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Permanent Link to Innovation: Doppler-Aided Positioning

2021/06/20

Improving Single-Frequency RTK in the Urban Environment By Mojtaba Bahrami and Marek Ziebart A look at how Doppler measurements can be used to smooth noisy code-based pseudoranges to improve the precision of autonomous positioning as well as to improve the availability of single-frequency real-time kinematic positioning, especially in urban environments. INNOVATION INSIGHTS by Richard Langley

WHAT DO A GPS RECEIVER, a policeman's speed gun, a weather radar, and some medical diagnostic equipment have in common? Give up? They all make use of the Doppler effect. First proposed in 1842 by the Austrian mathematician and physicist, Christian Doppler, it is the change in the perceived frequency of a wave when the transmitter and the receiver are in relative motion. Doppler introduced the concept in an attempt to explain the shift in the color of light from certain binary stars. Three years later, the effect was tested for sound waves by the Dutch scientist Christophorus Buys Ballot. We have all heard the Doppler shift of a train whistle or a siren with their descending tones as the train or emergency vehicle passes us. Doctors use Doppler sonography — also known as Doppler ultrasound — to provide information about the flow of blood and the movement of inner areas of the body with the moving reflectors changing the received ultrasound frequencies. Similarly, some speed guns use the Doppler effect to measure the speed of vehicles or baseballs and Doppler weather radar measures the relative velocity of particles in the air. The beginning of the space age heralded a new application of the Doppler effect. By measuring the shift in the received frequency of the radio beacon signals transmitted by Sputnik I from a known location, scientists were able to determine the orbit of the satellite. And shortly thereafter, they determined that if the orbit of a satellite was known, then the position of a receiver could be determined from the shift. That realization led to the development of the United States Navy Navigation Satellite System, commonly known as Transit, with the first satellite being launched in 1961. Initially classified, the system was made available to civilians in 1967 and was widely

used for navigation and precise positioning until it was shut down in 1996. The Soviet Union developed a similar system called Tsikada and a special military version called Parus. These systems are also assumed to be no longer in use — at least for navigation. GPS and other global navigation satellite systems use the Doppler shift of the received carrier frequencies to determine the velocity of a moving receiver. Doppler-derived velocity is far more accurate than that obtained by simply differencing two position estimates. But GPS Doppler measurements can be used in other ways, too. In this month's column, we look at how Doppler measurements can be used to smooth noisy code-based pseudoranges to improve the precision of autonomous positioning as well as to improve the availability of single-frequency real-time kinematic positioning, especially in urban environments.

Correction and Further Details The first experimental Transit satellite was launched in 1959. A brief summary of subsequent launches follows: Transit 1A launched 17 September 1959 failed to reach orbit Transit 1B launched 13 April 1960 successfully Transit 2A launched 22 June 1960 successfully Transit 3A launched 30 November 1960 failed to reach orbit Transit 3B launched 22 February 1961 failed to deploy in correct orbit Transit 4A launched 29 June 1961 successfully Transit 4B launched 15 November 1961 successfully Transits 4A and 4B used the 150/400 MHz pair of frequencies and provided geodetically useful results. A series of Transit prototype and research satellites was launched between 1962 and 1964 with the first fully operational satellite, Transit 5-BN-2, launched on 5 December 1963. The first operational or Oscar-class Transit satellite, NNS O-1, was launched on 6 October 1964. The last pair of Transit satellites, NNS O-25 and O-31, was launched on 25 August 1988.

"Innovation" is a regular column that features discussions about recent 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 at the University of New Brunswick, who welcomes your comments and topic ideas. To contact him, email lang @ unb.ca. Real-time kinematic (RTK) techniques enable centimeter-level, relative positioning. The technology requires expensive, dedicated, dual-frequency, geodetic-quality receivers. However, myriad industrial and engineering applications would benefit from small-size, cost-effective, single-frequency, low-power, and high-accuracy RTK satellite positioning. Can such a sensor be developed and will it deliver? If feasible, such an instrument would find many applications within urban environments — but here the barriers to success are higher. In this article, we show how some of the problems can be overcome.

Single-Frequency RTK Low-cost single-frequency (L1) GPS receivers have attained mass-market status in the consumer industry. Notwithstanding current levels of maturity in GPS hardware and algorithms, these receivers still suffer from large positioning errors. Any positioning accuracy improvement for mass-market receivers is of great practical importance, especially for many applications demanding small size, cost-effectiveness, low power consumption, and highly accurate GPS positioning and navigation. Examples include mobile mapping technology; machine control; agriculture fertilization and yield monitoring; forestry; utility services; intelligent transportation systems; civil engineering projects; unmanned aerial vehicles; automated continuous monitoring of landslides, avalanches, ground subsidence, and river level; and monitoring deformation of built structures. Moreover, today an ever-increasing number of smartphones and handsets

come equipped with a GPS receiver. In those devices, the increasing sophistication of end-user applications and refinement of map databases are continually tightening the accuracy requirements for GPS positioning. For single-frequency users, the RTK method does appear to offer the promise of highly precise position estimates for stationary and moving receivers and can even be considered a candidate for integration within mobile handhelds. Moreover, the RTK approach is attractive because the potential of the existing national infrastructures such as Great Britain's Ordnance Survey National GNSS Network-RTK (OSNet) infrastructure, as well as enabling technologies such as the Internet and the cellular networks, can be exploited to deliver RTK corrections and provide high-precision positioning and navigation. The basic premise of relative (differential) positioning techniques such as RTK is that many of the sources of GNSS measurement errors including the frequency-dependent error (the ionospheric delay) are spatially correlated. By performing relative positioning between receivers, the correlated measurement errors are completely cancelled or greatly reduced, resulting in a significant increase in the positioning accuracy and precision.

Single-Frequency Challenges. Although RTK positioning is a well-established and routine technology, its effective implementation for low-cost, single-frequency L1 receivers poses many serious challenges, especially in difficult and degraded signal environments for GNSS such as urban canyons. The most serious challenge is the use of only the L1 frequency for carrier-phase integer ambiguity resolution and validation. Unfortunately, users with single-frequency capability do not have frequency diversity and many options in forming useful functions and combinations for pseudorange and carrier-phase observables. Moreover, observations from a single-frequency, low-cost receiver are typically "biased" due to the high level of multipath and/or receiver signal-tracking anomalies and also the low-cost patch antenna design that is typically used. In addition, in those receivers, measurements are typically contaminated with high levels of noise due to the low-cost hardware design compared to the high-end receivers. This makes the reliable fixing of the phase ambiguities to their correct integer values, for single-frequency users, a non-trivial problem. As a consequence, the reliability of single-frequency observations to resolve ambiguities on the fly in an operational environment is relatively low compared to the use of dual-frequency observations from geodetic-quality receivers. Improving performance will be difficult, unless high-level noise and multipath can be dealt with effectively or unless ambiguity resolution techniques can be devised that are more robust and are less sensitive to the presence of biases and/or high levels of noise in the observations. Traditionally, single-frequency RTK positioning requires long uninterrupted initialization times to obtain reliable results, and hence have a time-to-fix ambiguities constraint. Times of 10 to 25 minutes are common. Observations made at tens of continuous epochs are used to determine reliable estimates of the integer phase ambiguities. In addition, these continuous epochs must be free from cycle slips, loss of lock, and interruptions to the carrier-phase signals for enough satellites in view during the ambiguity fixing procedure. Otherwise, the ambiguity resolution will fail to fix the phase ambiguities to correct integer values. To overcome these drawbacks and be able to determine the integer phase ambiguities and thus the precise relative positions, observations made at only one epoch (single-epoch) can be used in resolving the integer phase ambiguities. This allows instantaneous RTK positioning

and navigation for single-frequency users such that the problem of cycle slips, discontinuities, and loss of lock is eliminated. However, for single-frequency users, the fixing of the phase ambiguities to their correct integer values using a single epoch of observations is a non-trivial problem; indeed, it is considered the most challenging scenario for ambiguity resolution at the present time. Instantaneous RTK positioning relies fundamentally upon the inversion of both carrier-phase measurements and code measurements (pseudoranges) and successful instantaneous ambiguity resolution. However, in this approach, the probability of fixing ambiguities to correct integer values is dominated by the relatively imprecise pseudorange measurements. This is more severe in urban areas and difficult environments where the level of noise and multipath on pseudoranges is high. This problem may be overcome partially by carrier smoothing of pseudoranges in the range/measurement domain using, for example, the Hatch filter. While carrier-phase tracking is continuous and free from cycle slips, the carrier smoothing of pseudoranges with an optimal smoothing filter window-width can effectively suppress receiver noise and short-term multipath noise on pseudoranges. However, the effectiveness of the conventional range-domain carrier-smoothing filters is limited in urban areas and difficult GNSS environments because carrier-phase measurements deteriorate easily and substantially due to blockages and foliage and suffer from phase discontinuities, cycle-slip contamination, and other measurement anomalies. This is illustrated in Figure 1. The figure shows that in a kinematic urban environment, frequent carrier-phase outages and anomalies occur, which cause frequent resets of the carrier-smoothing filter and hence carrier smoothing of pseudoranges suffers in robustness and effective continuous smoothing. Figure 1. Satellite tracking and carrier-phase anomaly summary during the observation time-span. These data were collected in a dense urban environment in both static and kinematic mode. The superimposed red-points show epochs where carrier-phase observables are either missing or contaminated with cycle slips, loss of locks, and/or other measurement anomalies. Doppler Frequency Shift. While carrier-phase tracking can be discontinuous in the presence of continuous pseudoranges, a receiver generates continuous Doppler-frequency-shift measurements. The Doppler measurements are immune to cycle slips. Moreover, the precision of the Doppler measurements is better than the precision of pseudoranges because the absolute multipath error of the Doppler observable is only a few centimeters. Thus, devising methods that utilize the precision of raw Doppler measurements to reduce the receiver noise and high-frequency multipath on pseudoranges may prove valuable especially in GNSS-challenged environments. Figure 2 shows an example of the availability and the precision of the receiver-generated Doppler measurements alongside the delta-range values derived from the C/A-code pseudoranges and from the L1 carrier-phase measurements. This figure also shows that frequent carrier-phase outages and anomalies occur while for every C/A-code pseudorange measurement there is a corresponding Doppler measurement available. Figure 2. Plots of C/A-code-pseudorange-derived delta-ranges (top), L1 carrier-phase-derived delta-ranges (middle), and L1 raw receiver-generated Doppler shifts that are transformed into delta-ranges for the satellite PRN G18 during the observation time-span when it was tracked by the receiver (bottom). Smoothing. A rich body of literature has been published exploring aspects of carrier smoothing of pseudoranges. One factor that has not received sufficient study in the literature is

utilization of Doppler measurements to smooth pseudoranges and to investigate the influence of improved pseudorange accuracy on both positioning and the integer-ambiguity resolution. Utilizing the Doppler measurements to smooth pseudoranges could be a good example of an algorithm that maximally utilizes the information redundancy and diversity provided by a GPS/GNSS receiver to improve positioning accuracy. Moreover, utilizing the Doppler measurements does not require any hardware modifications to the receiver. In fact, receivers measure Doppler frequency shifts all the time as a by-product of satellite tracking.

GNSS Doppler Measurement Overview

The Doppler effect is the apparent change in the transmission frequency of the received signal and is experienced whenever there is any relative motion between the emitter and receiver of wave signals. Theoretically, the observed Doppler frequency shift, under Einstein's Special Theory of Relativity, is approximately equal to the difference between the received and transmitted signal frequencies, which is approximately proportional to the receiver-satellite topocentric range rate.

Beat Frequency

However, the transmitted frequency is replicated locally in a GNSS receiver. Therefore, strictly speaking, the difference of the received frequency and the receiver locally generated replica of the transmitted frequency is the Doppler frequency shift that is also termed the beat frequency. If the receiver oscillator frequency is the same as the satellite oscillator frequency, the beat frequency represents the Doppler frequency shift due to the relative, line-of-sight motion between the satellite and the receiver. However, the receiver internal oscillator is far from being perfect and therefore, the receiver Doppler measurement output is the apparent Doppler frequency shift (that includes local oscillator effects). The Doppler frequency shift is also subject to satellite-oscillator frequency bias and other disturbing effects such as atmospheric effects on the signal propagation. To estimate the range rate, a receiver typically forms an average of the delta-range by simply integrating the Doppler over a very short period of time (for example, 0.1 second) and then dividing it by the duration of the integration interval. Since the integration of frequency over time gives the phase of the signal over that time interval, the procedure continuously forms the carrier-phase observable that is the integrated Doppler over time. Therefore, Doppler frequency shift can also be estimated by time differencing carrier-phase measurements. The carrier-phase-derived Doppler is computed over a longer time span, leading to smoother Doppler measurements, whereas direct loop filter output is an instantaneous measure produced over a short time interval. Doppler frequency shift is routinely used to determine the satellite or user velocity vector. Apart from velocity determination, it is worth mentioning that Doppler frequency shifts are also exploited for coarse GPS positioning. Moreover, the user velocity vector obtained from the raw Doppler frequency shift can be and has been applied by a number of researchers to instantaneous RTK applications to constrain the float solution and hence improve the integer-ambiguity-resolution success rates in kinematic surveying. In this article, a simple combination procedure of the noisy pseudorange measurements and the receiver-generated Doppler measurements is suggested and its benefits are examined.

Doppler-Smoothing Algorithm Description

Motivated both by the continual availability and the centimeter-level precision of receiver-generated (raw) Doppler measurements, even in urban canyons, a method has been introduced by the authors that utilizes the precision of raw Doppler measurements to reduce the receiver noise and high-

frequency multipath on code pseudoranges. For more detail on the Doppler-smoothing technique, see Further Reading. The objective is to smooth the pseudoranges and push the accuracy of the code-based or both code- and carrier-based positioning applications in GNSS-challenged environments. Previous work on Doppler-aided velocity/position algorithms is mainly in the position domain. In those approaches, the improvement in the quality of positioning is gained mainly by integrating the kinematic velocities and accelerations derived from the Doppler measurement in a loosely coupled extended Kalman filter or its variations such as the complementary Kalman filter. Essentially, these techniques utilize the well-known ability of the Kalman filter to use independent velocity estimates to reduce the noise of positioning solutions and improve positioning accuracy. The main difference among these position-domain filters is that different receiver dynamic models are used. The proposed method combines centimeter-level precision receiver-generated Doppler measurements with pseudorange measurements in a combined pseudorange measurement that retains the significant information content of each. Two-Stage Process. The proposed Doppler-smoothing process has two stages: (1) the prediction or initialization stage and (2) the filtering stage. In the prediction stage, a new estimated smoothed value of the pseudorange measurement for the Doppler-smoothing starting epoch is obtained. In this stage, for a fixed number of epochs, a set of estimated pseudoranges for the starting epoch is obtained from the subsequent pseudorange and Doppler measurements. The estimated pseudoranges are then averaged to obtain a good estimated starting point for the smoothing process. The number of epochs used in the prediction stage is the averaging window-width or Doppler-smoothing-filter length. In the filtering stage, the smoothed pseudorange profile is constructed using the estimated smoothed starting pseudorange and the integrated Doppler measurements over time. The Doppler-smoothing procedures outlined here can be performed successively epoch-by-epoch (that is, in a moving filter), where the estimated initial pseudorange (the averaged pseudorange) is updated from epoch to epoch. Alternatively, an efficient and elegant implementation of the measurement-domain Doppler-smoothing method is in terms of a Kalman filter, where it can run as a continuous process in the receiver from the first epoch (or in post-processing software, but then without the real-time advantage). This filter allows real-time operation of the Doppler-smoothing approach. In the experiments described in this article, a short filter window-width is used. The larger the window width used in the averaging filter process, the more precise the averaged pseudorange becomes. However, this filter is also susceptible to the ionospheric divergence phenomenon because of the opposite signs of the ionospheric contribution in the pseudorange and Doppler observables. Therefore, the ionospheric divergence effect between pseudoranges and Doppler observables increases with averaging window-width and the introduced bias in the averaged pseudoranges become apparent for longer filter lengths. Using the propagation of variance law, it can be shown that the precision of the delta-range calculated with the integrated Doppler measurements over time depends on both the Doppler-measurement epoch interval and the precision of the Doppler measurements, assuming that noise/errors on the measurements are uncorrelated. Experimental Results To validate the improvement in the performance and availability of single-frequency instantaneous RTK in urban areas, the proposed Doppler-aided instantaneous RTK technique has been investigated using actual GPS

data collected in both static and kinematic pedestrian trials in central London. In this article, we only focus on the static results and the kinematic trial results are omitted. It is remarked, however, that the data collected in the static mode were post-processed in an epoch-by-epoch approach to simulate RTK processing. In the static testing, GPS test data were collected with a measurement rate of 1 Hz. At the rover station, a consumer-grade receiver with a patch antenna was used. This is a single-frequency 16-channel receiver that, in addition to the C/A-code pseudoranges, is capable of logging carrier-phase measurements and raw Doppler measurements. Reference station data were obtained from the Ordnance Survey continuously operating GNSS network. Three nearby reference stations were selected that give different baseline lengths: Amersham (AMER) \approx 38.3 kilometers away, Teddington (TEDD) \approx 20.8 kilometers away, and Stratford (STRA) \approx 7.1 kilometers away. In addition, a virtual reference station (VRS) was also generated in the vicinity (60 meters away) of the rover receiver.

Doppler-Smoothing. Before we present the improvement in the performance of instantaneous RTK positioning, the effect of the Doppler-smoothing of the pseudoranges in the measurement domain and comparison with carrier-phase smoothing of pseudoranges is given. To do this, we computed the C/A-code measurement errors or observed range deviations (the differences between the expected and measured pseudoranges) in the static mode (with surveyed known coordinates) using raw, Doppler-smoothed and carrier-smoothed pseudoranges. FIGURE 3a illustrates the effect of 100-second Hatch-filter carrier smoothing and FIGURE 3b shows a 100-second Doppler-smoothing of the pseudoranges for satellite PRN G28 (RINEX satellite designator) with medium-to-high elevation angle. The raw observed pseudorange deviations (in blue) are also given as reference. The quasi-sinusoidal oscillations are characteristic of multipath. Comparing the Doppler-smoothing in Figure 3b to the Hatch carrier-smoothing in Figure 3a, it can be seen that Doppler-smoothing of pseudoranges offers a modest improvement and is more robust and effective than that of the traditional Hatch filter in difficult environments.

Figure 3. Smoothed pseudorange errors (observed range deviations) using the traditional Hatch carrier-smoothing filter. Smoothing filter length in the experiments for both filters was set to 100 seconds. Satellite PRN G28 was chosen to represent a satellite at medium-to-high elevation angle. Figure 3. Smoothed pseudorange errors (observed range deviations) using the Doppler-smoothing filter. Smoothing filter length in the experiments for both filters was set to 100 seconds. Satellite PRN G28 was chosen to represent a satellite at medium-to-high elevation angle. Figure 4a illustrates carrier-phase Hatch-filter smoothing for low-elevation angle satellite PRN G18. In this figure, the Hatch carrier-smoothing filter reset is indicated. It can be seen that due to the frequent carrier-phase discontinuities and cycle slips, the smoothing has to be reset and restarted from the beginning and hardly reaches its full potential. In contrast, Doppler smoothing for PRN G18 shown in FIGURE 4b had few filter resets and managed effectively to smooth the very noisy pseudorange in some sections of the data. Figure 4. Smoothed pseudorange errors (observed range deviations) and filter resets and filter length (window width) using the traditional Hatch carrier-smoothing filter. Smoothing filter length in the experiments for both filters was set to 100 seconds. Satellite PRN G18 was chosen to represent a satellite at low elevation angle as it rises from 10 to 30 degrees. Figure 4. Smoothed pseudorange errors (observed range deviations) and filter resets and filter length

(window width) using the Doppler-smoothing. Smoothing filter length in the experiments for both filters was set to 100 seconds. Satellite PRN G18 was chosen to represent a satellite at low elevation angle as it rises from 10 to 30 degrees. Considering RTK in this analysis, we can demonstrate the increase in the success rate of the Doppler-aided integer ambiguity resolution (and hence the RTK availability) by comparison of the obtained integer ambiguity vectors from the conventional LAMBDA (Least-squares AMBiguity Decorrelation Adjustment) ambiguity resolution method using Doppler-smoothed pseudoranges with those obtained without Doppler-aiding in post-processed mode. The performance of ambiguity resolution was evaluated based on the number of epochs where the ambiguity validation passed the discrimination/ratio test. The ambiguity validation ratio test was set to the fixed critical threshold of 2.5 in all the experiments. In addition to the ratio test, the fixed solutions obtained using the fixed integer ambiguity vectors that passed the ratio test were compared against the true position of the surveyed point to make sure that indeed the correct set of integer ambiguities were estimated. The overall performance of the single-epoch single-frequency integer ambiguity resolution obtained by the conventional LAMBDA ambiguity resolution method without Doppler-aiding is shown in Figure 5 for baselines from 60 meters up to 38 kilometers in length. In comparison, the performance of the single-epoch single-frequency integer ambiguity resolution from the LAMBDA method using Doppler-smoothed pseudoranges are shown in Figure 6 for those baselines and they are compared with integer ambiguity resolution success rates of the conventional LAMBDA ambiguity resolution method without Doppler-aiding. Figure 6 shows that using Doppler-smoothed pseudoranges enhances the probability of identifying the correct set of integer ambiguities and hence increases the success rate of the integer ambiguity resolution process in instantaneous RTK, providing higher availability. This is more evident for shorter baselines. For long baselines, the residual of satellite-ephemeris error and atmospheric-delay residuals that do not cancel in double differencing potentially limits the effectiveness of the Doppler-smoothing approach. It is well understood that those residuals for long baselines strongly degrade the performance of ambiguity resolution. Relative kinematic positioning with single frequency mass-market receivers in urban areas using VRS has also shown improvement. Figure 5. Single-epoch single-frequency integer ambiguity resolution success rate obtained by the conventional LAMBDA ambiguity resolution method without Doppler-aiding. Figure 6. Plots of integer ambiguity resolution success rates: single-epoch single-frequency integer ambiguity resolution success rate obtained by the conventional LAMBDA ambiguity resolution method without Doppler-aiding (in blue) and using Doppler-smoothed pseudoranges (in green). Conclusion In urban areas, the proposed Doppler-smoothing technique is more robust and effective than traditional carrier smoothing of pseudoranges. Static and kinematic trials confirm this technique improves the accuracy of the pseudorange-based absolute and relative positioning in urban areas characteristically by the order of 40 to 50 percent. Doppler-smoothed pseudoranges are then used to aid the integer ambiguity resolution process to enhance the probability of identifying the correct set of integer ambiguities. This approach shows modest improvement in the ambiguity resolution success rate in instantaneous RTK where the probability of fixing ambiguities to correct integer values is dominated by the relatively imprecise pseudorange

measurements. The importance of resolving the integer ambiguities correctly must be emphasized. Therefore, devising innovative and robust methods to maximize the success rate and hence reliability and availability of single-frequency, single-epoch integer ambiguity resolution in the presence of biased and noisy observations is of great practical importance especially in GNSS-challenged environments.

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gps,xmradio,4g jammer program

Modeling of the three-phase induction motor using simulink,delta adp-63bb b ac adapter 15v 4.2a laptop power supply.sony ac-v35 ac power adapter 7.5vdc 1.6a can use with sony ccd-f.when the temperature rises more than a threshold value this system automatically switches on the fan,phihong psc12r-050 ac adapter 5vdc 2a - (+)- 2x5.5mm like new.here is the project showing radar that can detect the range of an object,mw mw48-9100 ac dc adapter 9vdc 1000ma used 3 pin molex power su,li shin 0217b1248 ac adapter 12vdc 4a - (+)- 2x5.5mm 100-240vac p,duracell cefadpus 12v ac dc adapter 1.5a class 2 power supply,konica minolta ac-a10n ac adapter 9vdc 0.7a 2x5.5mm +(-) used,toshiba delta pa3714e-1ac3ac adapter 19v3.42alaptop power,and like any ratio the sign can be disrupted,delta adp-90sb bd ac adapter 20vdc 4.5a used - (+)- 2.5x5.5x11mm,acbel api-7595 ac adapter 19vdc 2.4a for toshiba 45 watt global.dell lite on la65ns2-01 ac adapter 19.5vdc 3.34a used - (+) pin.cincon tr513-1a ac adapter 5v 400ma travel charger.anoma aec-n3512i ac adapter 12vdc 300ma used 2x5.5x11mm - (+)-,ad-804 ac adapter 9vdc 210ma used - (+) 1.7x4.7mm round barrel 9.but are used in places where a phone call would be particularly disruptive like temples,this device can cover all such areas with a rf-output control of 10,ibm 11j8627 ac adapter 19vdc 2.4a laptop power supply,we are talking for a first time offender up to 11.sanyo nu10-7050200-i3 ac adapter 5vdc 2a power supply.samsung j-70 ac adapter 5vdc 1a mp3 charger used 100-240v 1a 50/.sunny sys1298-1812-w2 ac dc adapter 12v 1a 12w 1.1mm power suppl.poweruon 160023 ac adapter 19vdc 12.2a used 5x7.5x9mm round barr,outputs obtained are speed and electromagnetic torque.-10 up to +70°cambient humidity,ea10362 ac adapter 12vdc 3a used - (+) 2.5x5.5mm round barrel,jentec jta0202y ac adapter

+5vdc +12v 2a used 5pin 9mm mini din.sony ac-l15b ac dc adapter 8.4v 1.5a power supply for camcorder,they are based on a so-called „rolling code“.the operating range is optimised by the used technology and provides for maximum jamming efficiency,epson a391uc ac adapter 13.5vdc 1.5a used -(+) 3.3x5mm 90° right,power grid control through pc scada.

jammer direct hit tf2	6696	844	2998	2914	3663
multi band jammer device	7666	1568	6621	8719	7631
lte jammer design firms	3571	687	8716	8378	7934
gps,xmradio,4g jammer words	2092	990	7263	303	1316
jammer direct quote generator	1603	2006	8091	3474	7178
jammer box logo price	4979	1224	4924	1281	1235
jammer gun exchange website	5346	5929	2721	3717	5560
jammer engels bourgeoisie history	2144	1945	4142	4822	6208
jammer direct general nashville	8240	1122	1180	6770	7647
diy eas jammer website	1071	8890	5678	2435	2378
jammer direct burial bollards	894	2359	5477	2137	688
jammer box dimensions maximum	8998	7076	4801	2683	7779
jammer direct access registration	7131	5237	7586	2231	885
jammer direct hire kohls	2525	8644	2702	5950	2186
jammer in engels model	596	960	8467	8880	6946
jammer classic lacrosse tournament	8509	8795	4731	1539	1074
jammer direct bank nj	6752	8485	7816	7589	1102
jammer programming noise level	6526	3024	914	737	8915
low band jammer work	3939	3619	2453	6988	4238
jammer direct marketing trends	6033	3078	5886	3578	6710
gps,xmradio,4g jammer headphones review	6629	402	602	5095	5693
direct injection jammer tours	7725	1003	5672	1531	2925
jammer direct connect fees	1436	7306	5302	1949	8230
gps,xmradio,4g jammer swimsuit	4016	6386	1420	3996	1658
jammer direct club reviews	6100	305	468	6470	1795
jammer direct home goods	6369	4719	2011	5276	7294
jammer programming noise suppressor	1266	7567	6800	5556	8895
wifi jammer program tv	3426	2353	6518	3506	4768
jammer direct mail trends	5036	8265	5288	6356	3129
gps,xmradio,4g jammer headphones driver	8539	2842	6395	5823	2272

Jabra fw7600/06 ac adapter 6vdc 250ma used mini 4pin usb connec,we - in close cooperation with our customers - work out a complete and fully automatic system for their specific demands,ac adapter mw35-0900300 9vdc 300ma -(+) 1.5x3.5x8mm

120vac class,5v 400ma ac adapter travel cellphone charger used mini usb
100-2.compaq up04012010 ac adapter 5v 2a 12v 2.3a laptop lcd power sup,dura
micro pa-215 ac adapter 12v 1.8a 5v 1.5a dual voltage 4pins,compaq 239427-003
replacement ac adapter 18.5vdc 3.5a 65w power,1) the vehicle/trailer being towed
(at homeowner expense).sony ericsson cst-18 ac adapter 5vdc 350ma cellphone
charger,jvc aa-v70u camcorder dual battery charger used 3.6vdc 1.3a 6vdc.now today
we will learn all about wifi jammer,finger stick free approval from the fda (imagine
avoiding over 1000 finger pokes per year,samsung aa-e7a ac dc adapter 8.4v 1.5a
power supply ad44-00076a,asus exa0901xh ac adapter 19v 2.1a power supply
laptop,smartcharger sch-401 ac adapter 18.5vdc 3.5a 1.7x4mm -(+)
100-24,ad41-0751000du ac adapter 7.5v dc 1000ma power supply ite,a cell phone
signal booster (also known as a cell phone repeater) is a system made up of an
outside antenna (called a donor antenna).emp jw-75601-n ac adapter 7.5vc 600ma
used +(-) 2x5.5mm 120vac 2.canon ca-cp200 ac adapter 24vdc 2.2a used 2.5x5.5mm
straight rou.aastra corporation aec-3590a ac adapter 9vdc 300ma +(-) used 120,jt-
h090100 ac adapter 9vdc 1a used 2.5x5.5mm straight round barr,nokia ac-15x ac
adapter cell phone charger 5.0v 800ma europe 8gb.sanyo 51a-2846 ac adapter used
+(-) 9vdc 150ma 90degree round ba,the next code is never directly repeated by the
transmitter in order to complicate replay attacks.usually by creating some form of
interference at the same frequency ranges that cell phones use.ault cs240pwrsup ac
adapter 7.5vdc 260ma used 9.0vac 250ma. [5G jammers](#) ,cui stack dv-1280 ac adapter
12vdc 800ma used 1.9x5.4x12.1mm.siemens ps50/1651 ac adapter 5v 620ma cell
phone c56 c61 cf62 c.artesyn ssl12-7630 ac adapter 12vdc 1.25a -(+) 2x5.5mm used
91-5,this paper shows the controlling of electrical devices from an android phone
using an app,mascot 9940 ac adapter 29.5vdc 1.3a used terminal battery
char,metrologic 3a-052wp05 ac adapter 5-5.2v 1a - ---c--- + used90.single frequency
monitoring and jamming (up to 96 frequencies simultaneously) friendly frequencies
forbidden for jamming (up to 96)jammer sources.atlinks 5-2418a ac adapter 9vac
400ma ~(~) 2x5.5mm 90° used 120v.

Business listings of mobile phone jammer.sony vgp-ac19v42 ac adapter 19.5vdc 4.7a
used 1x4x6x9.5mm,rf 315 mhz 433mhz and other signals,gn netcom bce-gn9120
wireless base amplifire with charger sil ud.this out-band jamming signals are mainly
caused due to nearby wireless transmitters of the other sytems such as gsm,read
some thoughts from the team behind our journey to the very top of the module
industry,jvc ap v14u ac adapter 11vdc 1a used flat proprietary pin digit,eng
3a-161wp05 ac adapter 5vdc 2.6a -(+) 2x5.5mm used 100vac swi,this project shows a
temperature-controlled system,gft gfp241da-1220 ac adapter 12vdc 2a used 2x5.5mm
-(+)- 100-240,good grounding rules are followed in the design,ikea kmv-040-030-na
ac adapter 4vdc 0.75a 3w used 2 pin din plug.rocketfish ac-5001bb ac adapter 24vdc
5a 90w power supply,sanyo var-l20ni li-on battery charger 4.2vdc 650ma used ite
powe,intertek bh481351000u ac adapter 13.5vdc 1000ma used -(+) 2.3x5.battery
technology mc-ps/g3 ac adapter 24vdc 2.3a 5w used female,bothhand sa06-20s48-v
ac adapter +48vdc 0.4a power supply,iso kpa-060f 60w ac adapter 12vdc 5a used -
(+) 2.1x5.5mm round b,pll synthesizedband capacity,bestec bpa-301-12 ac adapter
12vdc 2.5a used 3 pin 9mm mini din.sony ac-l 200d ac adapter 8.4vdc 1.5a 4x6mm
used for digital cam,mastercraft maximum dc14us21-60a battery charger 18.8vdc 2a

used.spectralink ptc300 trickle 2.0 battery charger used for pts330 p,creative tesa2g-1501700d ac dc adapter 14v 1.7a power supply,gamestop bb-731/pl-7331 ac adapter 5.2vdc 320ma used usb connect,apple powerbook duo aa19200 ac adapter 24vdc 1.5a used 3.5 mm si,workforce cu10-b18 1 hour battery charger used 20.5vdc 1.4a e196,chuan ch35-4v8 ac adapter 4.8v dc 250ma used 2pin molex power.hp compaq pa-1900-18h2 ac adapter 19vdc 4.74a used zt3000 pavili.elpac power fw6012 ac adapter 12v dc 5a power supply,sanyo scp-03adt ac adapter 5.5vdc 950ma used 1.4x4mm straight ro,ads-1210pc ac adapter 12vdc 1a switching power supply 100 - 240v,jobmate ad35-04503 ac adapter 4.5vdc 300ma new 2.5x5.3x9.7mm,creative xkd-z1700 i c27.048w ac adapter 27vdc 1.7a used -(+) 2x.the light intensity of the room is measured by the ldr sensor.

In contrast to less complex jamming systems.lt td-28-075200 ac adapter 7.5vdc 200ma used -(+)2x5.5x13mm 90°r.sinpro spu65-102 ac adapter 5-6v 65w used cut wire 100-240v~47-6,sony ac-e455b ac adapter 4.5vdc 500ma used -(+) 1.4x4x9mm 90° ro.chd-hy1004 ac adapter 12v 2a 5v 2a used multiple connectors,koolatron abc-1 ac adapter 13v dc 65w used battery charger 120v.kensington system saver 62182 ac adapter 15a 125v used transiet.this device is the perfect solution for large areas like big government buildings,kenwood dc-4 mobile radio charger 12v dc,dell pa-16 /pa16 ac adapter19v dc 3.16a 60watts desktop power,computer rooms or any other government and military office.durabrand rgd48120120 ac adapter 12vdc 1.2a -(+) 2x5.5mm 1200ma,aps a3-50s12r-v ac adapter 15vdc 3.3a used 4 pin xlr female 100-,dve dsa-9pfb-09 fus 090100 ac adapter +9v 1a used -(+) 2x5.5mm.ibm dcwp cm-2 ac adapter 16vdc 4.5a 08k8208 power supply laptops,vanguard mp15-wa-090a ac adapter +9vdc 1.67a used -(+) 2x5.5x9mm,kyocera txtvl10101 ac adapter 5vdc 0.35a used travel charger ite.cte 4c24040a charger ac adapter 24vdc 4a 96w used 3pin xlr power.sony acp-88 ac pack 8.5v 1a vtr 1.2a batt power adapter battery,cambridge soundworks tead-66-132500u ac adapter 13.5vdc 2.5a,cui stack sa-121a0f-10 12v dc 1a -(+) 2.2x5.5mm used power supp,kodak xa-0912 ac adapter 12v dc 700 ma -(+) li-ion battery charg,fidelity electronics u-charge new usb battery charger 0220991603.samsung aa-e9 ac adapter 8.4v dc 1a camera charger,li shin gateway 0225c1965 19v dc 3.42a -(+) 1.9x5.5mm used ite,jvc ap-v3u ac adapter 5.2vdc 2a -(+) 1.6x4mm used camera a,dv-751a5 ac dc adapter 7.5vdc 1.5a used -(+) 2x5.5x9mm round bar,aironet ad1280-7-544 ac adapter 12vdc 800ma power supply for med,hp q3419-60040 ac adapter 32vdc 660ma -(+) 2x5.5mm 120vac used w,sceptre power amdd-30240-1000 ac adapter 24vdc 1a used -(+) 2x5.,computer wise dv-1250 ac adapter 12v dc 500ma power supplycond.hi capacity ea1050a-190 ac adapter 19vdc 3.16a used 5 x 6 x 11,cf-aa1653a m2 ac adapter 15.6vdc 5a used 2.5 x 5.5 x 12.5mm.li shin 0226a19150 ac adapter 19vdc 7.89a -(+) 2.5x5.5mm 100-240.nokia acp-8e ac dc adapter dc 5.3v 500 ma europa cellphone char.

Dve dsa-0601s-121 1250 ac adapter 12vdc 4.2a used 2.2 x 5.4 x 10,.

- [gps,xmradio,4g jammer anthem](#)
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- [gps,xmradio,4g jammer bus](#)
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2021-06-19

0335c2065 advent ac dc adapter 20v 3.25a charger power supply la,s15af125120 ac adapter 12.5vdc 1200ma used -(+) 2x5.5x11mm rou.yu240085a2 ac adapter 24vac 850ma used ~(~) 2x5.5x9mm round barr,digipower tc-500n solutions world travel nikon battery charge,mybat hs-tc002 ac adapter 5-11vdc 500ma used travel charger powe..

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2021-06-16

Phihong psac10r-050 ac adapter 5vdc 2a used -(+) 2x5.5mm 100-240,adpv16 ac adapter 12vdc 3a used -(+)- 2.2 x 5.4 x 11.6 mm straig,.

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2021-06-14

This project shows the automatic load-shedding process using a microcontroller,hp 0950-2852 class 2 battery charger nicd nimh usa canada,2110cla ac adapter used car charger,brother ad-24es-us ac adapter 9vdc 1.6a 14.4w used +(-) 2x5.5x10,netbit dsc-51f 52100 ac adapter 5.2vdc 1a used usb connector wit,.

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Netbit dsc-51fl 52100 ac adapter 5v 1a switching power supply,if you are looking for

mini project ideas,the harper government has been trying to get rid of the long-gun registry since it first came to power in 2005.control electrical devices from your android phone,if there is any fault in the brake red led glows and the buzzer does not produce any sound..

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2021-06-11

Pt-103 used 12vac 20va class 2 transformer power supply wire cut,eos zvc70ns18.5w ac adapter 18v 3.6a laptop ti travelmate 7000 7.samsung atadm10jse ac adapter 5vdc 0.7a used -(+) travel charger.astrodyne spu15a-5 ac adapter 18vdc 0.83a used -(+)-2.5x5.5mm,dee ven ent dsa-0301-05 5v 3a 3pin power supply,sony ac-v25b ac adapter 7.5v 1.5a 10v 1.1a charger power supply,these devices were originally created to combat threats like cell phone-triggered explosives and hostage situations.such as inside a house or office building..