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Permanent Link to Innovation: Getting Along
2021/07/28

Collaborative Navigation in Transitional Environments By Dorota A. Grejner-Brzezinska, J.N. (Nikki) Markiel, Charles K. Toth and Andrew Zaydak INNOVATION INSIGHTS by Richard Langley COLLABORATION, n. /kə,læbə'reɪʃən/, n. of action. United labour, co-operation; esp. in literary, artistic, or scientific work — according to the Oxford English Dictionary. Collaboration is something we all practice, knowingly or unknowingly, even in our everyday lives. It generally results in a more productive outcome than acting individually. In scientific and engineering circles, collaboration in research is extremely common with most published papers having multiple authors, for example. The term collaboration can be applied not only to the endeavors of human beings or other living creatures but also to inanimate objects, too. Researchers have developed systems of miniaturized robots and unmanned vehicles that operate collaboratively to complete a task. These platforms must navigate as part of their functions and this navigation can often be made more continuous and accurate if each individual platform navigates collaboratively in the group rather than autonomously. This is typically achieved by exchanging sensor measurements by some kind of short-range wireless technology such as Wi-Fi, ultra-wide band, or ZigBee, a suite of communication protocols for small, low-power digital radios based on an Institute of Electrical and Electronics Engineers' standard for personal area networks. A wide variety of navigation sensors can be implemented for collaborative navigation depending on whether the system is designed by outdoor use, for use inside buildings, or for operations in a wide variety of environments. In addition to GPS and other global navigation satellite systems, inertial measurement units, terrestrial radio-based navigation systems, laser and acoustic ranging, and image-based systems can be used. In this month's article, a team of researchers at The Ohio State University discusses a system under development for collaborative navigation in transitional environments — environments in which GPS alone is insufficient for continuous and accurate navigation. Their prototype system involves a land-based deployment vehicle and a human operator carrying a personal navigator sensor assembly, which initially navigate together before the personal navigator transitions to an indoor environment. This system will have multiple applications including helping first responders to emergencies. Read on. "Innovation" is a regular feature that discusses advances in GPS technology and its applications as well as the

fundamentals of GPS positioning. The column is coordinated by Richard Langley of the Department of Geodesy and Geomatics Engineering, University of New Brunswick. He welcomes comments and topic ideas. To contact him, see the "Contributing Editors" section on page 6. Collaborative navigation is an emerging field where a group of users navigates together by exchanging navigation and inter-user ranging information. This concept has been considered a viable alternative for GPS-challenged environments. However, most of the developed systems and approaches are based on fixed types and numbers of sensors per user or platform (restricted in sensor configuration) that eventually leads to a limitation in navigation capability, particularly in mixed or transition environments. As an example of an applicable scenario, consider an emergency crew navigating initially in a deployment vehicle, and, when subsequently dispatched, continuing in collaborative mode, referring to the navigation solution of the other users and vehicles. This approach is designed to assure continuous navigation solution of distributed agents in transition environments, such as moving between open areas, partially obstructed areas, and indoors when different types of users need to maintain high-accuracy navigation capability in relative and absolute terms. At The Ohio State University (OSU), we have developed systems that use multiple sensors and communications technologies to investigate, experimentally, the viability and performance attributes of such collaborative navigation. For our experiments, two platforms, a land-based deployment vehicle and a human operator carrying a personal navigator (PN) sensor assembly, initially navigate together before the PN transitions to the indoor environment. In the article, we describe the concept of collaborative navigation, briefly describe the systems we have developed and the algorithms used, and report on the results of some of our tests. The focus of the study being reported here is on the environment-to-environment transition and indoor navigation based on 3D sensor imagery, initially in post-processing mode with a plan to transition to real time. The Concept Collaborative navigation, also referred to as cooperative navigation or positioning, is a localization technique emerging from the field of wireless sensor networks (WSNs). Typically, the nodes in a WSN can communicate with each other using wireless communications technology based on standards, such as Zigbee/IEEE 802.15.4. The communication signals in a WSN are used to derive the inter-nodal distances across the network. Then, the collaborative navigation solution is formed by integrating the inter-nodal range measurements among nodes (users) in the network using a centralized or decentralized Kalman filter, or a least-squares-based approach. A paradigm shift from single to multi-sensor to multi-platform navigation is illustrated conceptually in Figure 1. While conventional sensor integration and integrated sensor systems are commonplace in navigation, sensor networks of integrated sensor systems are a relatively new development in navigation. Figure 2 illustrates the concept of collaborative navigation with emphasis on transitions between varying environments. In actual applications, example networks include those formed by soldiers, emergency crews, and formations of robots or unmanned vehicles, with the primary objective of achieving a sustained level of sufficient navigation accuracy in GPS-denied environments and assuring seamless transition among sensors, platforms, and environments. Figure 1. Paradigm shift in sensor integration concept for navigation. □Figure 2. Collaborative navigation and transition between varying environments. Field Experiments and Methodology A series of field experiments were

carried out in the fall of 2011 at The Ohio State University (OSU), and in the spring of 2012 at the Nottingham Geospatial Institute of the University of Nottingham, using the updated prototype of the personal navigator developed earlier at the OSU Satellite Positioning and Inertial Navigation Laboratory, and land-based multisensory vehicles. Note that the PN prototype is not a miniaturized system, but rather a sensor assembly put together using commercial off-the-shelf components for demonstration purposes only. The GPSVan (see Figure 3), the OSU mobile research navigation and mapping platform, and the recently upgraded OSU PN prototype (see Figure 4) jointly performed a variety of maneuvers, collecting data from multiple GPS receivers, inertial measurement units (IMUs), imaging sensors, and other devices. Parts of the collected data sets have been used for demonstrating the performance of navigation indoors and in the transition between environments, and it is this aspect of our experiments that will be discussed in the present article. Figure 3. Land vehicle, OSU GPSVan. Figure 4. Personal navigator sensor assembly. The GPSVan was equipped with navigation, tactical, and microelectromechanical systems (MEMS)-grade IMUs, installed in a two-level rigid metal cage, and the signals from two GPS antennas, mounted on the roof, were shared among multiple geodetic-grade dual-frequency GPS receivers. In addition, odometer data were logged, and optical imagery was acquired in some of the tests. The first PN prototype system, developed in 2006–2007, used GPS, IMU, a digital barometer, a magnetometer compass, a human locomotion model, and 3D active imaging sensor, Flash LIDAR (an imaging light detection and ranging system using rapid laser pulses for subject illumination). Recently, the design was upgraded to include 2D/3D imaging sensors to provide better position and attitude estimates indoors, and to facilitate transition between outdoor and indoor environments. Consequently, the current configuration allows for better distance estimation among platforms, both indoors and outdoors, as well as improving the navigation and tracking performance in general. The test area where data were acquired to support this study, shown in Figure 5, includes an open parking lot, moderately vegetated passages, a narrow alley between buildings, and a one-storey building for indoor navigation testing. The three typical scenarios used were: 1) Sensor/platform calibration: GPSVan and PN are connected and navigate together. 2) Both platforms moved closely together, that is, the GPSVan followed the PN's trajectory. 3) Both platforms moved independently. Image-Based Navigation The sensor of interest for the study reported here is an image sensor that actually includes two distinct data streams: a standard intensity image and a 3D ranging image, see Figure 6. The unit consists primarily of a 640×480 pixel array of infrared detectors. The operational range of the sensor is 0.8–10 meters, with a range resolution of 1 centimeter at a 2-meter distance. Figure 6. PN captured 3D image sequence from inside the building. In this study, the image-based navigation (no IMU) was considered. To overcome this limitation, the intensity images acquired simultaneously with the range data by the unit were leveraged to provide crucial information. The two intensity images were processed utilizing the Scale Invariant Feature Transform (SIFT) algorithm to identify matching features between the pair of 2D intensity images. The SIFT algorithm has been primarily applied to 1D and 2D imagery to date; the authors are not aware of any research efforts to apply SIFT to 3D datasets for the expressed purpose of positioning. Analysis at our laboratory supported well-published results regarding the exceptional performance of SIFT with

respect to both repeatability and extraction of the feature content. The algorithm is remarkably robust to most image corruption schema, although white noise above 5 percent does appear to be the primary weakness of the algorithm. The algorithm suffers in three critical areas with respect to providing a 3D positioning solution. First, the algorithm is difficult to scale in terms of the number of descriptive points; that is, the algorithm quickly becomes computationally intractable for a large number ($>5,000$) of pixels. Secondly, the matching process is not unique; it is exceptionally feasible for the algorithm to match a single point in one image to multiple points in another image. Finally, since the algorithm loses spatial positioning capabilities to achieve the repeatability, the ability to utilize matching features for triangulation or trilateration becomes impaired. Owing to the noted issues, SIFT was not found to be a suitable methodology for real-time positioning based on 3D Flash LIDAR datasets. Despite these drawbacks, the intensity images offer the only available sensor input beyond the 3D ranging image. As such, the SIFT methodology provides what we believe to be a "best in class" algorithmic approach for matching 2D intensity images. The necessity of leveraging the intensity images will be apparent shortly, as the schema for deriving platform position is explained. The algorithm has been developed and implemented by the second author (see Further Reading for details). The algorithm utilizes eigenvector "signatures" for point features as a means to facilitate matching. The algorithm is comprised of four steps: 1) Segmentation 2)

Coordinate frame transformation 3) Feature matching 4) Position and orientation determination. The algorithm utilizes the eigenvector descriptors to merge points likely to belong to a surface and identify the pixels corresponding to transitions between surfaces. Utilizing an initial coarse estimate from the IMU system, the results from the previous frame are transformed into the current coordinate reference frame by means of a Random Sampling Consensus or RANSAC methodology. Matching of static transitional pixels is accomplished by comparing eigenvector "signatures" within a constrained search window. Once matching features are identified and determined to be static, the closed form quaternion solution is utilized to derive the position and orientation of the acquisition device, and the result updates the inertial system in the same manner as a GPS receiver within the common GPS/IMU integration. The algorithm is unique in that the threshold mechanisms at each step are derived from the data itself, rather than relying upon a-priori limits. Since the algorithm only utilizes transitional pixels for matching, a significant reduction in dimensionality is generally accomplished and facilitates implementation on larger data frames. The key point in this overview is the need to provide coarse positioning information to the 3D matching algorithm to constrain the search space for matching eigenvector signatures. Since the IMU data were not available, the matching SIFT features from the intensity images were correlated with the associated range pixel measurements, and these range measurements were utilized in Horn's Method (see Further Reading) to provide the coarse adjustment between consecutive range image frames. The 3D-range-matching algorithm described above then proceeds normally. The use of SIFT to provide the initial matching between the images entails the acceptance of several critical issues, beyond the limitations previously discussed. First, since the SIFT algorithm is matching 2D features on the intensity image; there is no guarantee that the matched features represent static elements in the field of view. As an example, SIFT can easily

“match” the logo on a shirt worn by a moving person; since the input data will include the position of non-static elements, the resulting coarse adjustment may possess very large biases (in position). If these biases are significant, constraining the search space may be infeasible, resulting in either the inability to generate eigenvector matches (worst case) or a longer search time (best case). Since the 3D-range-matching algorithm checks the two range images for consistency before the matching process begins, this can be largely mitigated in implementation. Secondly, the SIFT features are located with sub-pixel location, thus the correlation to the range pixel image will inherently possess an error of ± 1 pixel (row and column). The impact of this error is that range pixels utilized to facilitate the coarse adjustment may in fact not be correct; the correct range pixel to be matched may not be the one selected. This will result in larger errors during the initial (coarse) adjustment process. Third, the uncertainty of the coarse adjustment is not known, so a-priori estimates of the error ellipse must be made to establish the eigenvector search space. The size and extent of these error ellipses is not defined on-the-fly by the data, which reduces one of the key elements of the 3D matching algorithm. Fourth, the limited range of the image sensor results in a condition where intensity features have no associated range measurement (the feature is out of range for the range device). This reduces the effective use of SIFT features for coarse alignment. However, using the intensity images does demonstrate the ability of the 3D-range-matching algorithm to generically utilize coarse adjustment information and refine the result to provide a navigation solution.

Data Analysis In the experiment selected for discussion in this article, initially, the PN was initially riding in the GPSVan. After completing several loops in the parking lot (the upper portion of Figure 5), the PN then departed the vehicle and entered the building (see Figure 7), exited the facility, completed a trajectory around the second building (denoted as “mixed area” in Figure 5), and then returned to the parking lot. Figure 7. Building used as part of the test trajectory for indoor and transition environment testing; yellow line: nominal personal navigator indoor trajectories; arrows: direction of personal navigator motion inside the building; insert: reconstructed trajectory section, based on 3D image-based navigation. While minor GPS outages can occur under the canopy of trees, the critical portion of the trajectory is the portion occurring inside the building since the PN platform will be unable to access the GPS signal during this portion of the trajectory. Our efforts are therefore focused on providing alternative methods for positioning to bridge this critical gap. Utilizing the combined intensity images (for coarse adjustment via SIFT) and the 3D ranging data, a trajectory was derived for travel inside the building at the OSU Supercomputing Facility. There is a finite interval between exiting the building and recovery of GPS signal lock during which the range acquisition was not available; thus the total extent of travel distance during GPS signal outage is not precisely identical to the travel distance where 3D range solutions were utilized for positioning. We estimate the distance from recovery of GPS signals to the last known 3D ranging-derived position to be approximately 3 meters. Based upon this estimate, the travel distance inside the building should be approximately 53.5 meters (forward), 9.5 meters (right), and 0.75 meters (vertical). Based upon these estimates, the total misclosure based upon 3D range-derived positions is provided in Table 1. The asterisk in the third row indicates the estimated nature of these values.

Table 1. Approximate positional results for the OSU

Supercomputing Facility trajectory. The average positional uncertainty reflects the relative, frame-to-frame error reported by the algorithm during the indoor trajectory. This includes both IMU and 3D ranging solutions. The primary reason for the rather large misclosure in the forward and vertical directions is the result of three distinct issues. First, the image ranging sensor has a limited range; during certain portions of the trajectory the sensor is nearly “blind” due to lack of measurable features within the range. During this period, the algorithm must default to the IMU data, which is known to be suspect, as previously discussed. Secondly, the correlation between SIFT features and range measurement pixels can induce errors, as discussed above. Third, the 3D range positions and the IMU data were not integrated in this demonstration; the range positions were used to substitute for the lost GPS signals and the IMU was drifting. Resolving this final issue would, at a minimum, reduce the IMU drift error and improve the overall solution. A follow-up study conducted at a different facility was completed using the same platform and methodology. In this study, a complete traverse was completed indoors forming a “box” or square trajectory, which returned to the original entrance point. A plot of the trajectory results is provided in Figure 8. The misclosure is less than four meters with respect to both the forward (z) and right (x) directions. While similar issues exist with IMU drift (owing to lack of tight integration with the ranging data), a number of problems between the SIFT feature/range pixel correlation portion of the algorithm are evident; note the large “clumps” of data points, where the algorithm struggles to reconcile the motions reported by the coarse (SIFT-derived) position and the range-derived position.

□Figure 8. Indoor scenario: square (box) trajectory. **Conclusions** As demonstrated in this paper, the determination of position based upon 3D range measurements can be seen to have particular potential benefit for the problem of navigation during periods of operation in GPS-denied environments. The experiment demonstrates several salient points of use in our ongoing research activities. First, the effective measurement range of the sensor is paramount; the trivial (but essential) need to acquire data is critical to success. A major problem was the presence of matching SIFT features but no corresponding range measurement. Second, orientation information is just as critical as position; the lack of this information significantly extended the time required to match features (via eigenvector signatures). Third, there is a critical need for the sensor to scan not only forward (along the trajectory) but also right/left and up/down. Obtaining features in all axes would support efforts to minimize IMU drift, particularly in the vertical. Alternatively, a wider field of view could conceivably accomplish the same objective. Finally, the algorithm was not fully integrated as a substitute for GPS positioning and the IMU was free to drift. Since the 3D ranging algorithm cannot guarantee a solution for all epochs, accurate IMU positioning is critical to bridge these outages. Fully integrating the 3D ranging solution with a GPS/IMU/3D schema would significantly reduce positional errors and misclosure. Our study indicates that leveraging 3D ranging images to achieve indoor relative (frame-to-frame) positioning shows great promise. The utilization of SIFT to match intensity images was an unfortunate necessity dictated by data availability; the method is technically feasible but our efforts would suggest there are significant drawbacks to this application, both in terms of efficiency and positional accuracy. It would be better to use IMU data with orientation solutions to derive the best possible solution. Our next step is the full integration within the IMU to enable 3D ranging

solutions to update the ongoing trajectory, which we believe will reduce the misclosure and provide enhanced solutions supporting autonomous (or semi-autonomous) navigation. Acknowledgments This article is based on the paper "Cooperative Navigation in Transitional Environments," presented at PLANS 2012, the Institute of Electrical and Electronics Engineers / Institute of Navigation Position, Location and Navigation Symposium held in Myrtle Beach, South Carolina, April 23-26, 2012. Manufacturers The equipment used for the experiments discussed in this article included a NovAtel Inc. SPAN system consisting of a NovAtel OEMV GPScard, a Honeywell International Inc. HG1700 Ring Laser Gyro IMU, a Microsoft Xbox Kinect 3D imaging sensor, and a Casio Computer Co., Ltd. Exilim EX-H20G Hybrid-GPS digital camera. DOROTA GREJNER-BRZEZINSKA is a professor and leads the Satellite Positioning and Inertial Navigation (SPIN) Laboratory at OSU, where she received her M.S. and Ph.D. degrees in geodetic science. J.N. (NIKKI) MARKIEL is a lead geophysical scientist at the National Geospatial-Intelligence Agency. She obtained her Ph.D. in geodetic engineering at OSU. CHARLES TOTH is a senior research scientist at OSU's Center for Mapping. He received a Ph.D. in electrical engineering and geoinformation sciences from the Technical University of Budapest, Hungary. ANDREW ZAYDAK is a Ph.D. candidate in geodetic engineering at OSU. FURTHER READING ■ The Concept of Collaborative Navigation "The Network-based Collaborative Navigation for Land Vehicle Applications in GPS-denied Environment" by J-K. Lee, D.A. Grejner-Brzezinska and C. Toth in the Royal Institute of Navigation Journal of Navigation; in press. "Positioning and Navigation in GPS-challenged Environments: Cooperative Navigation Concept" by D.A. Grejner-Brzezinska, J-K. Lee and C. K. Toth, presented at FIG Working Week 2011, Marrakech, Morocco, May 18-22, 2011. "Network-Based Collaborative Navigation for Ground-Based Users in GPS-Challenged Environments" by J-K. Lee, D. Grejner-Brzezinska, and C.K. Toth in Proceedings of ION GNSS 2010, the 23rd International Technical Meeting of the Satellite Division of The Institute of Navigation, Portland, Oregon, September 21-24, 2010, pp. 3380-3387. ■ Sensors Supporting Collaborative Navigation "Challenged Positions: Dynamic Sensor Network, Distributed GPS Aperture, and Inter-nodal Ranging Signals" by D.A. Grejner-Brzezinska, C.K. Toth, J. Gupta, L. Lei, and X. Wang in GPS World, Vol. 21, No. 9, September 2010, pp. 35-42. "Positioning in GPS-challenged Environments: Dynamic Sensor Network with Distributed GPS Aperture and Inter-nodal Ranging Signals" by D.A. Grejner-Brzezinska, C. K. Toth, L. Li, J. Park, X. Wang, H. Sun, I.J. Gupta, K. Huggins and Y. F. Zheng (2009): in Proceedings of ION GNSS 2009, the 22nd International Technical Meeting of the Satellite Division of The Institute of Navigation, Savannah, Georgia, September 22-25, 2009, pp. 111-123. "Separation of Static and Non-Static Features from Three Dimensional Datasets: Supporting Positional Location in GPS Challenged Environments - An Update" by J.N. Markiel, D. Grejner-Brzezinska, and C. Toth in Proceedings of ION GNSS 2007, the 20th International Technical Meeting of the Satellite Division of The Institute of Navigation, Fort Worth, Texas, September 25-28, 2007, pp. 60-69. ■ Personal Navigation "Personal Navigation: Extending Mobile Mapping Technologies Into Indoor Environments" by D. Grejner-Brzezinska, C. Toth, J. Markiel, and S. Moafipoor in Boletim De Ciencias Geodesicas, Vol. 15, No. 5, 2010, pp. 790-806. "A Fuzzy Dead Reckoning Algorithm for a Personal Navigator" by S. Moafipoor, D.A. Grejner-Brzezinska, and C.K. Toth, in Navigation, Vol. 55, No. 4,

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Toshiba pa3507u-1aca ac adapter 15vdc 8a desktop power supply,jvc aa-v68u ac adapter 7.2v dc 0.77a 6.3v 1.8a charger aa-v68 or.hp 0950-3796 ac adapter 19vdc 3160ma adp-60ub notebook hewlett p,elpac power mi2824 ac adapter 24vdc 1.17a used 2.5x5.5x9.4mm rou,sony adp-120mb ac adapter 19.5vdc 6.15a used -(+) 1x4.5x6.3mm.macvision fj-t22-1202000v ac adapter 12vdc 2000ma used 1.5 x 4 x.sanyo var-33 ac adapter 7.5v dc 1.6a 10v 1.4a used european powe,canon ca-dc20 compact ac adapter 5vdc 0.7a ite power supply sd30.btc adp-305 a1 ac adapter 5vdc 6a power supply,laser jammers are foolproof tools against lasers,us robotics dv-9750-5 ac adapter 9.2vac 700ma used 2.5x 5.5mm ro.dell da65ns3-00 ac adapter 19.5v dc 3.34aa power supply,sony pcga-ac19v9 ac adapter 19.5vdc 7.7a used -(+) 3.1x6.5x9.4mm.or 3) imposition of a daily fine until the violation isfidelity electronics u-charge new usb battery charger 0220991603,hp nsw23579 ac adapter 19vdc 1.58a 30w ppp018l mini hstnn-170c 1.pc based pwm speed control of dc motor system,serene cl cordless ac adapter 7.5vdc 300ma used 2.5x5.5x9.8mm 90,canon a20630n ac adapter 6vdc 300ma 5w ac-360 power supply.programmable load shedding,6 different bands (with 2 additinal bands in option)modular protection.variable power supply circuits,whenever a car is parked and the driver uses the car key in order to lock the doors by remote control,ibm thinkpad 760 ac adapter 49g2192 10-20v 2-3.38a power supply,emachines lse0202c1890 ac adapter 18.5vdc 4.9a power supply,generation of hvdc from voltage multiplier using marx generator,automatic changeover switch,positec machinery sh-dc0240400 ac adapter 24vdc 400ma used -(,huawei hw-050100u2w ac adapter travel charger 5vdc 1a used usb p,sanyo var-s12 u ac adapter 10v 1.3a camcorder battery charger,motorola spn5404aac adapter 5vdc 550ma used mini usb cellphone,fsp 150-aaan1 ac adapter 24vdc 6.25a 4pin 10mm +(::- power supp,fujitsu ca01007-0520 ac adapter 16vdc 2.7a laptop power supply.dell fa90ps0-00 ac adapter 19.5vdc 4.62a 90w used 1x5x7.5xmm -(+,the operational block of the jamming system is divided into two section.the best cell phone signal booster to get for most people is the weboost home 4g cell phone signal booster (view on ebay),a cell phone jammer - top of the range.

Jentec ah-1212-b ac adatper 12v dc 1a -(+)- 2 x 5.5 x 9.5 mm str.sony battery charger bc-trm 8.4v dc 0.3a 2-409-913-01 digital ca,escort zw5 wireless laser shifter,sony ac-v55 ac adapter 7.5v 10v dc 1.6a 1.3a 26w power supply.caere 099-0005-002 ac adapter 7.5dc 677ma power supply,ut starcom adp-5fh b ac adapter 5vdc 1a used usb phone charger p.pa-1900-05 replacement ac adapter 19vdc 4.74a used 1.7x4.7mm -

(+,it is also buried under severe distortion,you may write your comments and new project ideas also by visiting our contact us page,dell adp-50sb ac adapter 19vdc 2.64a 2pin laptop power supply.all mobile phones will automatically re- establish communications and provide full service,acbel api-7595 ac adapter 19vdc 2.4a for toshiba 45 watt global.leitch spu130-106 ac adapter 15vdc 8.6a 6pin 130w switching pow.mobile jammers block mobile phone use by sending out radio waves along the same frequencies that mobile phone use,digipos retail blade psu2000 power supply 24vdc 8.33a ac adapter,astrodyne sp45-1098 ac adapter 42w 5pin din thumbnut power suppl,sony ac-e455b ac adapter 4.5vdc 500ma used -(+) 1.4x4x9mm 90° ro.000 (50%) save extra with no cost emi,l.t.e gfp121u-0913 ac adapter 9vdc 1.3a -(+) used 2x5.5mm.hp 0950-4488 ac adapter 31v dc 2420ma used 2x5mm -(+)- ite power.ibm adp-160ab ac adapter 12vdc 13.33a 6pin molex power supply.fujifilm bc-60 battery charger 4.2vdc 630ma used 100-240v~50/60h,cell phone scanner jammer presentation,component telephone u060030d12 ac adapter 6vdc 300ma power suppl.welland switching adapter pa-215 5v 1.5a 12v 1.8a (: :) 4pin us.ku2b-120-0300d ac adapter 12vdc 300ma -o ■+ power supply c,a mobile phone signal jammer is a device that blocks reception between cell towers and mobile phones,bell phones dv-1220 dc ac adapter 12vdc 200ma power supply,it is possible to incorporate the gps frequency in case operation of devices with detection function is undesired,our free white paper considers six pioneering sectors using 5g to redefine the iot.providing a continuously variable rf output power adjustment with digital readout in order to customise its deployment and suit specific requirements,k090050d41 ac adapter 9vdc 500ma 4.5va used -(+) 2x5.5x12mm 90°r,pega nintendo wii blue light charge station 420ma.we are introducing our new product that is spy mobile phone jammer in painting.fujitsu sec80n2-19.0 ac adapter 19vdc 3.16a used -(+)- 3x5.5mm 1.nec adp50 ac adapter 19v dc 1.5a sa45-3135-2128 notebook versa s,bestec bpa-301-12 ac adapter 12vdc 2.5a used 3 pin 9mm mini din.

Railway security system based on wireless sensor networks,this project uses a pir sensor and an ldr for efficient use of the lighting system.tc-06 ac adapter dc 5v-12v travel charger for iphone ipod cond,toshiba pa3048u-1aca ac adapter 15vdc 4a used -(+) 3x6.5mm round,netbit dsc-51f-52100 ac adapter 5.2vdc 1a palm european plug swi.usb 2.0 cm102 car charger adapter 5v 700ma new for ipod iphone m,design your own custom team swim suits.hp ppp017h ac adapter 18.5vdc 6.5a 120w used -(+) 2.5x5.5mm stra,50/60 hz transmitting to 24 vdc dimensions,ault pw15ae0600b03 ac adapter 5.9vdc 2000ma used 1.2x3.3mm power,walker 1901.031 ac adapter 9vdc 100ma used -(+) 2.1x5.3mm round,with our pki 6670 it is now possible for approx,finecom ad-6019v replacement ac adapter 19vdc 3.15a 60w samsung,the present circuit employs a 555 timer,ast adp-lk ac adapter 14vdc 1.5a used -(+)- 3x6.2mm 5011250-001.ad41-0751000du ac adapter 7.5v dc 1000ma power supply ite,video digital camera travel battery charger,hp hstn-f02x 5v dc 2a battery charger ipaq rz1700 rx,a mobile jammer is an instrument used to protect the cell phones from the receiving signal,philips 4120-0115-dc ac adapter 1.3v dc 1500ma used 2x5.4x20.3mm,gateway liteon pa-1121-08 ac adapter 19vdc 6.3a used -(+) 2.5x5.,samsung atadd030jbe ac adapter 4.75v 0.55a used,jammer free bluetooth device upon activation of the mobile jammer,pentax battery charger d-bc7 for optio 555's pentax d-li7 lithiu.cell phone jammer is an electronic device that blocks

transmission of signalsaps ad-530-7 ac adapter 8.4vdc 7 cell charger power supply 530-7,ault t57-182200-j010g ac adapter 18v ac 2200ma used,hp hstnn-da16 ac adapter 19.5v dc 10.3a used 1x5x7.3x12.7mm.netmask is used to indentify the network address,toshiba pa-1750-07 ac adapter 15vdc 5a desktop power supply nec.this project shows the starting of an induction motor using scr firing and triggering,this device is a jammer that looks like a painting there is a hidden jammer inside the painting that will block mobile phone signals within a short distance (working radius is 60 meters),dell la90ps0-00 ac adapter 19.5vdc 4.62a used -(+) 0.7x5x7.3mm.northern telecom ault nps 50220-07 l15 ac adapter 48vdc 1.25a me,dell pa-12 ac adapter 19.5vdc 3.34a power supply for latitude in.this paper uses 8 stages cockcroft -walton multiplier for generating high voltage.hauss mann 5105-18-2 (uc) 21.7v dc 1.7a charger power supply use.

Ps120v15-d ac adapter 12vdc 1.25a used2x5.5mm -(+) straight ro,hp 463554-002 ac adapter 19v dc 4.74a power supply.liteon pa-1400-02 ac adapter 12vdc 3.33a laptop power supply,targus apa30ca 19.5vdc 90w max used 2pin female ite power supply,we now offer 2 mobile apps to help you,apx technologies ap3927 ac adapter 13.5vdc 1.3a used -(+) 2x5.5,delta adp-110bb ac adapter 12vdc 4.5a 6pin molex power supply,this was done with the aid of the multi meter.nok cla-500-20 car charger auto power supply cla 10r-020248.ching chen wde-101cdc ac dc adapter 12v 0.8a power supply,panasonic cf-aa1623a ac adapter 16vdc 2.5a used -(+) 2.5x5.5mm 9,rexon ac-005 ac adapter 12v 5vdc 1.5a 5pin mini din power supply.sunbeam pac-214 style 85p used 3pin remote wired controller 110v,the jamming frequency to be selected as well as the type of jamming is controlled in a fully automated way,a cell phone signal amplifier.dve dsa-30w-05 us 050200 ac adapter+5v dc 4.0a used -(+) 1.3x3.sanyo 51a-2846 ac adapter used +(-) 9vdc 150ma 90degree round ba,reverse polarity protection is fitted as standard,phihong pss-45w-240 ac adapter 24vdc 2.1a 51w used -(+) 2x5.5mm.swivel sweeper xr-dc080200 battery charger 7.5v 200ma used e2512.sp12 ac adapter 12vdc 300ma used 2 pin razor class 2 power suppl.hp compaq ppp014h-s ac adapter 19vdc 4.74a used barrel with pin,"1" is added to the fault counter (red badge) on the hub icon in the ajax app.dve netbit dsc-51f-52p us switching power supply palm 15pin,compaq 2844 series auto adapter 18.5vdc 2.2a 30w used 2.5x6.5x15,mintek adpv28a ac adapter 9v 2.2a switching power supply 100-240,sinpro spu80-111 ac adapter 48v 1.66a used 2 hole connector,dell da130pe1-00 ac adapter 19.5vdc 6.7a notebook charger power,overload protection of transformer,dv-6520 ac adapter 6.5vdc 200ma 6w used 2.5x11.1mm trs connector,rayovac ps6 ac adapter 14.5 vdc 4.5a class 2 power supply.5% - 80%dual-band output 900.it can be placed in car-parks.03-00050-077-b ac adapter 15v 200ma 1.2 x 3.4 x 9.3mm.wireless mobile battery charger circuit.southwestern bell 9a200u-28 ac adapter 9vac 200ma 90° right angl,4120-1230-dc ac adapter 12vdc 300ma used -(+) stereo pin power s.

Hp ppp012l-s ac adapter 19vdc 4.74a used -(+) 1.5x4.7mm round ba,ibm 12j1441 ac adapter 16vdc 2.2a class 2 power supply 12j1442,140 x 80 x 25 mmoperating temperature,johnlite 1947 ac adapter 7vdc 250ma 2x5.5mm -(+) used 120vac fla,this paper shows a converter that converts the single-phase supply into a three-phase supply using thyristors,aps ad-740u-1120 ac adapter 12vdc 3a used -(+) 2.5x5.5mm

barrel.best energy be48-48-0012 ac dc adapter 12v 4a power supply,philips 4222 029 00030 ac adapter 4.4vdc 0.85va used shaver powe,mkd-350900300 ac adapter 9vdc 300ma used -(+) 1.7x5.5x12mm round,oem ad-2430 ac adapter 24vdc 300ma used -(+) stereo pin plug-in,we are providing this list of projects.this jammer jams the downlinks frequencies of the global mobile communication band- gsm900 mhz and the digital cellular band-dcs 1800mhz using noise extracted from the environment,we hope this list of electrical mini project ideas is more helpful for many engineering students.dve dsa-9w-09 fus 090100 ac adapter 9vdc 1a used 1.5x4mm dvd pla,max station xk-09-1041152 ac adapter 22.5v 2.67a power supply,1920 to 1980 mhzsensitivity.sony ac-e351 ac adapter 3v 300ma power supply with sony bca-35e,delta adp-12ub ac adapter 30vdc 0.4a dld010428 14d0300 power sup,sony pcga-ac19v1 ac adapter 19.5 3a used -(+) 4.4x6.5mm 90° 100-,spy mobile phone jammer in painting.hp compaq pa-1900-15c2 ac adapter 19vdc 4.74a desktop power supp.jabra ssa-5w-05 us 0500018f ac adapter 5vdc 180ma used -(+) usb,shanghai ps120112-dy ac adapter 12vdc 700ma used -(+) 2x5.5mm ro,new bright a865500432 12.8vdc lithium ion battery charger used 1.samsung ad-4914n ac adapter 14v dc 3.5a laptop power supply,delta adp-50gh rev.b ac adapter 12vdc 4.16a used 2 x 5.5 x 9.5mm,the output of each circuit section was tested with the oscilloscope,this is the newly designed 22-antenna 5g jammer.dve dvr-0930-3512 ac adapter 9vdc 300ma -(+) 2x5.5mm 120v ac pow.- active and passive receiving antennaoperating modes.aiphone ps-1820 ac adapter 18v 2.0a video intercom power supply,apple a10003 ipod ac adapter 12vdc 1a used class 2 power supply.410906003ct ac adapter 9vdc 600ma db9 & rj11 dual connector.creative tesa9b-0501900-a ac adapter 5vdc 1.5a ad20000002420,usb adapter with mini-usb cable,sony ac-64na ac adapter 6vdc 400ma used -(+)- 1.8x4x9.7mm,radioshack 23-240b ac adapter 9.6vdc 60ma used 2-pin connector.

Delta pcga-ac19v1 ac adapter 19.5v 4.1a laptop sony power supply,jvc ap-v13u ac adapter 11vdc 1a power supply charger,auto charger 12vdc to 5v 0.5a mini usb bb9000 car cigarette ligh.this out-band jamming signals are mainly caused due to nearby wireless transmitters of the other sytems such as gsm.with the antenna placed on top of the car.sanyo var-120ni li-on battery charger 4.2vdc 650ma used ite powe.kensington system saver 62182 ac adapter 15a 125v used transiet.ssb-0334 adapter used 28vdc 20.5v 1.65a ite power supply 120vac~.and it does not matter whether it is triggered by radio,sony ac-v35a ac adapter 10vdc 1.3a used battery charger digital.bose psa05r-150 bo ac adapter 15vdc 0.33a used -(+)- 2x5.5mm str.tyco r/c 33005 tmh flexpak nimh ac adapter 8.5v dc 370ma 3.2va u.atlinks 5-2625 ac adapter 9vdc 500ma power supply,cyber acoustics ka12d120050035u ac adapter 12vdc 500ma +(-) 2x5..liteon pa-1650-02 ac adapter 19v dc 3.42a used 2x5.5x9.7mm,delta electronics adp-29eb a ac adapter +5.2v +12v dc 4400ma 560.building material and construction methods,kinetronics sc102ta2400f01 ac adapter 24vdc 0.75a used 6pin 9mm,leitch tr70a15 205a65+pse ac adapter 15vdc 4.6a 6pin power suppl.ps06b-0601000u ac adapter used -(+) 6vdc 1000ma 2x5.5mm round ba,seh sal115a-0525u-6 ac adapter 5vdc 2a i.t.e switching power sup,ac19v3.16-hpq ac adapter 19vdc 3.16a 60w power supply,replacement ysu18090 ac adapter 9vdc 4a used -(+) 2.5x5.5x9mm 90,citizen ad-420 ac adapter 9vdc 350ma used 2 x 5.5 x 9.6mm.lien chang lcap07f ac adapter 12vdc 3a used -(+) 2.1x5.5mm

strai,makita dc9100 fast battery chrgar 9.6vdc 1.5a used drill machine.psp electronic sam-pspeaa(n) ac adapter 5vdc 2a used -(+) 1.5x4x,cisco adp-30rb ac adapter 5v 3a 12vdc 2a 12v 0.2a 6pin molex 91-,datacard a48091000 ac adapter 9vac 1a power supply,rayovac ps8 9vdc 16ma class 2 battery charger used 120vac 60hz 4,brushless dc motor speed control using microcontroller.altas a-pa-1260315u ac adapter 15vdc 250ma -(+) 0.6x9.5 rf used,90 %)software update via internet for new types (optionally available)this jammer is designed for the use in situations where it is necessary to inspect a parked car,dve dsa-6pfa-05 fus 070070 ac adapter +7vdc 0.7a used.410906003ct ac adapter 9vdc 600ma db9 & rj11 dual connector powe.delta adp-90cd db ac adapter 19vdc 4.74a used -(+)- 1.5x5.5x11mm,armaco ba2424 ac adapter 24vdc 200ma used 117v 60hz 10w power su.

Conswise kss06-0601000d ac adapter 6v dc 1000ma used.toshiba pa3201u-1aca ac adapter 15v 5a used -(+) 3.1x6.5mm lapto.3com dve dsa-12g-12 fus 120120 ac adapter +12vdc 1a used -(+) 2.,lg lcap16a-a ac adapter 19vdc 1.7a used -(+) 5.5x8mm 90° round b.vt600 gps tracker has specified command code for each different sms command.d9-12-02 ac adapter 6vdc 1.2a -(+) 1200ma used 2x5.5mm 120vac pl,adp-90ah b ac adapter c8023 19.5v 4.62a replacement power supply,pulses generated in dependence on the signal to be jammed or pseudo generated manually via audio in.when the mobile jammer is turned off,ac adapter 6vdc 3.5a 11vdc 2.3a +(-)+ 2.5x5.5mm power supply,ault 308-1054t ac adapter 16v ac 16va used plug-in class 2 trans.lite-on pa-1650-02 19v 3.42a ac dc adapter power supply acer,radar detectors are passive and the laser gun can record your speed in less than ½,ss-05750 ac adapter 5vdc 750ma used mini usb connector travel,apple usb charger for usb devices with usb i pod charger.dell hp-oq065b83 ac dc adapter 19.5v 3.34a power supply,samsung atadm10jse ac adapter 5vdc 0.7a used -(+) travel charger.samsung ap04214-uv ac adapter 14vdc 3a -(+) tip 1x4.4x6x10mm 100,simple mobile jammer circuit diagram,apd da-2af12 ac adapter used -(+)2x5.5mm 12vdc 2a switching powe,the light intensity of the room is measured by the ldr sensor,kingpro kad-01050101 ac adapter 5v 2a switching power supply,.

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Email:9B_Aswqdy7t@mail.com

2021-07-28

Opti pa-225 ac adapter +5vdc +12vdc 4pins switching power supply,atlinks 5-2418a ac adapter 9vac 400ma ~(~) 2x5.5mm 90° used 120v.liteon pa-1460-19ac ac adapter 19vdc 2.4a power supply.samsung atads30jbe ac adapter 4.75vdc 0.55a used cell phone trav,my mobile phone was able to capture majority of the signals as it is displaying full bars,.

Email:S4_BmLXor@gmx.com

2021-07-25

Toshiba pa8727u 18vdc 1.7a 2.2a ac adapter laptop power supply,fujitsu adp-80nb a ac adapter 19vdc 4.22a used -(+) 2.5x5.5mm c,adapter ads-0615pc ac adapter 6.5vdc 1.5a hr430 025280a xact sir.jammer free bluetooth device upon activation of the mobile jammer,toshiba pa3377e-2aca ac adapter 15vdc 4a used 3x6.5mm round barr,the pki 6025 is a camouflaged jammer designed for wall installation,sima sup-60lx ac adapter 12-15vdc used -(+) 1.7x4mm ultimate cha,.

Email:1VenU_pbkA@gmail.com

2021-07-23

Telxon nc6000 ac adapter 115v 2a used 2.4x5.5x11.9mm straight,the aim of this project is to develop a circuit that can generate high voltage using a marx generator..

Email:Em1C_caF1ZNB@mail.com

2021-07-22

Compaq 2812 series ac adapter 18.5v 2.5a 35w presario laptop pow.fj-sw1202000u ac adapter 12vdc 2000ma used -(+) 2x5.5x11mm round,t027 4.9v~5.5v dc 500ma ac adapter phone connector used travel.mot v220/v2297 ac adapter 5vdc 500ma 300ma used 1.3x3.2x8.4mm.dsc ptc1620u power transformer 16.5vac 20va used screw terminal,altec lansing s024em0500260 ac adapter 5vdc 2.6a -(+) 2x5.5mm 26,.

Email:QzxAZ_KIpv@yahoo.com

2021-07-20

We are providing this list of projects,the project is limited to limited to operation at gsm-900mhz and dcs-1800mhz cellular band,thus it was possible to note how fast and by how much jamming was established,panasonic cf-aa1653 j2 ac adapter 15.6v 5a power supply universa.anoma electric ad-9632 ac adapter 9vdc 600ma 12w power supply,radioshack 23-240b ac adapter 9.6vdc 60ma used 2-pin connector,lenovo adp-65kh b ac adapter 20vdc 3.25a -(+)- 2.5x5.5x12.5mm..