Active Location Tracking for High Altitude Balloons

Introduction

High altitude balloons are commonly used to collect data from the upper atmosphere for both scientific exploration and weather reporting [1]. These balloons often need to be tracked both during flight and on the descent back to the surface for recovery. To locate the balloons, global positioning system (GPS) receivers are used in many applications. Once position is determined by the receiver, the balloon can then be actively or passively tracked. Active tracking can be done by transmitting the data in real time. The two best options for transmission include amateur radio which requires a license to operate and satellite messaging systems which require monthly subscriptions for data transmission [2]. This paper reviews the commercially available methods and technology for active location tracking.

GPS Location Tracking Technology Overview

GPS uses a network of 24 satellites to track location and movement. These satellites transmit their current position and time which is then read by the GPS receiver. To calculate position, the receiver requires signals from at least three satellites. Distance from the satellite is determined using the transit time of the signal. Location is then calculated using trilateration. Tracking systems can be either passive of active. Passive tracking systems store location information in memory for later analysis. Active tracking systems use transmitters to send position data through a network for real time updates [3].

GPS Receiver Specifications

This section covers the technical specifications of GPS receivers. Size is a tradeoff for most modules due to antenna size. Smaller antennas can affect the accuracy and timing of position measurements. Most modules are on the scale of tens of millimeters which allows for sufficient position accuracy [4]. The frequency at which the position is recalculated depends on the update rate of the device and varies depending on application. The standard rate is 1 Hz which is adequate for slow moving devices, but a higher rate, 5 to 10 Hz, is needed for flying vehicles. The speed at which a position can be determined is dependent on the number of channels. More channels will result in a faster lock on position, but the system will require more power. Most applications require 12 to 14 channels which is a standard feature. The average accuracy of the position calculation is 3 m, but can vary depending on time of day and reception clarity. Power requirements for a standard unit are 30 mA at 3.3 V [4].

Two examples of GPS receivers on the market are the Copernicus II [5] and the Venus 638FLPx [6]. The Copernicus II GPS module has a package size of 19 mm x 19 mm x 2.54 mm with an external antenna and is priced at $44.95. The update rate is 1 Hz, and it has 12 channels. It requires 3.3 V and 44 mA [4],[5]. The update rate is low if the GPS is to be used for any fast moving applications. The Venus638FLPx has a size of 10 mm x 10 mm x 1.3 mm and a price of $29.95. This module is about half

the size of the previously described module, but the technical specifications are comparable. The update rate is set at a default 1 Hz but can be increased to 20 Hz. The dynamic update rate allows for optimization of computing power. If a high update rate is not necessary for the intended use, the user may select a lower rate to optimize the allocation of resources on the module. There are 14 channels for reception which is two more channels than the Copernicus module. This difference is negligible. The required power is 3.3 V and 29 mA [4],[6].

Active Tracking Systems

GPS tracking systems combine a GPS receiver and a transmitter to send information back to the user. When used in a high altitude balloon, the transmission method must be independent of location and altitude in order to be reliable. The best methods use amateur radio or satellite messaging systems to transmit data [2].

Amateur Radio Tracking

Amateur radio tracking uses ham radio signals and allows for position updates in one minute increments. Position can be reported for the entire duration of a high altitude balloon flight [2]. Automatic Packet Reporting System (APRS) is the preferred service available to transmit the position data using ham radio. This data may then be sent over the internet to be visualized in a web browser [7]. An amateur radio license is required to use this method and can be obtained after completing a short course [2]. Trackers that utilize this technology are usually on the scale of centimeters with a weight between 50 and 100 g. They are priced, on average, at $200. The Tracksoar is a commercially available module that is 5 cm x 2 cm x 1.3 cm in size and 56.7 g in weight. The transmit interval is programmable and has a maximum frequency of once every 10 seconds [8].

Satellite Messaging Systems

Satellite messaging systems use satellite networks for data transmission. Due to extensive networks, the system will be able to transmit data at any point in the world where there is a clear connection to the satellites. A subscription fee is required to receive the data, but a license is not required. The monthly fee of a module that is on the Iridium network is $14. The Iridium Network is preferred for high altitude balloon satellite communication due to its global coverage. The RockBLOCK 9603 is a module sold by Iridium at a price of $249.95. This module has a size of 45 mm x 45 mm x 15.5 mm and weighs 36 g. It is able to transmit data once every 40 seconds [9].

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