Research on road vehicle positioning technology based on UWB communication

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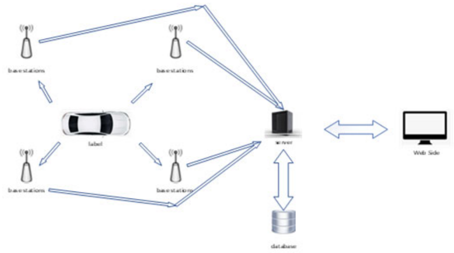
Abstract

- In order to accelerate the construction of intelligent transportation network, we will design and develop a high-precision vehicle lane positioning platform for highway centimeters to realize the integration of vehicle and road clouds. The design of the highway vehicle precision positioning system is based on STM32F103CBT6, UWB chip as the core to achieve the design of anchor and tag. At the same time, by adding RF amplifiers, modifying the transmitting power and optimizing the software code, it is possible to achieve high precision long distance positioning in real time and guarantee 150m communication. Finally, the QT interface presents the vehicle's trajectory. Experimental results show that the system is stable and reliable, the positioning error can be achieved within 10cm, and the high refresh rate of the second can be achieved on the QT platform.

Introduction

- As a new type of radio communication technology, ultra-wideband wireless communication technology has good development prospects and this technology has been recognized as one of the top ten technologies for future communication in the industry. The use of UWB technology to build a highway vehicle positioning system can achieve transportation networking. UWB positioning system using anchors, tag and intelligent management platform as a whole, not only can be used on the highway but also in any location can achieve target positioning, especially tunnels, caves and forests and other locations without signal or signal is particularly weak. The use of UWB technology to carry out the whole process of vehicle monitoring is of great significance.

Structure and methodology



(a)

Fig. 1. (a) Overall system architecture

- The vehicle positioning system includes two parts: hardware and software system, the hardware part is a wireless sensor network based on the UWB (IEEE802.15.4) protocol, including Tag, Anchor. The software part includes hardware embedded software and host computer software. Tag and anchor are designed based on this chip. The tag is installed on the mobile vehicle and sends and receives pulse signals between an anchor and another anchor in real time. The anchor is installed on the anchor pile on both sides of the highway, and the timestamp information is obtained by continuously communicating with the tag. The timestamp information is converted into distance information by calculation and uploaded by the 4G wireless transmission module to the MYSQL database of the cloud server. The host computer takes the location information of the tag in the database and displays the actual location on the map.

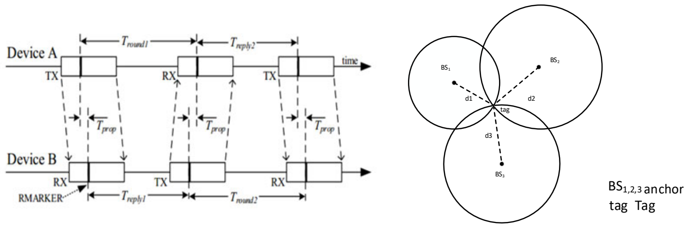


Fig. 5. (a) Ranging schematic (b)Positioning schematic

- Bilateral bidirectional ranging is an extended ranging method of unilateral bidirectional ranging, which records two round-trip timestamps and finally obtains flight time. Although it increases the response time, significantly reduces the ranging error. The positioning method adopted by this system is the TOA positioning method. The principle of this method is to calculate the distance between the positioning tag and the anchor by the propagation time of the signal emitted by the positioning tag to reach the anchor.

Results

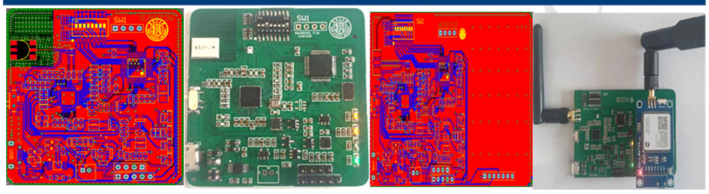


Fig. 2. (a),(b) Tag PCB diagram (c),(d) Tag physical drawing

- The DW1000 requires the differential impedance of RF_P and RF_N to be kept at 100Ω. Here the HHM1595A1 is used to convert the 100Ω differential impedance to a single-ended 50Ω single-ended impedance. The ground layer is chosen as the reference layer when we design the PCB. The signal channels are all kept to maintain a 50Ω single-ended impedance and to avoid impedance discontinuities that can cause signal emission problems.

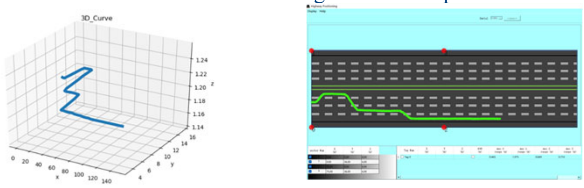


Fig. 3.(a) 3D Trajectory chart (b) Vehicle trajectory

- Host PC software is based on Qt5.14, the PC-side computer of the system can run on the Windows system, and the next computer can be used. The main functions implemented by the host computer software are:
  (1) Connect with the serial port of the UWB system and obtain data;
  (2) Set the actual placement position of the anchor;
  (3) Solve the specific position of the tag;
  (4) You can import the map in PNG format to achieve the zoom of the map and the fine adjustment of the coordinates;
  (5) The trajectory of motion can be retained on the simulation map to facilitate the judgment of the trajectory.

The following figure shows the trajectory route of the vehicle left behind when the host computer is working.

- The upload of ranging information is achieved remotely through the Core-Air724 module of YinErda Company. The server selects the server of Alibaba Cloud, which can realize data upload by configuring the host address 39.104.79.204, port 8083, and subscribing to the same theme device as the 4G module. It facilitates the subsequent establishment of databases, data deep analysis and web interface development and application.

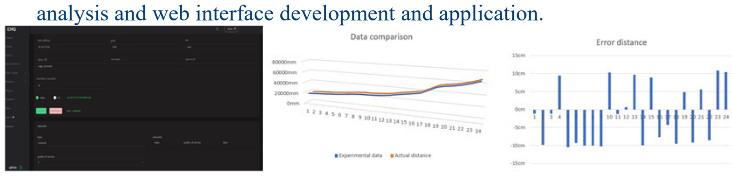


Fig. 4. (a)Console interface (b)Data comparison charts (c)Error distance

- The comparison between the actual measured data and the experimental data using the tape measure is as follows, in the real-time data comparison of the tag and anchor 0, it is fully in line with the expected goal. By making a difference between the real distance and the actual distance, while ensuring a high refresh rate, the actual measurement error is within 10cm, which effectively solves the problem of high precision.

CONCLUSION

- This paper designs a highway precision positioning system based on DW1000. The system uses the TOA positioning algorithm. The transmitting power has been increased and the transmitting and receiving process has been reworked to solve the problem of communication blockages. The system achieves high precision accuracy, high refresh rates and a communication distance of 150 meters with an experimental error of 10cm or less. It can fully meet the requirements.

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