Research and Implementation of Multi - source Fusion Positioning and Navigation Technology

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Abstract. With the rapid development and promotion of science and technology. Location Based Service (LBS) play a more and more important role in Military research, scientific research and all aspects of people's lives. The core of the LBS is whether the positioning is accurate enough. The accuracy of positioning is the key to all applications. Nowadays, the mainstream of positioning technology are Global Positioning System (GPS) and Inertial Navigation System (INS).However, both approaches have advantages and disadvantages. INS has a strong anti-jamming capability and is not affected by terrain factors, but the accuracy will over time have a greater error. GPS positioning is very accurate. However, due to weather changes or building block and other factors GPS signals will fluctuate or even disappear. Therefore, the combination of GPS and INS is a good way to positioning. GPS is used to calibrate the INS for precise positioning. However, because GPS signals are affected by weather and terrain, how to use INS to locate in the time when GPS signal disappears is the core problem of positioning accuracy. In this paper, a new method of INS localization have been designed and implemented for this problem.

1. Introduction

With the development of science and technology, people have more and more requirements for accurate positioning. Real-time, accurate and no regional restrictions of the positioning technology has become a popular research.

Nowadays, the mainstream of positioning technology are Global Positioning System (GPS) and Inertial Navigation System (INS).GPS has all-weather, high precision and automatic measurement characteristics, but it will be subject to some objective factors, such as bad weather or high-rise blocks. On the contrary, INS is not subject to these objective factors, but with the passage of time will produce data drift, resulting in a larger error. Therefore, the combination of GPS and INS positioning method is the most mainstream positioning method. But the combination of GPS and INS still can not change the fact that the GPS signal will disappear. How to prevent the data drift of

INS positioning when the GPS signal disappears is the core problem which affects the positioning accuracy.

When the GPS disappears, locating with INS alone will cause two problems. The first problem is how to determine the state of motion of the object. The second problem is that over time INS positioning will produce data drift resulting in inaccurate positioning. In this paper, the solution to these two problems is proposed, and the feasibility of the solution is proved through experiments.

2. Designs and Implements

Designs. To exclude the effect of the GPS signal on the experiment, we used an x-IMU device that did not include a GPS module, instead of an electronic device such as a mobile phone. The x-IMU was designed to be the most versatile Inertial Measurement Unit (IMU) and Attitude Heading Reference System (AHRS) platform available. Its host of on-board sensors, algorithms, configurable auxiliary port and real-time communication via USB, Bluetooth or UART make it both a powerful sensor and controller. The inclusion of gyroscopes and acceleration detectors in the x-IMU provides us with the raw data for INS positioning. At the same time x-IMU provides a good interface to facilitate access to MATLAB for data analysis. With regard to the test method, we experimented with the human being wearing the device, because the human can not only simulate various movement states but also have cost less.

In the absence of GPS, there are two difficulties in locating with INS alone. The first difficulty is to determine whether the object is stationary or moving. GPS can observe whether the object has generated a displacement to easily determine whether the object is moving. However, it is difficult to determine the motion state of the object in the INS by only the values such as acceleration and angular velocity. Especially the static state and uniform motion state, because the acceleration of these state is almost 0 so it is more difficult to distinguish. In order to solve this problem, we distinguish the state of motion by set the threshold.

First of all, the initial state of motion of the object is easily obtained and we set thresholds for the initial velocity and the initial acceleration on the basis of the initial state of motion of the object. Since the object can not be in absolute static state, the speed and acceleration of the measuring instrument can not be zero. In order to find the appropriate threshold, we conducted a number of tests and concluded that when the object is in relative static state, the acceleration is not more than $0.05m/s^2$ and the velocity is less than 0.01m/s.

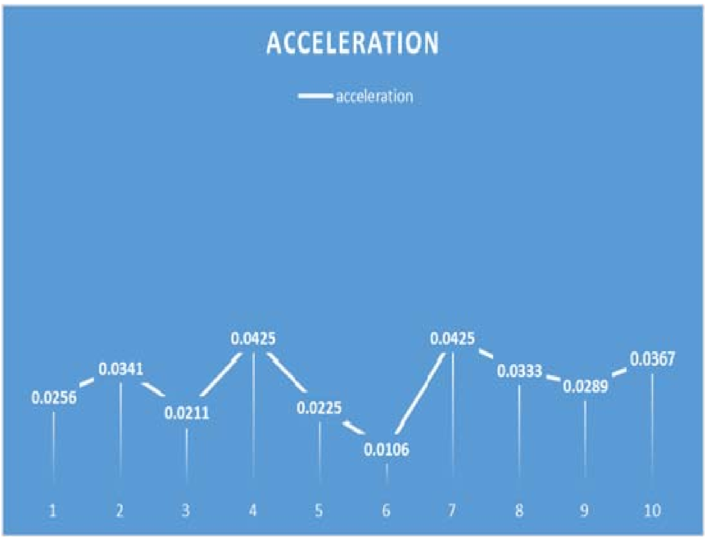

Fig. 1 Accelerometer measurement data

Therefore, in the experiment, we set the threshold value of initial velocity V_0 to 0.01 m/s and the threshold value of acceleration A to 0.05 m/s^2. Then according to the set threshold can be divided into four cases:

(1) When V_0 <0.01 m/s and A<0.05 m/s^2 the object is considered to be stationary.

(2) When V_0 <0.01 m/s but A> 0.05 m/s^2 when the object is in an accelerated state.

(3) When V_0> 0.01 m/s but A<0.05 m/s^2 when the object is in constant motion.

(4) When V_0> 0.01 m/s and A> 0.05 m/s^2 when the object in accordance with the direction of acceleration in the acceleration or deceleration state.

The second difficulty is that INS long run, if there is no GPS calibration, positioning will have a significant error. Therefore, it is also necessary to calibrate INS positioning in the absence of GPS signals. Since we can obtain the initial state and position of the object motion, we can calibrate the INS position with the initial position of the object and the values of the current motion state during the experiment. We can also use the last set of data before the GPS signal disappears as the baseline data to calibrate the INS positioning.

We use high-pass filter and low-pass filter to deal with the raw data that we collect. The low-pass filter is a filter that allows a signal below the cut-off frequency to pass but a signal above the cut-off frequency can not pass. The low-pass filter is used to filter out some high values that can not occur during the acquisition process. The high-pass filter, also known as a low-cut filter, a low-pass filter, allows a frequency higher than a cut-off frequency, and greatly attenuates a lower frequency filter. The high-pass filter is used to filter out some low values that can not occur during the acquisition process. At the same time, according to the threshold set to determine when the object is in a static state, we set the speed to 0 to make the experimental results more accurate and make the image more clear, which will make it easier for us to draw conclusions.

Implements. According to the above design, we conducted a number of experiments and I will take one of the experimental results to illustrate. The experiment was carried out by a person wearing an X-IMU walk in the building. The walking path includes straight walking, turning and upstairs. The experimental data after processing by MATLAB graphics are as follows:

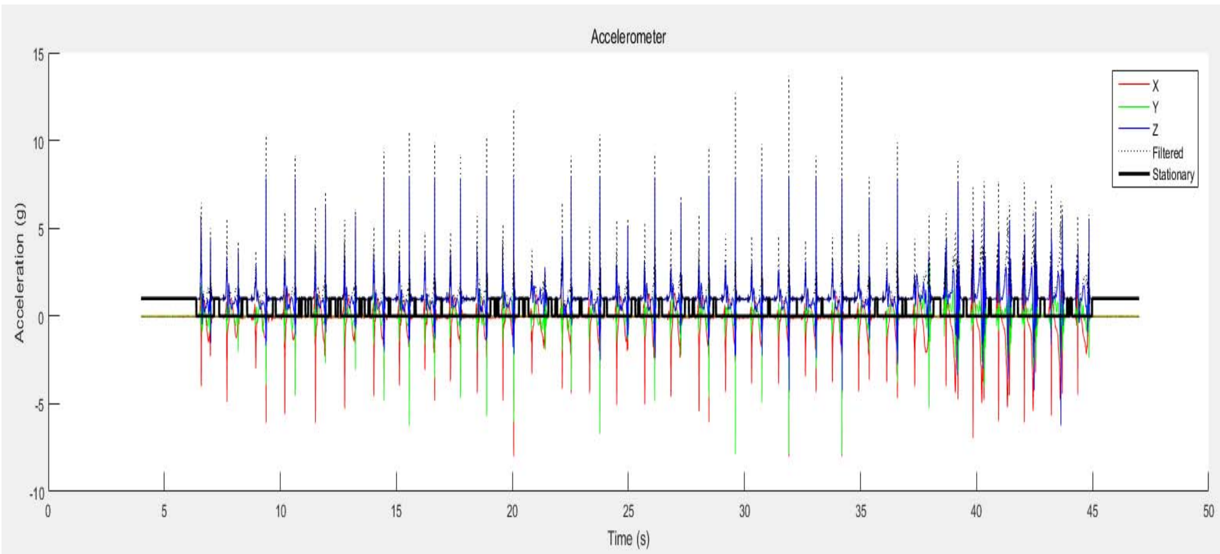

Fig. 2 Accelerometer raw data diagram

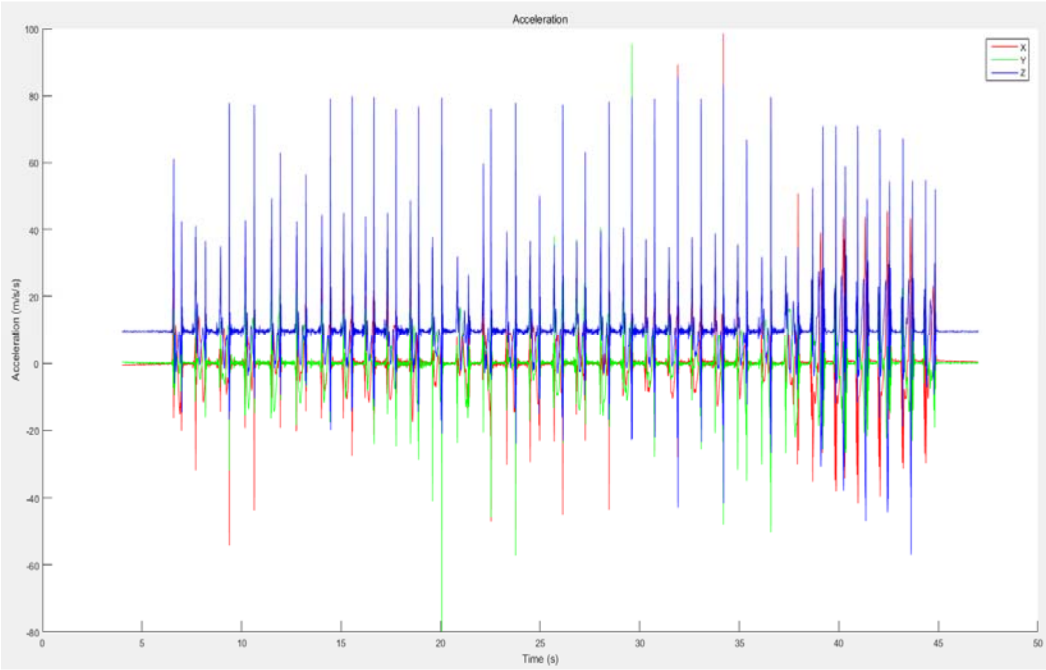

Fig. 3 Accelerometer filtered data diagram

Comparing the original data and the processed data collected by the accelerometer, it is not difficult to find that the high-pass filter and the low-pass filter have obvious effects. The raw data is filtered to filter out some noise data. Which avoids the influence of noise data on the accuracy of experimental results.

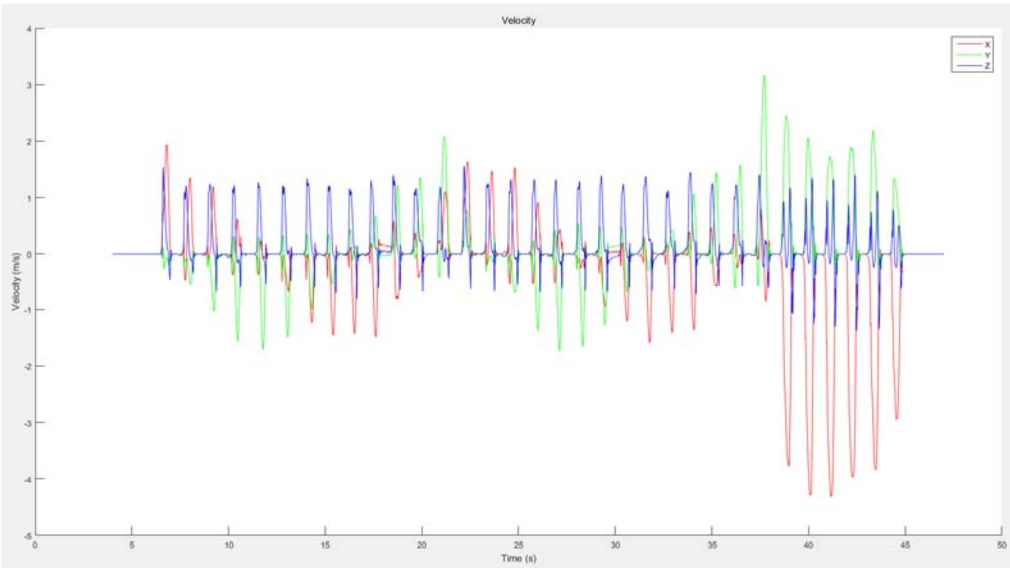

Fig. 4 velocity diagram

Observing the velocity diagram, we can see that, at the beginning and the end, the person is at rest and the speed is zero. This is in line with our original intention of the design. Observe the acceleration and velocity diagram can be found, when the speed is less than 0.01m/s, acceleration is less than 0.05m/s^2 speed graphics have an instant fall, no longer a smooth curve. This means that the setting threshold is valid. The velocity of the object in the static state is set to zero.

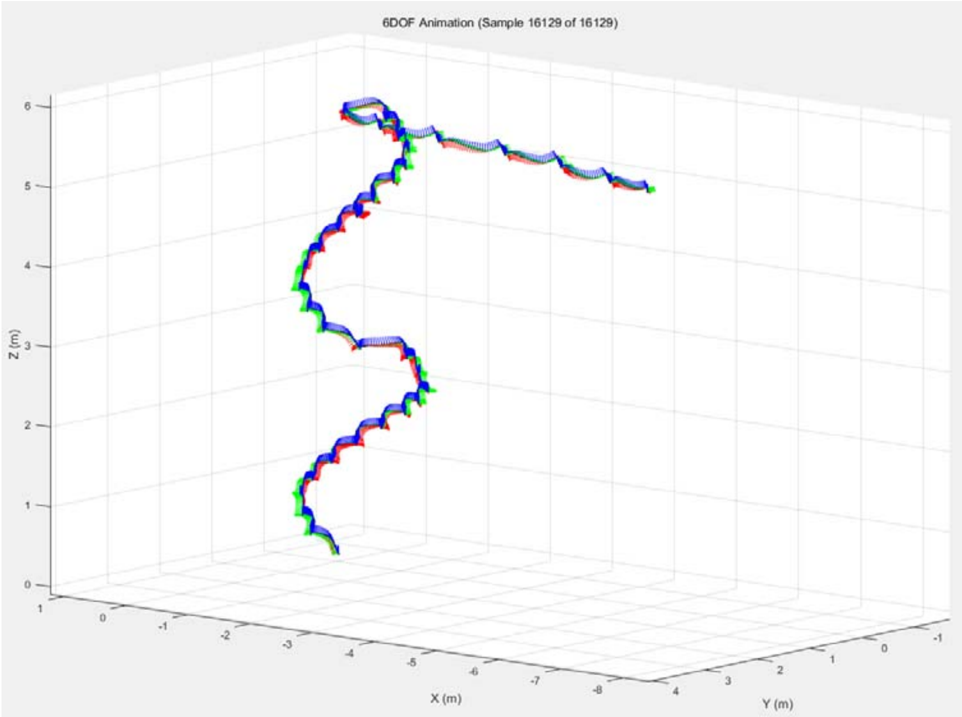

Fig. 5 Motion trajectory

It is easy to see from the velocity and acceleration plots that the graphs are approximately symmetrical and that no data offsets have occurred. This shows that the INS positioning has been calibrated. Observe Fig. 5, it can be clearly seen that the distance is straight after the stairs, which once again proved that the positioning is correct. The results drawn on the graph reflect the trajectory of the movement in line with the actual trajectory. This shows that we can locate the moving object correctly by setting the threshold and initializing the INS data in the absence of GPS signal.

3. Summary

This paper presents the problem of only using INS localization when GPS disappears. At the same time, this paper proposes a solution to this problem and carry out an experiment. Through experiments we found that the use of filters for raw data processing is necessary, the processed data will make the experimental results more accurate. More importantly, setting the threshold and using the initial value to correct the INS data can accurately position when the GPS signal disappears for a short time, our proposed solution proved to be feasible.

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