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RESEARCH ARTICLE

ATTITUDE`ESTIMATIONOF AMOVING VEHICLE USING MOUNTED SATCOM

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ABSTRACT

This paper develops a low-cost method to determine the vehicle attitude for vehicle-mounted satellite communication (satcom)-on-the-move (SOTM) uses a micro inertial measurement unit (MIMU) and a two-antenna global positioning system (GPS). An adaptive Euler-angle-based unscented Kalman filter (UKF) is utilized to fuse these sensors to guard against the effects induced by GPS outages and vehicle accelerations. When the two-antenna GPS can provide the vehicle yaw angle, the vehicle accelerations that introduce large errors to the accelerometer-measured gravitational acceleration can be corrected by the GPS-measured velocity and sideslip angle. When the two-antenna GPS fails to provide the yaw angle and needed information, the yaw angle is estimated only by integrating gyroscopes. The estimation of the pitch and roll angles is adaptively controlled by the vehicle acceleration detection rules. These rules make full use of the gyroscope output and the filtering results, which are more compatible with vehicle use than conventional accelerometer norm-based rule. The proposed method is verified with driving tests, suggesting that this technique is a viable candidate for low cost SOTM.

INTRODUCTION

The need for broadband connectivity from a moving vehicle has dramatically increased in the past few years for both military and civilian uses. To meet this increasing need, satcom-on-the-move (SOTM) may be the best choice at present. This new technology enables the commander to effectively execute battle command tasks while displaced from the command post, and it maintains both voice and data connectivity on the move, which provides near-real-time battlefield information. With this new technology, civilian users can benefit from high-speed global data communications and reliable true broadband connectivity on the move, all of which enable travelers to access the Internet or watch television on board for work or personal entertainment. Furthermore, it is critical for emergency vehicles, such as police, fire, and search and-rescue platforms. To set up a successful satellite link with the vehicle-mounted SOTM, one of the biggest challenges is maintaining accurate targeting toward the satellite while the vehicle is in motion. Many previous works on low-cost attitude estimation focus on the fusion of inexpensive sensors, including micro electromechanical-system-based (MEMS) gyroscopes and accelerometers, magnetometers, and the global positioning system (GPS).Gyroscopes can be integrated to provide angles but suffer from accumulating errors induced by gyroscope biases. Accelerometers can provide the pitch and roll angles by measuring the gravity vector if the vehicle is stationary or moving in a constant speed. The accelerometer-based attitude is drift free but affected by vibration noise and vehicle accelerations. Magnetometers are widely used for yaw-angle measurement, which are subject to large disturbance near ferromagnetic subsistence and magnetic surroundings. Single- and multi-axis models of accelerometer are available to detect magnitude and direction of the proper acceleration and can be used to sense orientation (because direction of weight changes), coordinate acceleration (so long as it produces g-force or a change in g-force), vibration, shock, and falling in a resistive medium (a case where the proper acceleration changes, since it starts at zero, then increases). Accelerometers are increasingly present in portable electronic devices and video game controllers, to detect the position of the device or provide for game input.

Literature Survey

Alam *et al* (2011) proposed position information, as a fundamental element for many of the modern vehicle-based logistic applications, is comprehensively provided by GNSS such as the GPS. A variety of applications, including navigation and intelligent transpiration systems, require position data with certain accuracy. However, the shortcomings of GNSS such as limited accuracy and availability have been a motivation for recently emerging CP methods basedon vehicle-

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vehicle and vehicle-infrastructure communications. Bolandhemmat *et al* (2005) proposednovel hybrid tracking method for mobile active phased-array antenna systems is developed. The proposed technique consists of a mechanical stabilization loop and a direction-of-arrival (DOA) estimation algorithm, which is based on electronic beam forming. Compared with other tracking methods, the proposed method requires only one low-cost yaw rate sensor. The method utilizes electronic feedback from the phased-array antenna to compensate for the low-cost sensor irregularities. The effectiveness of the proposed tracking method is demonstrated by measured performance of a fast-moving ultra-low-profile phased-array satellite terminal, which uses the proposed approach. Chan *et al* (2011) proposed an efficient search scheme for an underwater radiating source is developed by introducing intermediate variables which are products of some of the unknowns. The search dimension is only two in x- y position instead of five. The resultant intermediate equations become linear and are easier to solve, the major calculation at each grid point requires an inversion of a 3×3 matrix.

Drawil *et al* (2005) proposed an awareness of a vehicle's precise location in VANET is vital so that any vehicle can provide accurate data to its peers. Currently, typical localization techniques integrate the GPS receiver data and the measurements of the vehicle's motion. However, when the vehicle passes through an environment that creates multipath signals, these techniques fail to produce the high localization accuracy that they attain in open environments. The goal of this research is to minimize the multipath effect with respect to the localization accuracy of the vehicles in VANET. The proposed technique IVCAL, takes advantage of the communications among the VANET vehicles in order to obtain more information from the vehicle's neighbors. Maeder, U *et al* (2011) proposed a novel method for the estimation of the attitude of an automotive vehicle is presented. The algorithm uses low-cost sensors, namely, a Global Positioning System (GPS) receiver and a three-axis accelerometer. It employs a kinematic model of the vehicle, which is augmented by unknown parameters of the system. An extended Kalman filter (EKF) is employed, which produces estimates of the vehicle attitude, as well as the installation angles of the sensor unit with respect to the vehicle. Compared with existing approaches, it does not require knowledge of the road tilt angle. Nima Alam *et al* (2013) proposed a method which is based on range-rate-based vehicular CP using Doppler shift of the signal, which is used for vehicular communication. In this system, GSM and GPS technology along with doppler shift technique is used for identifying the vehicle position and transferring the information of the vehicle. And also the nearby vehicles positions also estimated using the proposed system. Elimination of infrastructure costs which required for conventional DGPS, achieving higher accuracy and precision by eliminating errors caused by infrastructure nodes.

Proposed System

This paper introduces a novel vehicle AES. The proposed technique combines a MEMS gyroscope triad and a MEMS accelerometer triad with a two-antenna GPS system to keep the antenna pointing to the desired satellite accurately. Because vehicle accelerations are the main disturbance in the pitch- and roll-angle measurements and the two-antenna GPS is susceptible to obstructions, we make full use of these sensors and perform the fusion in two cases according to the working states of the two-antenna GPS. When the two-antenna GPS can provide the yaw angle, the vehicle accelerations are corrected with the GPS-measured velocity and the sideslip angle. When the two-antenna GPS cannot provide the yaw angle due to obstructions, the yaw angle is estimated by gyroscope integration, and the pitch and roll angles are estimated by an adaptive UKF. The adaptive scheme is based on the vehicle acceleration detection rules. These rules are associated with the turning-rate measurements and the acceleration predictions, which produce a better performance than the accelerometer norm-based rule.

Block Diagram of Vehicle Mounted Satcom

With this vehicle mounted sitcom, civilian users can benefit from high-speed global data communications and reliable true broadband connectivity on the move, all of which enable travelers to access the Internet or watch television on board for work or personal entertainment. Furthermore, it is critical for emergency vehicles, such as police, fire, and search and-rescue platforms. To set up a successful satellite link with the vehicle-mounted SOTM, one of the biggest challenges is maintaining accurate targeting toward the satellite while the vehicle is in motion. Many previous works on low-cost attitude estimation focus on the fusion of inexpensive sensors, including micro electromechanical-system-based (MEMS) gyroscopes and accelerometers, magnetometers, and the global positioning system (GPS). The below fig 1 represents the block diagram of vehicle mounted satcom

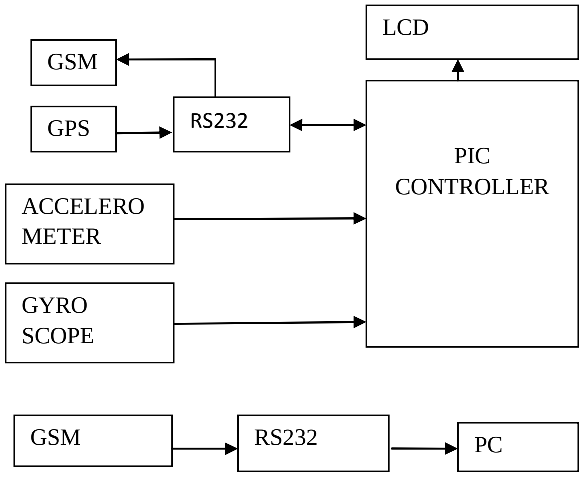

Fig 1 Block diagram of vehicle mounted satcom

An accelerometer is a device that measures proper acceleration. The proper acceleration measured by an accelerometer is not necessarily the coordinate acceleration (rate of change of velocity). Instead, the accelerometer sees the acceleration associated with the phenomenon of weight experienced by any test mass rest in the frame of reference of the accelerometer device. For example, an accelerometer at rest on the surface of the earth will measure an acceleration g= 9.81 m/s^2 straight upwards, due to its weight. By contrast, accelerometers in free fall or at rest in outer space will measure zero. Another term for the type of acceleration that accelerometers can measure is g-force acceleration. The below fig 2 represents the circuit diagram of accelerometer.

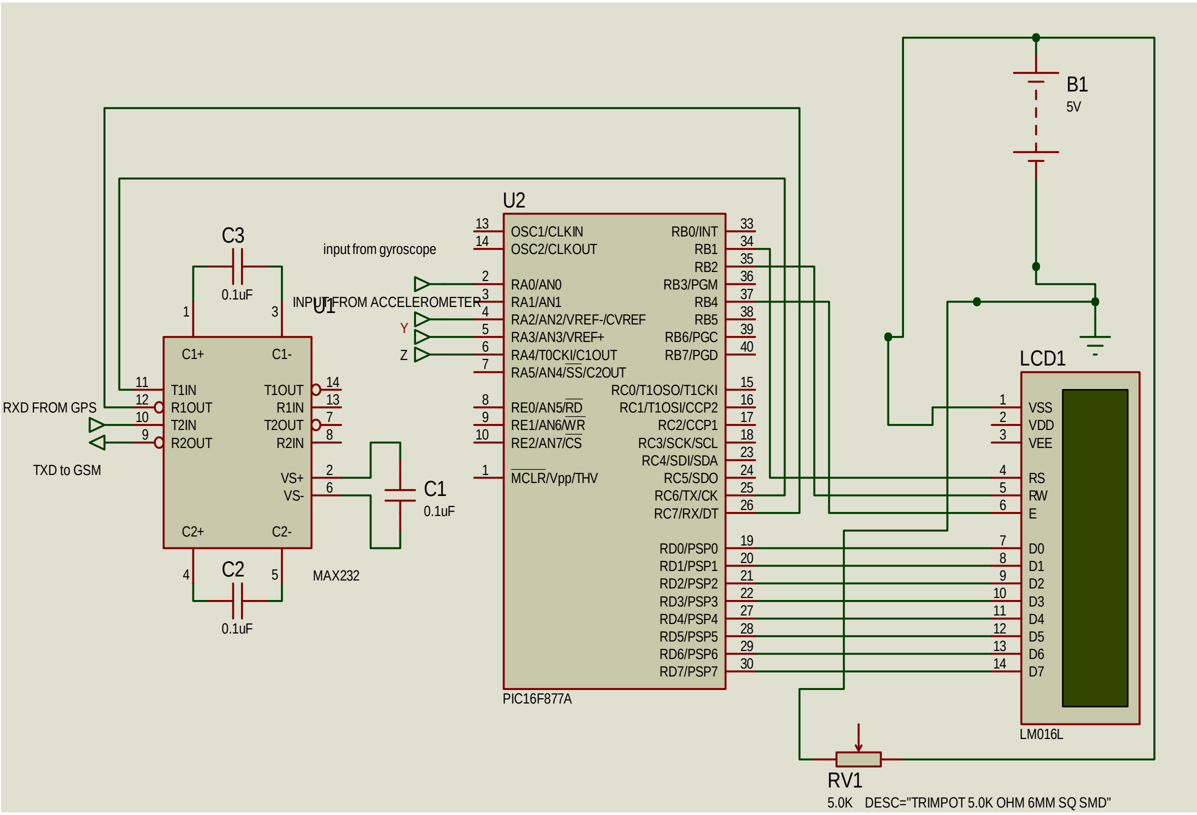

Fig 2 Circuit diagram of Accelerometer

Accelerometers have multiple applications in industry and science. Highly sensitive accelerometers are components of inertial navigation systems for aircraft and missiles. Accelerometers are used to detect and monitor vibration in rotating machinery. Accelerometers are used in tablet computers and digital cameras so that images on screens are always displayed upright. Single- and multi-axis models of accelerometer are available to detect magnitude and direction of the proper acceleration (or g-force), as a vector quantity, and can be used to sense orientation (because direction of weight changes), coordinate acceleration (so long as it produces g-force or a change in g-force), vibration, shock, and falling in a resistive medium (a case where the proper acceleration changes, since it starts at zero, then increases). Micro machined accelerometers are increasingly present in portable electronic devices and video game controllers, to detect the position of the device or provide for game input.

Pairs of accelerometers extended over a region of space can be used to detect differences (gradients) in the proper accelerations of frames of references associated with those points. These devices are called gravity gradiometers, as they measure gradients in the gravitational field. Such pairs of accelerometers in theory may also be able to detect gravitational waves.

Gyroscope

A gyroscope is a device for measuring or maintaining orientation, based on the principles of angular momentum. Mechanically, a gyroscope is a spinning wheel or disc in which the axle is free to assume any orientation.

Although this orientation does not remain fixed, it changes in response to an external torque much less and in a different direction than it would without the large angular momentum associated with the disc's high rate of spin and moment of inertia.

GSM Technology

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil and commercial users around the world. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver.

RS-232

RS-232 is an interfacing cable that supports high data rate serial communication. It is mainly used for interfacing two data equipments. It supports various printing modes and extensively used for interfacing PIC Microcontrollers. The extensive uses of RS-232 have been decreased due to the coming of Universal Serial Bus**.**

LCD

LCD is defined as the Liquid Crystal Display. Extensively used for display purposes in Microcontrollers. The LCD screen is composed of a liquid material that prevents any damage to the human eyes.

RESULT

The below fig 3 represents the experimental setup of vehicle mounted SATCOM. The performance of the vehicle mounted SATCOM does not depend on the accelerometer and magnetometer. Thus the computational burden of the vehicle mounted SATCOM can be optimized by managing the gyroscope and two antenna based GPS system. There is no existing method of vehicle mounted satellite communication on-the-move with high accuracy. The accelerometer-based attitude is drift free but affected by vibration noise and vehicle accelerations. Magnetometers are widely used for yaw-angle measurement, which are subject to large disturbance near ferromagnetic subsistence and magnetic surroundings. Multi baseline GPS can determine attitude by using carrier-phase differential technology. However, it suffers from signal blockages and a low update rate. Thus, it makes sense to fuse these sensors for accurate attitude. In, the AES mainly focuses on the fusion algorithm and does not consider the external accelerations and magnetic disturbance, which is impractical for vehicle-mounted SOTM.

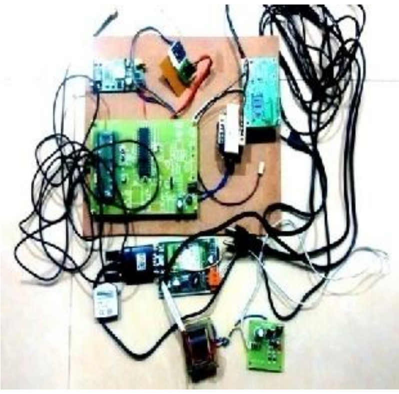

Fig 3 Experimental setup of vehicle mounted SATCOM

CONCLUSION

This paper develops a low-cost AES for vehicle-mounted SOTM using low-grade MEMS gyroscopes and accelerometers, as well as a two-antenna GPS. The basic idea behind the mechanization techniques described is to make full use of the measurements of different sensors; thus, it is basically a hybrid information fusion process. The fusion of the gyroscopes with the aiding system (accelerometers and two-antenna GPS) results in a blended output that has both short-term accuracy (due to the gyroscopes) and long-term accuracy (due to the aiding system). The drawbacks of the aiding system are overcome by the switching rules for adaptive filtering. The experimental results demonstrate that the sensor fusion algorithm can successfully deal with the accumulating errors caused by gyroscope biases, the accelerometer disturbance induced by vehicle accelerations, and the signal blockage of the two-antenna GPS system.

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