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Maneuvering An Wheeled Robot Using Inertial Sensors In Smartphone For Achieving Intelligence And Automation

M. Vishnu Vigneshwar, S. Sakthitharan, Dr, A. Bhuvaneswari

P.G. Scholar, Dept of CSE, Assistant professor, Dept of CSE, Professor, Dept of CSE,
Adhiparasakthi engineering college, Melmaruvathur, kanchiputam, Tamil Nadu,
m.vishnulee@adhiparasakthi.in, tharansakthi@adhiparasakthi.in, bhuvan@adhiparasakthi.in

ABSTRACT: The researchers in the field of robotics were maneuvering with several techniques for moving the wheeled robots by using the GPS system, wireless sensor network systems and also with wireless personal area networks. while considering such an land rover robot they might be limited to the battery, also the GPS systems may use large amount of battery power. In order to overcome such a limitation we are making use of the alternative idea for the maneuvering an rover. In our system we are maneuvering an rover to be navigated with limited use of GPS device. By making use of the inertial sensors present in mobile along with the collected sensor data the trajectory of navigation is calculated and the rover is navigated. Though this, SINSAR provides the energy efficient navigation system by using the gyro sensor and compass sensors available in the smartphone. The trajectory details of the current location will be dynamically loaded to the land rover from the smartphone and this makes that autonomous robot to reach the destination without any remote controlled device.

I. Introduction

The land rover robot can navigate in a terrain with a given set of waypoints spaced with specific distance apart. There are several methods available for identifying the waypoints they are by using the GPS system, wireless sensor network systems and also with wireless personal area networks. The GPS system produce an microwaves to communicate with the satellite. The connection with minimum of 4 satellites help to locate the position. The accuracy level of the GPS system depends on the number of satellites connected. In the wireless sensor network, first the number of sensor signals available is deducted and based on their signal strength and the number of signals available the accuracy of the position depended. while considering the wheel rotation in calculating the number of rotation made, the wheel rotation may also done irrespective of the wheel movement in an mounted of irregular surface and also in surface having mud like substance. In SINSAR, the maneuvering an rover to be navigated with limited use of GPS device By making use of the inertial sensors present in mobile along with the collected sensor data the trajectory of navigation is calculated and the rover is navigated. The trajectory details of the current location will be dynamically loaded to the land rover from the smartphone and this makes that autonomous rover in maneuvering to reach the destination without any remote controlled device.

II. Problem Statement

A) Navigating with GPS

The GPS is an abbreviation of Global Positioning System. This is an positioning system, using this for navigation is efficient but with some limitations. The navigation system plays major role in day to day life. The battery usage graph is shown in figure 1. The GPS system is the efficient system in calculating the current location. This system also used in cars, bikes and etc., even in smart phones. While considering an robot it is also important to consider the amount of battery usage. The GPS system consumes more amount of the battery charge. There must be direct line of sight from at least four GPS satellites, which is not always possible always. Hence GPS fails especially in the buildings and the areas where the radio signals are interrupted. This makes land rover robot's battery to be getting drained down quickly.

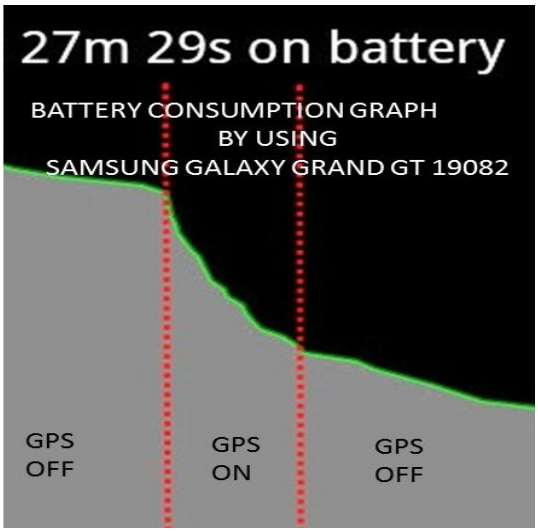

Figure 1 *Battery usage by GPS*

The sensor and control system for the land rover robot can make it to traverses through terrain. The control system described allowed the rover to successfully navigate in a terrain given a set of waypoints spaced with specific distance apart. There must be direct line of sight from at least four GPS satellites, which is not always possible always. Hence GPS fails especially in the buildings and the areas where the radio signals are interrupted as shone in figure 2.

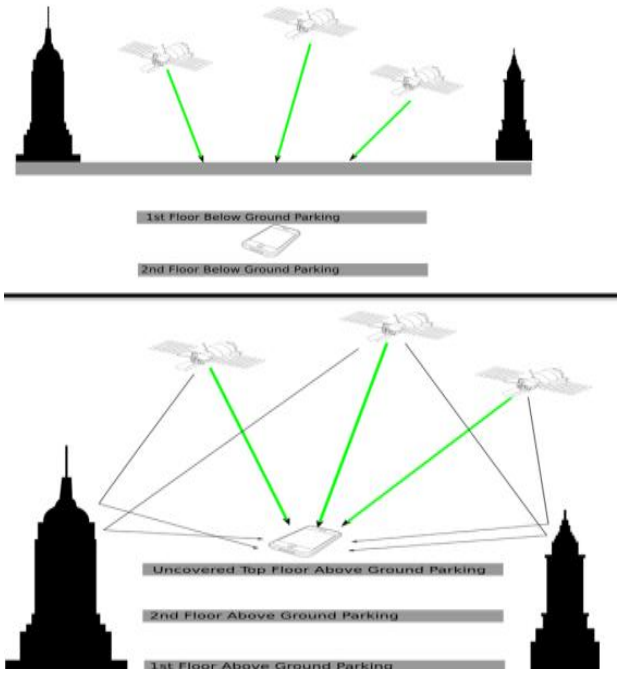

Figure 2 *GPS signal avilability*

B) Calculating Number of times the wheel rotated

When considering the wheel rotation the wheel rotation may also done irrespective of the wheel movement in an mounted of irregular surface and also in surface having mud like substance. when using the method of RPM of the wheel the wheel rotation may also done irrespective of the wheel movement in an mounted of irregular surface and also in surface having mud like substance. The Problem is that the wheel with mud increases the radius of the wheel, leads to big error which is clearly shown in figure3.

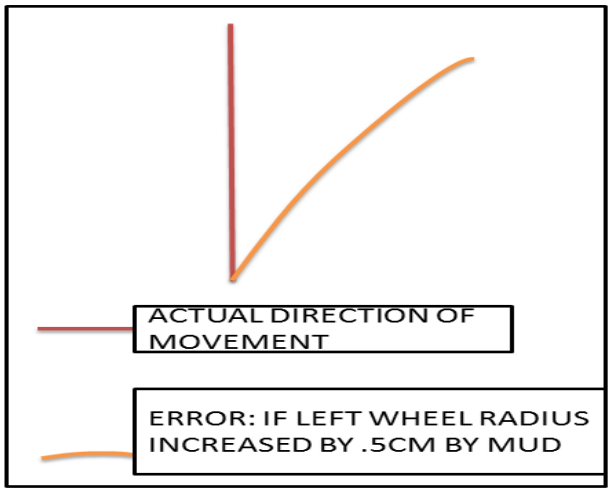

Figure 3 *Issues in using RPM for calculating distance of movement*

C) Remotely controlling by user with sensor reading and camera.

The control system uses input from a variety of sensors including heading, roll, pitch, an array of proximity sensors, camera, and laser source distance finder. The control system is adequate, when combined with the rover's mobility system to make its way and to know when it is getting diverted so far. This deals with the fuzzy control of autonomous mobile robot motion in unknown environment with obstacles and gives the wireless sensor-based remote control of autonomous mobile robot motion in greenhouse environments using the Sun SPOT technology. In this proposed system the rover is just instructed the destination location the rover will reach the destination with without any remotely controlled. In SINSAR, maneuveringan rover to be navigated with limited use of GPS device By making use of the inertial sensors present in mobile along with the collected sensor data the trajectory of navigation is calculated and the rover is navigated. The trajectory details of the current location will be dynamically loaded to the land rover robot from the smart phone and this makes that autonomous rover in maneuvering to reach the destination without any remote controlled device.

III.SINSAR Architecture

The rover design consists of the servo motor of torque capability up to 8 kg, two stepper motors for maneuvering is an specific direction. This rover is designed to carry an smart phone, this rover is controlled autonomously only through the signals from the smartphone. The smartphone will generate the serial data to control the rover, this signal will be carried out to the rover via the usb port of the smart phone.

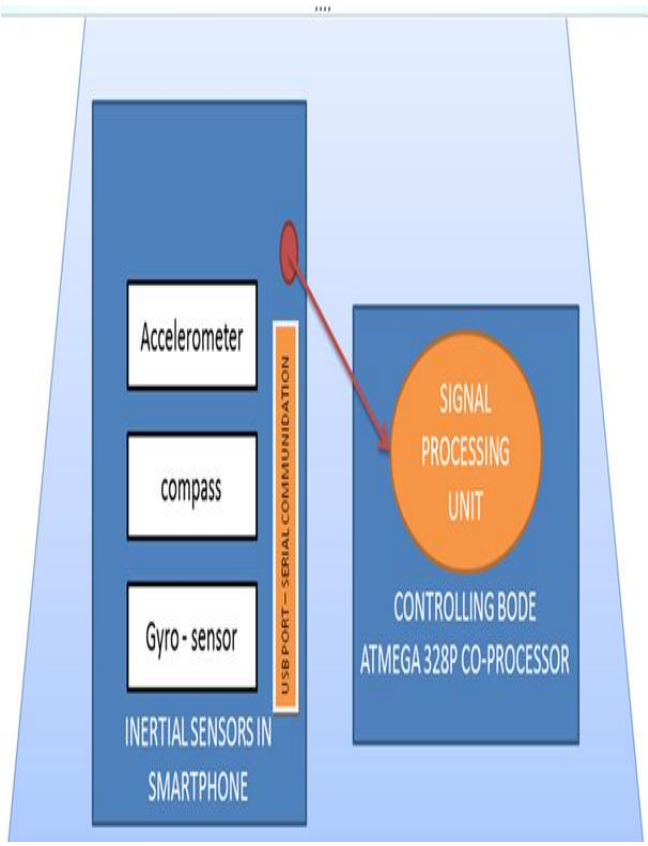

Figure 4 *Architecture of SINSAR*

The Figure4 shows the architecture. The inertial sensors-accelerometer, compass and gyroscope form the smart phone is going to be used for determining the locomotion. The pre-loaded trajectory map of the location and the current locomotion based trajectory map generated by the smart phone by using the inertial sensors will be compared and this determine their position without involvement of the GPS satellite and any other external networks. The filtered Accelerometer value is noted continuously during each change. The compass reading is listened to maintain the direction. The acceleration produces values in meter per Second Square. When integrating with respect to the time by using numerical integration method and comparing with the gyro sensor values to avoid un wanted noise and Then the speed and direction at different unit of time is calculated. The calculated.value in converted into a trajectory and by comparing with the pre-loaded trajectory which is an intelligent data about map of the navigation plane the current position and navigation route for the rover is decided. The advantages are less GPS dependent, battery consumption is less when considering the GPS and wireless sensor networks, maneuvering the rover become much easier, Positioning itself is made easy by using the inertial sensors and pre-loaded map. The figure 5 shows the physical design.

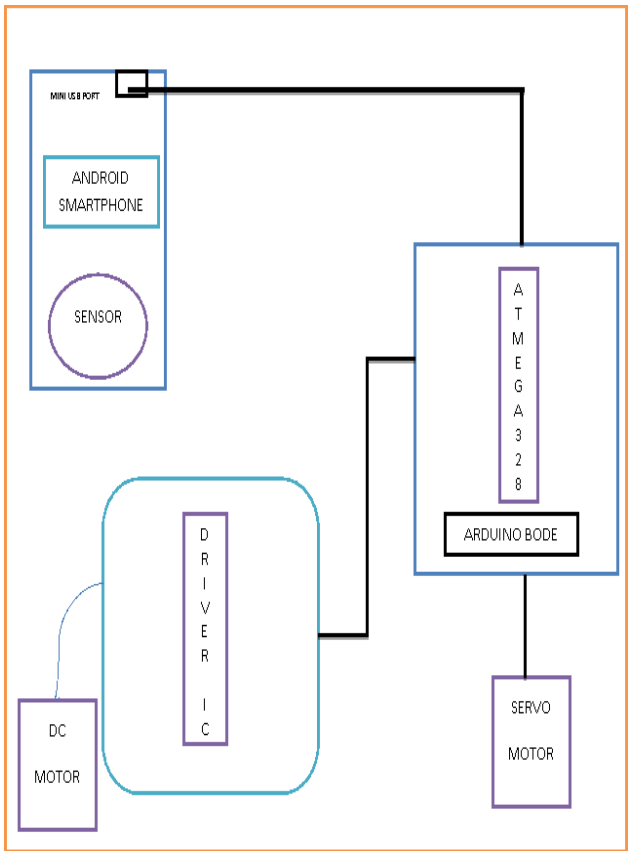

Figure 5 *Physical design of SINSAR*

The SINSAR is designed by integrating the android smart phone with in the body of Rover safely in such a way it cannot be removed from its body. The sensor reading is being used by the Intelligence program in Android smart phone

IV.SINSAR: Algorithm

The initial location of the rover can either be instructed by human or it can collect form positioning devise available. After getting the location details, the rover will start moving to the destination after the current location map is loaded at the dynamic time when needed. The current location map is the knowledge for the rover that it can understand the new path for the destination. now it is capable of taking own decision in selecting the path to reach the destiny. The rover first notes down the angle of movement and the distance to which the rover have to be move. Now the rover will start moving in the direction specified. In parallel the acceleration along the axis of movement will be noted at each moment. The accelerometer value is used in finding the distance of the movement. As the accelerometer sensor is providing value in the unit of meters per second square. Now the different method is applied and tested manually. This testing involves how many instances are needed to provide accuracy in results along with that which method need less number of instances per unit to provide the accurate results in defining the movement and its angle at each unit of time. This collected data will be calculated at each moment and get compared with the loaded map. This comparison results in determining the position of the rover, Decision making in finding the dynamic routs to the destination. The positioning is calculated by calculating the reference angle between some subtle points and the distance between them. This makes the positioning done at the rover without the help of the external positioning device. The dynamic decision making can be done by finding the shortest route or best route form the current position to the destination.

V. Experimental Results

This system is proposed in increasing the efficiency of the navigation in the terms if reducing the dependency with the external devices, increasing the level of accuracy for maneuvering the rover and reduced consumption of the battery power. As on the expectation about the battery consumption consider the figure 1 and figure 6. This shows that with the limited use of GPS and making use of the inertial sensors makes the land rover robot to be increased in the battery life time and is graphical representation is shown in figure 6.

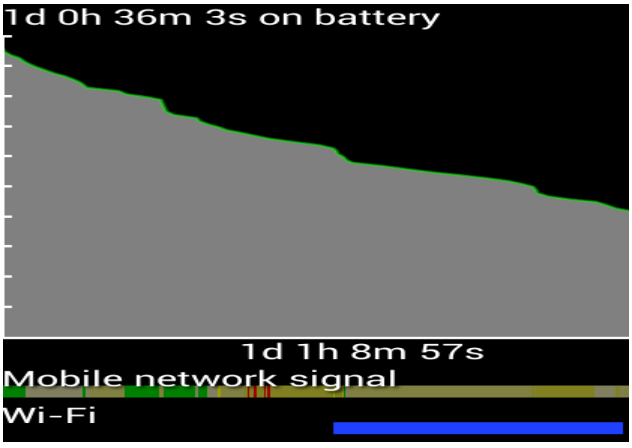

Figure 6 *Battery Consumption while using inertial sensors with limited use of GPS*

The land rover is tested manually by instructing it to reach the destination form source with a set of waypoints for 15 times in the same route. The land rover robot reaches the destination without remotely controlled. Then for proving the accuracy 3 land rover robot have been placed and instructed to reach the destination form source with the set of way points and instructed not to use path covered by other another rover. The intelligent data is loaded dynamically to the smart phone from the private cloud server. The each rover covers the path which is not covered by one another.

VI. Discussion

The land rover robot design consists of the servo motor of torque capability up to 8 kg, two stepper motors for maneuvering in specific direction. This rover is designed to carry an smart phone, this rover is controlled autonomously only through the signals from the smart phone. The smart phone will generate the series of instructions to control the rover by sending the instruction as the serial data, this serial data will be carried out to the rover via the mini USB port of the smart phone. The inertial sensors-accelerometer, compass and gyroscope form the smart phone is going to be used for determining the locomotion. The pre-loaded trajectory map of the location and the current locomotion based trajectory map generated by the smart phone by using the inertial sensors will be compared and this determine their position without involvement of the GPS satellite and any other external networks. advantage of Proposed system are Less GPS dependent, Battery consumption is less when considering the GPS and wireless sensor networks, maneuvering the rover become much easier, Positioning itself is made easy by using the inertial sensors and pre-loaded map.

VII. Conclusion

Through this SINSAR, a rover is able to maneuver with the limited use of the GPS devices by making use of the inertial sensors present in mobile. With the data collected from sensor a trajectory of navigation will be drawn and the rover is navigated by comparing with the previously loaded intelligent data. The trajectory details of the current location will be dynamically loaded to the land rover from the smartphone and this makes that autonomous rover in maneuvering to reach the destination without any remotely controlled. This even makes the rover to position itself by comparing the sensor collected data and the previously known trajectory of the current location.

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