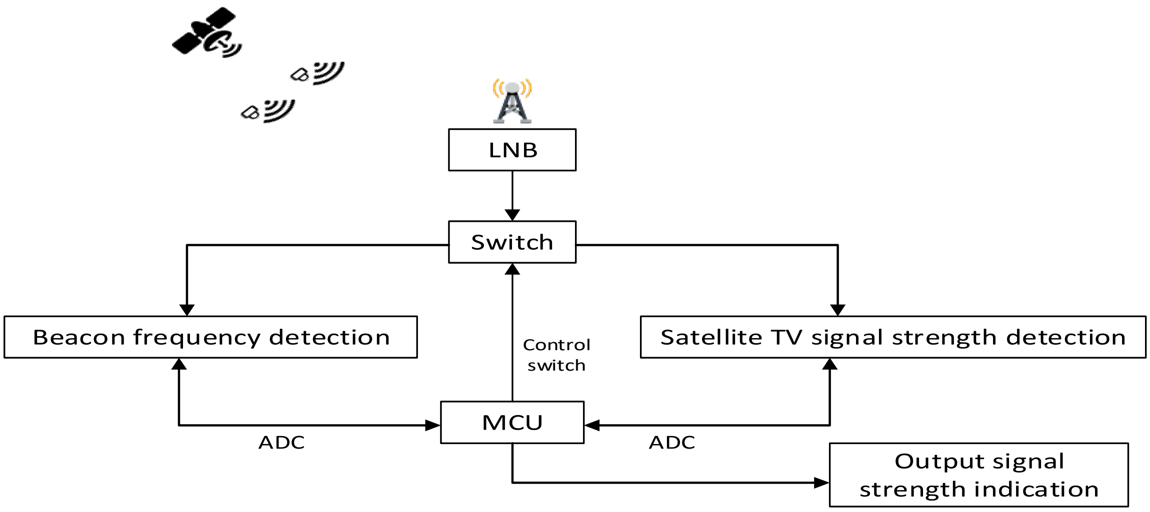

Fig. 3. System structure

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