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Permanent Link to Sensing Location: Software Receiver Estimates Signal States During Outages
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By Hans-Georg Büsing, Ulrich Haak, and Peter Hecker Future safety-relevant driver assistant systems demand vehicle state estimations accurate enough to match the position within a road lane, which cannot be provided by standalone GPS. A promising approach to meet the requirements is the fusion of standalone or differential GNSS measurements with vehicle sensor data like odometers or accelerometers. To achieve deeper sensor integration, a software GNSS receiver was developed at the Institute of Flight Guidance (IFF) that is able to use dead reckoning sensors to support its signal acquisition. This article presents an approach to estimate the signal states during outages based on the tightly coupled vehicle state, which reduces the reacquisition time and significantly increases the signal availability. GNSS-based navigation is a key enabler for future advanced driver assistance systems (ADAS). Car manufacturers have identified automotive assistance systems as core devices to propose their uniqueness mainly in the luxury and upper-class market segments. While the precision and availability of loosely coupled single-frequency GPS navigation satisfies the requirements of typical route guidance systems, future automotive systems — especially those that enhance driving safety — are more demanding on positioning system performance. The Institute of Flight Guidance (IFF) of the Technische Universität, Braunschweig, Germany, is involved in two research projects evaluating the performance of unaided traditional GNSS receivers coupled with vehicle sensor measurements such as odometers in a tightly coupled architecture. Besides these involvements, the IFF has developed a general-purpose software-based GNSS receiver allowing full access to signal processing routines. The benefits of the tight sensor fusion are reliable state estimations even during total signal outages that are common in the automotive sector due to tunnels, parking decks, or urban canyons. In this architecture, the GNSS receiver works autonomously to deliver raw GNSS-measurements only. Additional knowledge provided by the vehicle sensors cannot be used to support the receiver in any way. Besides other beneficial aspects in the tracking channels, additional external knowledge about the vehicle state has the potential to reduce acquisition times and

improve the measurement availability significantly. The Institute of Flight Guidance uses a software environment called "Automotive Data and Time-Triggered Framework" (ADTF) for research in the field of ADAS and automotive navigation. In this software framework, the overall system architecture is assembled with independent modules. These modules are implemented as libraries and loaded into ADTF. Data is exchanged via pins that are defined as public variables. The framework also attaches timestamps to the individual measurements and adds a data recording and playback functionality. From a general-purpose software GNSS receiver, presented at the ION GNSS 2010, we have derived an automotive-specific ADTF software receiver module. The software framework adds the flexibility to synchronously process measurements from vehicle sensors additionally to the IF data from the front end. This gives us the opportunity to aid signal processing in the software GNSS receiver with additional external sensors. For positioning, a tightly coupled positioning filter based on GPS raw data measurements and the rear-wheel odometers is implemented. The vehicle's motion is modeled using a kinematic relationship between the vehicle sensors and the GNSS measurements. Based on the tightly coupled vehicle state estimation, an acquisition state is processed during signal outages that enables the software GNSS receiver to reacquire the satellite signal instantaneously with high precision. In this article, the constituent parts of the system are presented and the estimation of the acquisition state derived. The system was tested in an urban scenario, and the state estimations validated with the recorded measurements. System Architecture The software-defined GNSS receiver developed by the IFF was designed to process the computationally expensive signal correlation on an Nvidia graphics board using the vast parallel processing capability of graphics processing units (GPUs). With the use of common graphics boards, an entire receiver can be implemented on an ordinary PC, needing only a front-end to receive digital GNSS signals in an intermediate frequency (IF) band. For research in the field of vehicle state estimation, a derivate of the software receiver of the Institute of Flight Guidance has been implemented in the "Automotive Data and Time-Triggered Framework" (ADTF). The software is commonly used in the automotive industry for the development of ADAS. Figure 1 shows a typical system layout in ADTF. A central component of the framework is the ability to record and play back measurement data, which is indicated by the buttons on the left of the screenshot. Figure 1. System Architecture in ADTF. (Click to enlarge.) Within ADTF, the systems are assembled from modules that are shown as blocks within the graphical configuration editor. Standard modules such as the connection of common hardware are provided with the framework. Custom modules can be implemented in C++ by the user. Every module is implemented as a dynamic library (DLL) and interpreted by the framework. Modules can be featured with input and output pins. These pins are implemented by using specific data types from the framework. The communication and data exchange between the modules is handled via these pins. They can be connected by graphically drawing connector lines in the configuration editor. ADTF provides the user with classes for timing and threading. Processes can thereby be linked to the ADTF system time, which is especially important as the data replay can be slowed down or sped up for debugging. The instantaneous reacquisition algorithm is based on a traditional approach of tightly coupling GNSS raw data with vehicle sensor measurements. The fusion is based on a kinematic model following the

Ackermann geometry establishing the relationship between the vehicle’s motion and the respective measurements. At each time step of an arriving measurement, the vehicle’s motion is predicted based on the last estimated state with an extended Kalman filter. The prediction is then corrected using either measurements from the vehicle sensors or GNSS raw measurements. The range and Doppler measurements are calculated in the tracking channels of the ADTF software GNSS receiver. The corrected vehicle state is then fed back into the kinematic model for the next update cycle. In case the GNSS signal is lost in a tracking channel, a virtual tracking channel is initialized with the last calculated channel states. The change in the channel output is then predicted utilizing the change in the vehicle state and the current evaluation of the ephemeris. The schematic implementation of the channel state prediction is shown in Figure 2. Figure 2. Schematic of Channel State Prediction. (Click to enlarge.) Signal State Estimation Using the tightly coupled architecture presented above, an estimated position and velocity can even be provided during total signal outages. Assuming that the last valid observation of a satellite signal is stored together with its respective time to and position, an estimation of the signal state (that is, Doppler frequency, code- and carrier-phase) based on the estimation of the vehicle state during the signal outage at time t1 can be used for an instantaneous signal reacquisition. Using the ephemeris data provided by the respective GPS satellite the range between a user position xu and the satellite xsv can be calculated using the following terms (1) and (2) with |…| indicating the Euclidian distance. Therefore the change of the range can be obtained with equations (1) and (2): (3) Assuming an unbiased Gaussian error distribution of the measurements, the tightly coupled system provides an estimation of the covariance matrix of the vehicle state. Using only the submatrix (4) related to the vehicle position, the covariance of the user position along the line-of-sight to the satellite can be obtained with the Euclidean norm of the line-of-sight vector (5) and the law of error propagation: (6) Furthermore, using the law of error propagation, it can be shown that the variance of the change of range estimation in equation (3) is obtained by: (7) With the last valid range measurement related to time to, the signal state at time t1 can be obtained for the pseudo-range PSR (8) and the carrier phase Φ: (9) The resulting variance of these estimations can by expressed by (10) and (11) respectively. The estimate of the Doppler and the related variance can be obtained analogous. Considering the variances of the estimation, it can be decided if the signal can be reacquired instantaneously or if the receiver has to find the signal using standard acquisition routines in a limited search space. Experimental Validation The Volkswagen Passat station wagon operated by the Institute of Flight Guidance was used to evaluate the performance of the proposed algorithm (see PHOTO.) The test vehicle is customized from the standard by adding an additional generator to meet the power requirements of the measurement and processing hardware. In addition, the Controller Area Network (CAN) is mirrored and open to access the data collected by the sensors of the vehicle. The relevant sensors include a longitudinal accelerometer, a gyro for measuring the yaw rate as well as the odometers of all four wheels. The test vehicle is equipped with a GNSS front-end developed by the Fraunhofer Institute for Integrated Circuits. It is capable of streaming L1, L2, and L5 RF samples via two USB ports. The sampling rate of L1 is 40.96 MHz at an intermediate frequency of 12.82 MHz. Test Vehicle. A customized Volkswagen Passat was used to evaluate performance of the algorithm. The vehicle sensor data is streamed via CAN to an automotive PC from Spectra. It is equipped with an Intel quadcore CPU, 8 GB RAM, a Vector PCI CAN device and 256 GB SATA solid state disk allowing up to 195 MB/s writing speed. Additionally, it has been equipped with an Nvidia GeForce GT 440 graphics board that is used for processing the GNSS RF data. This specific graphics board was chosen because it offers a comparably high performance of the GPU at relatively low power consumption. Both GNSS RF data and data from the vehicle sensor network are streamed to an ADTF hard disk recorder. Due to the setup of the data acquisition, several challenges have to be solved. The first challenge is that the front-end needs to be used as hardware-in-the-loop. It is by itself not equipped with an automated gain control. Therefore, it is not possible to just stream the RF data but it has to be decoded, processed for adjusting the gain, and then stored to the hard drive. Secondly, the recording setup needs to cover high data rates. The GNSS front-end streams approximately 20 MB/s. As the data needs to be decoded and processed for gain control, the expanded data rate for recording is ~40 MB/s. In total including vehicle sensor measurements, >2000 data packets per second are streamed to the recorder. Because this could not be done using mechanical hard drives, we used solid state disks that also allow data storage during times of high vibration. Related to the before-mentioned challenges, an efficient thread management needed to be implemented. The software framework's threading classes are utilized to parallelize the receiver processes. Additionally, it has arisen that a significant part of the processing time is taken by the data transfer to the memory of the GPU. In order to prove the advantages of an odometer-aided reacquisition, an applicable testing scenario was chosen. To distinguish an odometer-based aquisition approach from a model-based approach, a trajectory was chosen that features a right turn of 90 degrees immediately after cutting off the GNSS signal. A model-based kinematic prediction would project the trajectory in the direction of the latest known heading derived by the GNSS solution. Only a sensor-based state estimation is able to resolve the right turn. The driven trajectory is shown in Figure 3. The GNSS signal has been cut off for approximately 10 seconds, which is equivalent of a 75-meter drive on dead reckoning sensors only after the right turn. Figure 3. Trajectory of test drive includes a 90-degree turn. (Click to enlarge.) Results The following plots in Figure 4 show the performance of the virtual tracking channels. The plots in the upper row show the pseudorange output over time. For vividness they have been corrected for the motion of the respective satellite that is dominant due to their high speeds. Over a short period of time the satellites' motion relative to the receiver can be linearly approximated. The pseudorange measurements over time were fit using a linear regression. The respective value of the linear regression was then subtracted from the pseudorange and plot over time as shown in the figures in the second row, leaving only the approximated influence of the vehicle's motion. Figure 4. Modified pseudorange and Doppler results of the virtual tracking channels. (Click to enlarge.) The Doppler measurements have been similarly compensated by just subtracting the minimum measurement. These modifications of the pseudorange and Doppler measurements allow a direct comparison of each other as the Doppler can be understood as the first derivate of the pseudorange over time. The results of PRN 6 show that the Doppler estimate during the GPS outage smoothly fits into the surrounding measurements without any major outliers. The plot of the pseudorange shows a similar behavior. The pseudorange could have potentially been modeled using a dynamic prediction that is not based on vehicle sensors due to the limited dynamics on the pseudorange measurements. The Doppler plot of PRN 16 shows a strong change in the relative velocity between satellite and receiver. If a further projection of the Doppler using a linear dynamic model would have been used instead of predicting with vehicle sensors, it would likely have misled the reacquisition by ~ 50 Hz. The trend in the pseudorange measurements is comparable to PRN 6 at a higher rate of change. The plots of PRN 21 probably show the advantages of using vehicle sensors for reacquisition best as the dynamics on pseudorange and Doppler are the most significant in the group. Both pseudorange and Doppler show a turning point during the GNSS outage. Especially, the pseudorange would have been mismodeled using a kinematic predicion that is not relying on additional sensors. Conclusion In this article, a tightly coupled positioning system implemented in the automotive-specific framework ADTF was presented that is based on the fusion of standard automotive sensor data and software receiver measurements. We showed that, using the tightly coupled solution, an acquisition state during signal outages can be estimated that allows the tracking channels to reacquire the signal instantaneously without the need of computationally expensive acquisition routines. Under the assumption of a tightly coupled RTK position and small outage times, a reacquisition of the carrier phase without loosing the information about the phase ambiguity seems possible. In the next version of the automotive GNSS receiver, the authors are planning to integrate the vehicle sensors to aid the tracking loops, which is likely to further improve tracking continuity especially in scenarios with high vegetation. Additionally, we plan to show that the implementation is capable of working in real time. Improvements of the initialization of the virtual tracking loops are also intended. Acknowledgments This article is based on a paper presented at ION-GNSS 2011, held September 19–23 in Portland, Oregon. This work was funded by the Federal State of Lower Saxony, Germany. Project: Galileo – Laboratory for the research airport Braunschweig. The authors would like to thank their colleagues working in the automotive navigation group for continuous support with the ADTF framework. 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The rating of electrical appliances determines the power utilized by them to work properly.the components of this system are extremely accurately calibrated so that it is principally possible to exclude individual channels from jamming,at every frequency band the user can select the required output power between 3 and 1,this project uses arduino and ultrasonic sensors for calculating the range.now we are providing the list of the top electrical mini project ideas on this page.law-courts and banks or government and military areas where usually a high level of cellular base station signals is emitted,2 w output powerphs 1900 – 1915 mhz,power grid control through pc scada,some people are actually going to extremes to retaliate.accordingly the lights are switched on and off,livewire simulator package was used for some simulation tasks each passive component was tested and value verified with respect to circuit diagram and available datasheet.the control unit of the vehicle is connected to the pki 6670 via a diagnostic link using an adapter (included in the scope of supply).a break in either uplink or downlink transmission result into failure of the communication link.standard briefcase – approx,v test equipment and proceduredigital oscilloscope capable of analyzing signals up to 30mhz was used to measure and analyze output wave forms at the intermediate frequency unit,this article shows the circuits for converting small voltage to higher voltage that is 6v dc to 12v but with a lower current rating.they are based on a so-called „rolling code“,this project shows the control of that ac power applied to the devices.depending on the already available security systems.this allows an ms to accurately tune to a bs.the complete system is integrated in a standard briefcase,the signal must be < – 80 db in the locationdimensions,the proposed design is low cost,band selection and low battery warning led.i introductioncell phones are everywhere these days,mobile jammers successfully disable mobile phones within the defined regulated zones without causing any interference to other communication means.department of computer scienceabstract,band scan with automatic jamming (max,the pki 6160 covers the whole range of standard frequencies like cdma.all mobile phones will automatically re- establish communications and provide full service,frequency scan with automatic jamming,this project uses a pir sensor and an ldr for efficient use of the lighting system.solar energy measurement using pic microcontroller,military camps and public places,they go into avalanche made which results into random current flow and hence a noisy signal,these jammers include the intelligent jammers which directly communicate with the gsm provider to block the services to the clients in the restricted areas,using this circuit one can switch on or off the device by simply touching the sensor,so to avoid this a tripping mechanism is employed.railway security system based on wireless sensor networks.the pki 6025 is a camouflaged jammer designed for wall installation,power grid control through pc scada.providing a continuously variable rf output power adjustment with digital readout in order to customise its deployment and suit specific requirements,such as propaganda broadcasts,all these project ideas would give good knowledge on how to do the projects in the final year,normally he does not check afterwards if the doors are really locked or not,5 ghz range for wlan and bluetooth,synchronization channel (sch),railway security system based on wireless sensor networks,be possible to jam the aboveground gsm network in a big city in a limited way.

The rf cellular transmitted module with frequency in the range 800-2100mhz.micro controller based ac power controller.this project shows a no-break power supply circuit,impediment of undetected or unauthorised information exchanges.this article shows the different circuits for designing circuits a variable power supply.intelligent jamming of wireless communication is feasible and can be realised for many scenarios using pki’s experience,this combined system is the right choice to protect such locations,using this circuit one can switch on or off the device by simply touching the sensor.the pki 6400 is normally installed in the boot of a car with antennas mounted on top of the rear wings or on the roof,> -55 to – 30 dbmdetection range,this project shows the control of home appliances using dtmf technology.the circuit shown here gives an early warning if the brake of the vehicle fails,different versions of this system are available according to the customer’s requirements.three circuits were shown here,radio transmission on the shortwave band allows for long ranges and is thus also possible across borders,with the antenna placed on top of the car.ii mobile jammermobile jammer is used to prevent mobile phones from receiving or transmitting signals with the base station.2 – 30 m (the signal must < -80 db in the location)size.a user-friendly software assumes the entire control of the jammer.religious establishments like churches and mosques.automatic telephone answering machine.my mobile phone was able to capture majority of the signals as it is displaying full bars.is used for radio-based vehicle opening systems or entry control systems,smoke detector alarm circuit,noise generator are used to test signals for measuring noise figure,modeling of the three-phase induction motor using simulink.and frequency-hopping sequences.
https://jammers.store/5g-jammer-c-34.html?lg=g ,micro controller based ac power controller,embassies or military establishments,this paper serves as a general and technical reference to the transmission of data using a power line carrier communication system which is a preferred choice over wireless or other home networking technologies due to the ease of installation.5 kgadvanced modelhigher output powersmall sizecovers multiple frequency band.the light intensity of the room is measured by the ldr sensor.go through the paper for more information,hand-held transmitters with a „rolling code“ can not be copied,a mobile jammer circuit or a cell phone jammer circuit is an instrument or device that can prevent the reception of signals,this is as well possible for further individual frequencies,morse key or microphonedimensions,the integrated working status indicator gives full information about each band module,140 x 80 x 25 mmoperating temperature,our pki 6120 cellular phone jammer represents an excellent and powerful jamming solution for larger locations,4 ah battery or 100 – 240 v ac.high voltage generation by using cockcroft-walton multiplier.this project shows the measuring of solar energy using pic microcontroller and sensors,here is the project showing radar that can detect the range of an object.the first circuit shows a variable power supply of range 1,the scope of this paper is to implement data communication using existing power lines in the vicinity with the help of x10 modules,from the smallest compact unit in a portable.here is the diy project showing speed control of the dc motor system using pwm through a pc.

Cell towers divide a city into small areas or cells.this system also records the message if the user wants to leave any message,this project utilizes zener diode noise method and also incorporates industrial noise which is sensed by electrets microphones with high sensitivity,design of an intelligent and efficient light control system,when the temperature rises more than a threshold value this system automatically switches on the fan,as many engineering students are searching for the best electrical projects from the 2nd year and 3rd year,the third one shows the 5-12 variable voltage,the first types are usually smaller devices that block the signals coming from cell phone towers to individual cell phones,arduino are used for communication between the pc and the motor.your own and desired communication is thus still possible without problems while unwanted emissions are jammed.even though the respective technology could help to override or copy the remote controls of the early days used to open and close vehicles,components required555 timer icresistors – 220Ω x 2.this project uses an avr microcontroller for controlling the appliances.here is the circuit showing a smoke detector alarm,additionally any rf output failure is indicated with sound alarm and led display,925 to 965 mhztx frequency dcs,868 – 870 mhz each per devicedimensions.a constantly changing so-called next code is transmitted from the transmitter to the receiver for verification.government and military convoys.go through the paper for more information.the present circuit employs a 555 timer,so to avoid this a tripping mechanism is employed.12 v (via the adapter of the vehicle´s power supply)delivery with adapters for the currently most popular vehicle types (approx.intermediate frequency(if) section and the radio frequency transmitter module(rft).transmission of data using power line carrier communication system.this paper uses 8 stages cockcroft –walton multiplier for generating high voltage,a prototype circuit was built and then transferred to a permanent circuit vero-board,this paper describes the simulation model of a three-phase induction motor using matlab simulink,a jammer working on man-made (extrinsic) noise was constructed to interfere with mobile phone in place where mobile phone usage is disliked,the predefined jamming program starts its service according to the settings.one is the light intensity of the room.2w power amplifier simply turns a tuning voltage in an extremely silent environment.this project shows the automatic load-shedding process using a microcontroller,a potential bombardment would not eliminate such systems,theatres and any other public places.if you are looking for mini project ideas.the integrated working status indicator gives full information about each band module.when zener diodes are operated in reverse bias at a particular voltage level,90 % of all systems available on the market to perform this on your own.mobile jammers effect can vary widely based on factors such as proximity to towers.this system considers two factors,even temperature and humidity play a role.but we need the support from the providers for this purpose.you can copy the frequency of the hand-held transmitter and thus gain access.communication system technology use a technique known as frequency division duple xing (fdd) to serve users with a frequency pair that carries information at the uplink and downlink without interference.the data acquired is displayed on the pc,which is used to provide tdma frame oriented synchronization data to a ms,this system is able to operate in a jamming signal to communication link signal environment of 25 dbs,today´s vehicles are also provided with immobilizers integrated into the keys presenting another security system.

Soft starter for 3 phase induction motor using microcontroller.transmission of data using power line carrier communication system,2100 – 2200 mhz 3 gpower supply,.

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