

## Sensor – Based Dead Rockening for land vehicle navigation system

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### Abstract:

The Extended Kalman filter (EKF) is used for sensor fusion in a land vehicle navigation system. As the defects of the first-order linearization create that the EKF can introduce estimated errors, and will not provide better performance. To yield higher accuracy of navigation, in this paper, a novel particle filter for sensor fusion is proposed and the sampling of the particle filter shows better performances when compared with the EKF. The areas which will affect Terrain, buildings, and foliage can block the propagation of GPS signals and in tunnels or in parking garages, the receiver will see no satellites at all. Consequently, continuous navigation in many cities is impossible for conventional GPS-only navigation systems. In the absence of the GPS, the historical GPS data can be combined with sensors to provide continuous navigation in even the most-challenging environments, with the possibility of the modified particle filter algorithm to avoid dead reckoning for land vehicle navigation system.

**Keyword:** GPS, Accelerometer, Dead Reckoning, Extended Kalman Filter [EKF] Inertial Navigation System[INS]

### 1. INTRODUCTION

This paper addresses an approach which integrates the location estimation using dead reckoning techniques in step-based pedestrian navigation. In the proposed method, the pedestrian is equipped with a GPS equipped device along with a sensor module to record the accelerations of walk and determine the headings while walking. To improve the step detection accuracy, normal walk method is taken into consideration. The walking speed can be measured through counting the steps and assess the step length from which the distance traveled is estimated. By coupling the distance with the azimuth, navigation through the pedestrian dead reckoning is considered.

This research provides a possible seamless pedestrian navigation solution which can be applied to a wide range of areas where the global navigation satellite system

### 1.1 Challenging Environments:

GPS has gained widespread acceptance for personal, commercial, and government applications requiring location awareness. More than 24 satellites orbit the earth in six orbital planes to provide visibility to four or more satellites from any location on Earth. Four satellites are required to compute three dimensional position fixes. The visibility to the satellites is hindered so continuous navigation for tracking is not guaranteed.

- GPS navigation with fewer than four satellites.
- SBAS making more satellites available for ranging, and

Sensor-based dead reckoning Navigation with < 4 Satellites. As mentioned, at least four satellites are required for three-dimensional navigation. If the number of satellites drops to two, then another assumption must be made to continue navigation for single-satellite navigation, three assumptions must be made concerning altitude, trajectory, and clock offset.

### 1.2 Literature Survey:

SBAS. Today's GPS receivers support satellite based augmentation systems (SBAS) such as the Wide Area Augmentation System (WAAS) in North America and the European Geostationary Navigation Overlay Service (EGNOS) in Europe.

### 1.2.1 Principle of dead reckoning.

The calculated position is determined from the continuously updated distance and direction traveled

the dead reckoning error increases with time unless an accurate position fix is obtained [1]

### 1.2.2. Distance Sensing:

- Odometer pulses (absolute distance traveled),
- Digital speed information (distance is reconstructed from a single integration),
- Linear accelerometers (distance reconstructed from double-integrating acceleration), and
- Radar, optical, and acoustic sensors [2].

### 1.2.3. Direction Sensing:

- Turn rate sensor (gyroscopes),
- Linear accelerometers,
- Steering linkage angular sensor,
- Differential speed information,
- Magnetic compass.

**1.2.4. Variable Reluctance:** The variable reluctance sensor placed above a rotating toothed steel disk generates a sinusoidal voltage signal from changing magnetic flux. [3]

**1.2.5. Hall Effect:** Hall effect sensors also are suitable for measuring absolute angular positions of mechanical parts and for sensing direction.

**1.2.6. Optical Sensors:** The functionality of optical sensors is self-explanatory, but they are vulnerable to dirt and a malfunctioning light source.

**1.2.7. Pulse Frequency:** The frequency of the pulses generated by sensors is generally proportional to the speed. Knowledge of the precise wheel diameter and number of teeth on the rotating disk is needed to accurately calculate the number of pulses per mile or kilometer traveled. [4]

**1.2.8. Data Recorders:** In many countries, legislation requires tachographs or equivalent data recorders in commercially used vehicles to track vehicle usage and enforce driver work-time regulations.

The equivalent information needs to be extracted from the proprietary vehicle control system.

**1.2.9. Linear Accelerometers:** If no access to odometer pulses or equivalent information is available, linear accelerometers may help. Linear accelerometers recognize x-axis (front-back) acceleration.

Double integration of sensed acceleration giving distance leads to immediate accumulation of speed and distance error.

**1.2.10. Other Distance-Sensing Options:** Other forms of distance sensors are Doppler radar, and optical grid sensors recognizing moving surface patterns; microphones sensing engine and vehicle noises to derive speed; and last but not least, wind sensors..

The easiest approach is to use a small turn-rate sensor, also called a gyroscope. The first two types provide excellent accuracy but are large and costs are often unacceptably high. Vibrating gyroscopes excel in their small size, good performance, and user-friendliness.

**1.2.11. MEMS Gyroscopes:** Common MEMS gyroscopes contain a vibrating tuning fork or comparable structures contained on a silicon substrate.

**1.2.12. Linear Accelerometers:** Alternatively, less costly linear accelerometers positioned along the y-axis (left-right) may work, but the sensing behavior is highly dependent on the location in the vehicle and the actual speed.

**1.2.13. Control Sensors:** If access to the electronic car control system is available, process data such as the angular position of the steering wheel or steering linkage (measured with a Hall effect position sensor) can be utilized.

**1.2.14 Compass.** It detects the orientation of the local geomagnetic field, identifies the direction to the magnetic poles, and finally computes the driving direction.

**1.2.15 Map Matching:** For in-vehicle navigation systems, the map database is an excellent supplementary information source to help eliminate the accumulating position and heading error resulting from dead reckoning.

**1.2.16 GPS With Dead Reckoning:** Odometer pulses or equivalent distance information and use of a gyroscope are an optimum combination for accurate sensor-based dead reckoning.

The benefits of GPS and sensor information are complementary and can, if properly applied, eliminate the mutual disadvantages.

## 2. Objectives and Requirements:

Designing of a complete sensor-based GPS navigation system contains other devices in addition to the standard GPS functionality: Gyroscope and temperature sensor with analog to-digital converter, a signal conditioning and filtering circuit for the incoming electrical odometer pulses, and dead-reckoning software running in the GPS engine. Although all dead-reckoning algorithms work similarly when no GPS signals are available, they differ significantly in the way they operate in conditions where a limited number of GPS satellites are visible or the accuracy of the GPS signal is

compromised by changing visible satellite constellation or signal multi path effects.

Two solutions to the vehicle location problem are commonly discussed for Intelligent Transportation Systems (ITS): active roadside beacons and GPS satellites. This paper presents requirements for new linear referencing sensors, defined as sensors that will identify a vehicle's location along a roadway in terms of distance along the roadway from known points or by the automatic identification of known points. Requirements for linear referencing sensors come from new national location referencing standards being developed by initiatives of the U.S. DOT and from international location referencing standardization activities. Linear referencing sensors can extract information from the visual scene presented by the roadside environment, or from the environment illuminated by laser or microwave radiation.

They can also be based on new, low cost techniques for labeling roads or by modulating lane reflectors or other regular road infrastructure components. Such sensors, singly and in combination, avoid the map matching problem common to vehicle navigation systems that rely on GPS, and can be deployed at much lower cost than roadside beacons, particularly when designed as one function of multipurpose in-vehicle sensors and computers.

The disadvantages of these curve sensors is that they do not have any preview characteristics. This leads in many driving situations to misinterpretations by the ACC system. The consequence is that the ACC car brakes due to vehicles in adjacent lanes or it ignores relevant obstacles. In the following a second generation ACC system will be presented whose curve sensor is realized by a real time image processing system with the support of a GPS based navigation system. This multi-sensor fusion system is now suitable for collision avoidance and stop and go applications.

### 3. GPS and the necessity for Dead Rockening:

The adopted approach consists of two parts: the estimation of car position using the least-squares method and Differential GPS data, and the estimation of drag parameters by processing car 3D LS position estimates using the extended Kalman filter... The approach applied is suitable in obtaining the mechanical drag parameter with some average value... The noise situation is caused by the change in satellite constellation.

The position-velocity-time solution is obtained by blending the GPS-derived position with sensor data.

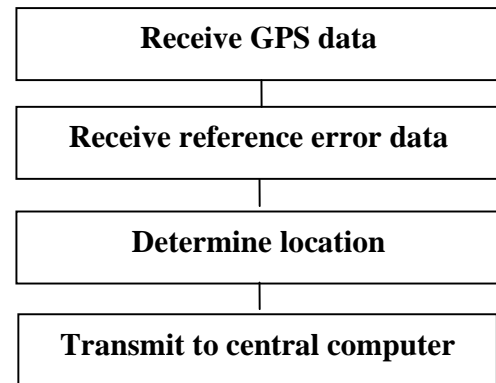


Fig: 1 Dead rockening applied after receiving error data.

### 4. Conclusion and future works:

This paper proposes some ideas about vehicle navigation system and the dead rockening methods and its applications. Extended Kalman filter forms an excellent role in performing the navigation accuracy.

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