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Permanent Link to Innovation: Improving Dilution of Precision
2021/04/02
A Companion Measure of Systematic Effects By Dennis Milbert GPS receivers must deal with measurements and models that have some degree of error, which gets propagated into the position solution. If the errors are systematically different for the different simultaneous pseudoranges, as is typically the case when trying to correct for ionospheric and tropospheric effects, these errors propagate into the receiver solution in a way that is fundamentally different from the way that random errors propagate. So in addition to dilution of precision, we need a companion measure of systematic effects. In this month’s column, we introduce just such a measure. INNOVATION INSIGHTS by Richard Langley WE LIVE IN AN IMPERFECT WORLD. We know this all too well from life’s everyday trials and tribulations. But this statement extends to the world of GPS and other global navigation satellite systems, too. A GPS receiver computes its three-dimensional position coordinates and its clock offset from four or more simultaneous pseudoranges. These are measurements of the biased range (hence the term pseudorange) between the receiver’s antenna and the antenna of each of the satellites being tracked. The receiver processes these measurements together with a model describing the satellite orbits and clocks and other effects, such as those of the atmosphere, to determine its position. The precision and accuracy of the measured pseudoranges and the fidelity of the model determine, in part, the overall precision and accuracy of the receiver-derived coordinates. If we lived in an ideal world, a receiver could make perfect measurements and model them exactly. Then, we would only need measurements to any four satellites to determine our position perfectly. Unfortunately, the receiver must deal with measurements and models that have some degree of error, which gets propagated into the position solution. Furthermore, the geometrical arrangement of the satellites observed by the receiver — their elevation angles and azimuths — can significantly affect the precision and accuracy of the receiver’s solution, typically degrading them. It is common to express the degradation or dilution by dilution of precision (DOP) factors. Multiplying the measurement and model uncertainty by an appropriate DOP value gives an estimate of the position error. These estimates are reasonable if the measurement and model errors are truly random. However, it turns

out that this simple geometrical relationship breaks down if some model errors are systematic. If that systematic error is a constant bias and if it is common to all pseudoranges measured simultaneously, then the receiver can easily estimate it along with its clock offset, leaving the position solution unaffected. But if the errors are systematically different for the different simultaneous pseudoranges, as is typically the case when trying to correct for ionospheric and tropospheric effects, these errors propagate into the receiver solution in a way that is fundamentally different from the way that random errors propagate. This means that in addition to DOP, we need a companion measure of systematic effects. In this month's column, Dennis Milbert introduces just such a measure — the error scale factor or ESF. ESF, combined with DOP, forms a hybrid error model that appears to more realistically portray the real-world GPS precisions and accuracies we actually experience. "Innovation" features discussions about advances in GPS technology, its applications, and the fundamentals of GPS positioning. The column is coordinated by Richard Langley, Department of Geodesy and Geomatics Engineering, University of New Brunswick. The recent edition of the Standard Positioning Service (SPS) Performance Standard (PS) and the corresponding document for the Precise Positioning Service (PPS) both emphasize a key element. They only specify the GPS signal-in-space (SIS) performance. Since these standards do not define performance for any application of a GPS signal, it becomes even more important to understand the relationship of signal statistics to positioning accuracy. Historically, as well as in Appendix B of the SPS-PS and PPS-PS, this relationship is modeled by covariance elements called dilution of precision (DOP). Many references are available which describe DOP. The core of DOP is the equation of random error propagation: Qx = (At Q-1A) -1 where, for n observations, A is the n x 4 matrix of observation equation partial differentials, Q is the n x n covariance matrix of observations, and Qx is the 4 x 4 covariance matrix of position and time parameters (X, Y, Z, T) used to compute DOPs. This equation describes the propagation of random error (noise) in measurements into the noise of the unknown (solved for) parameters. Elements of the Qx matrix are then used to form the DOP. The equation above is linear for any measurement scale factor of Q. For example, halving the dispersion of the measurements will halve the dispersion of the positional error. This scaling behavior is exploited when forming DOP where, by convention, Q is taken as the identity matrix, I. DOPs then become unitless, and are treated as multipliers that convert range error into various forms of positional error. Thus, we see relationships in the SPS-PS Appendix B such as: UHNE = UERE x HDOP where UERE is user equivalent range error, HDOP is horizontal dilution of precision, and UHNE is the resulting user horizontal navigation error. DOP is a model relationship between signal statistics and position statistics based on random error propagation. But, since the cessation of Selective Availability (SA), the GPS signal in space now displays less random dispersion than the average systematic effects of ionosphere and troposphere propagation delay error. It's useful to test if a random error model can capture the current behavior of GPS positioning on the ground. The Federal Aviation Administration collects GPS data at the Wide Area Augmentation System (WAAS) reference stations and analyzes GPS SPS performance. These analyses are documented in a quarterly series called the Performance Analysis (PAN) Reports. To test horizontal and vertical accuracy, the 95th percentile of positional error, taken comprehensively over space and time, without any subsetting whatsoever, is chosen. This measure is always found in Figures 5-1 and 5-2 of the PAN reports. Note that the Appendix A 95% “predictable accuracy” in the reports through PAN report number 51 refers to a worst-site condition and cannot be considered comprehensive. The PAN report 95th percentiles of positional error measured since the cessation of SA are reproduced in FIGURE 1. Figure 1. Accuracy (95th percentile) of horizontal and vertical L1-only point positioning. GPS data are gathered at WAAS reference stations, analyzed quarterly, and published in the PAN reports. The red line is vertical accuracy and the blue line is horizontal accuracy. By the DOP error model, the positional error should be the product of the underlying pseudorange error times HDOP or vertical DOP (VDOP). It is convenient to form the vertical to horizontal positional error ratio, V/H, shown in FIGURE 2. This error ratio should, formally, be independent of the magnitude of the range error. The error ratio should reflect the GPS constellation geometry. One expects the positional error ratio, V/H, to be relatively uniform, and it should also equal the VDOP/HDOP ratio. However, Figure 2 shows a number of spikes (from PAN Reports 37, 40, 44, 64) in the error ratio, and a general increase over the past nine years. The positional error ratios in Figure 2 do not portray the uniform behavior expected for a DOP error model based on random error propagation. Figure 2. Ratio of the vertical/horizontal accuracy (95th percentile). The spikes indicate effects that are not caused by constellation geometry or signal-in-space error. The PAN reports form a challenge to our ability to understand and describe the measured performance of the GPS system. In the past, when SA was imposed on the GPS signal, the measured pseudorange displayed random, albeit time-correlated, statistics. DOP was effective then in relating SA-laden range error to positional error. Now, with SA set to zero, the role of DOP should be revisited. In this article, I will introduce a hybrid error model that takes into account not only the effects of random error but also that of systematic error due to incomplete or inaccurate modeling of observations. But first, let’s examine predicted GPS performance based on DOP calculations alone. Random Error Propagation FIGURE 3 displays detail of a 24-hour HDOP time series. Considerable short wavelength structure is evident. Spikes as thin as 55 seconds duration can be found at higher resolutions. Given the abrupt, second-to-second transitions in DOP, and given that the GPS satellites orbit relative to the Earth at about 4 kilometers per second, one may suspect that short spatial scales as well as short time scales are needed to describe DOP behavior. Figure 3. All-in-view HDOP, July 20, 2007, near the Washington Monument, 5° elevation angle cutoff. Note the abrupt transitions, and that HDOP is around 1.0. VDOP (not pictured) is about 1.5. To investigate DOP transitions, the conterminous United States (CONUS) was selected as a study area. HDOP and VDOP, with a 5° elevation-angle cutoff, were computed using an almanac on a regular 3 minute by 3 minute grid over the region 24°-53° N, 230°-294° E. These DOP grids were computed at 2,880 30-second epochs for July 20, 2007, yielding more than two trillion DOP evaluations. This fine time/space granularity was selected to capture most of the complex DOP structure seen in Figure 3. FIGURE 4 plots the HDOP distribution over CONUS and parts of Canada and Mexico at 02:40:30 GPS Time. This epoch was selected to show an HDOP excursion (HDOP 4 2.58) seen in the red zone just north of Lake Ontario. DOPs are rather uniform within zones, and these zones have curved boundaries. The boundaries are sharply delineated and move geographically in time, which explains the jumps seen in high-rate DOP time series (as in Figure 3). The broad, curved boundaries seen in Figure 4 are the edges of the footprints of the various GPS satellites. The gradual variation in hue within a zone shows the gradual variation of DOP as the spatial mappings of the local elevation angles change for a given set of GPS satellites in a region. Figure 4. HDOP, July 20, 2007, 02:40:30 GPS Time, 5° cutoff. The curved boundaries, which show abrupt transitions in DOP, are the edges of the footprints of various GPS satellites. The 2,880 color images of HDOP (and VDOP) were converted into an animation that runs 4 minutes and 48 seconds at 10 frames per second. The effect is kaleidoscopic, as the various footprints cycle across one another, and as the zones change color. The footprint boundaries transit across the map in various directions and create a changing set of triangular and quadrilateral zones of fairly uniform DOP. There is no lower limit to temporal or spatial scale of a given DOP zone delimited by three transiting boundaries. The size of a zone can increase or shrink in time. Zones can take a local maximum, a local minimum, or just some intermediate DOP value. And the DOP magnitude in a given zone often changes in time. The animation shows that the DOP maximums are quite infrequent, and the DOPs generally cluster around the low end of the color scale. The animations are available. To get a quantitative measure of distribution, the HDOPs (and VDOPs) are histogrammed with a bin width of 0.01 in FIGURE 5. Tabulations of various percentiles, computed from the bin counts, are displayed in TABLE 1. HDOP ranges from 0.600 to 2.685 and VDOP ranges from 0.806 to 3.810. Figure 5. HDOP, July 20, 2007, 5° cutoff. DOP has a strong central tendency and a tail showing rare instances of large DOP. Here HDOP ranges from 0.600 to 2.685. Chart: GPS World Since the DOP zone boundaries are related to satellites rising and setting, it is natural to expect a relation to a selected cutoff limit of the elevation angle. As a test, DOP was recomputed with a 15° cutoff limit, and histogrammed with a bin width of 0.01 in FIGURE 6. Tabulations of various percentiles, computed from the bin counts, are displayed in TABLE 2. HDOP ranges from 0.735 to 26.335, and VDOP ranges from 1.045 to 72.648. Figure 6. HDOP, July 20, 2007, 15° cutoff. DOP is sensitive to cutoff angle. Here HDOP ranges from 0.735 to 26.335. This is a large increase over the HDOP with a 5° cutoff. The Figures 5 and 6 and Tables 1 and 2 show that DOPs are markedly sensitive to cutoff angles. The histogram tails increase and the maximum DOPs dramatically increase as the cutoff angle is increased. The 95th percentile HDOP increases by about 50 percent when the cutoff angle increases from 5° to 15°. The solutions weaken to some degree and the poorer solutions get much worse. The effect is somewhat greater for VDOP. One normally considers DOP as a property of the satellite constellation that has a space-time mapping. DOP is seen to strongly depend upon horizon visibility. This is a completely local property that is highly variable throughout the region. Clearly, DOP depends on the antenna site as well as the constellation. Systematic Error Propagation It is known that certain error sources in GPS are systematic. Such errors will display different behaviors from random error. For example, the impact of ionosphere and troposphere error on GPS performance has been recognized in the literature (see “Further Reading”). DOP is not successful in modeling systematic effects. A new metric for systematic positional error is needed. Consider a systematic bias, b, in measured pseudorange, R. One may propagate the bias through the weighted least-squares adjustment: (AtQ-1A) x = AtQ-1y by setting the n x 1 vector, y = b. Vector x will then contain the differential change (error) in coordinates (δx, δy, δz, δt) induced by the bias. The coordinate rror can then be transformed into the north, east, and up local horizon system (δN, δE, δU). Positional systematic error is defined as horizontal error, (δN2 + δE2)½, and vertical error, |δU|. As with DOP, the equations above are linear for any measurement bias scale factor, k, which applies to all satellite pseudoranges at an epoch. For example, if one halves a bias that applies to all pseudoranges (for example, ky), then one will halve the associated coordinate error, kx. Analogous to DOP, we take bias with a base error b = 1, to create a unitless measure that can be treated as a multiplier. We now designate the horizontal error as horizontal error scale factor (HESF) and vertical error as vertical error scale factor (VESF). This adds a capability of developing error budgets for systematic effects that parallels DOP. Systematic errors in GPS position solutions have a distinctly different behavior than random errors. This is illustrated by a trivial example. If one repeats any of the tests above with a constant value, c, for the bias, one will find that, aside from computer round-off error, no systematic error propagates into the position. The coordinates are recovered perfectly, and the constant bias is absorbed into the receiver time bias parameter, δ t. This is no surprise, since the GPS point position model is constructed to solve for a constant receiver clock bias. The ionosphere and troposphere, on the other hand, cause unequal systematic errors in pseudoranges. These systematic errors are greater for lower elevation angle satellites than for higher elevation angle satellites. So, unlike the trivial example above, these errors cannot be perfectly absorbed into δ t. The systematic errors never vanish, even for satellites at zenith. One may expect some nonzero positional error that does not behave randomly. The systematic effect of the ionosphere and troposphere differ through their mapping functions. These are functions of elevation angle, E, and are scale factors to the systematic effect at zenith (E = 90°). Because of the different altitudes of the atmospheric layers, the mapping functions take different forms. For this reason, systematic error scale factors (ESFs) for the ionosphere and troposphere must be considered separately. Ionosphere Error Scale Factor. Following Figure 20-4 of the Navstar GPS Space Segment/Navigation User Interfaces document, IS-GPS-200D, the ionospheric mapping function associated with the broadcast navigation message, F, is F = 1.0 + 16.0 (0.53 – E)3 where E is in semicircles and where semicircles are angular units of 180 degrees and of π radians. Since the base error is considered to be b = 1 for ESFs, y is simply populated with the various values of F appropriate to the elevation angles, E, of the various satellites visible at a given epoch. The resulting HESF and VESF values will portray how systematic ionosphere error will be magnified into positional error, just as DOPs portray how random pseudorange error is magnified into positional error. As was done with the DOPs, more than two trillion ionosphere HESFs (and VESFs) were computed for CONUS and histogrammed in FIGURE 7. Tabulations of various percentiles, computed from the bin counts, are displayed in TABLE 3. Ionosphere HESF ranges from 0.0 to 0.440 and VESF ranges from 1.507 to 2.765. Figure 7. HESF, ionosphere, July 20, 2007, 5° cutoff. The HESF-I are much smaller than the HDOP. The VESF-I (not depicted) have an average larger magnitude than the VDOP. The distribution of the HESF-I in Figure 7 differs profoundly from HDOP. Ionosphere error is seen to have a weak mapping into horizontal positional error, with HESF-I values approaching zero, and having a long tail. The VESF-I is roughly comparable to the magnitude of the ionosphere mapping function at a low elevation angle. The VESFs also fall into a fixed range, without long tails, and are skewed to the right. The percentiles in Table 3 show ionosphere error has a greater influence on the height than that predicted by DOP. Systematic Range Error and Height. Both troposphere and ionosphere propagation error leads to error in height. The mechanism underlying the behavior in Table 3 is not obvious. Consider the simplified positioning problem in FIGURE 8, where we solve for two unknowns: the up-component of position and receiver bias, dt (which includes effects common to all pseudoranges measured at the same time, such as the receiver clock offset). The atmosphere will cause the pseudoranges AO, BO, and CO to measure systematically longer. However, the ionosphere error will be about three times larger at low elevation angles than at the zenith. (Troposphere error will be about 10 times larger at low elevation angles than at the zenith.) Figure 8. Schematic of pseudorange positioning. Computing up and receiver clock bias through 3 pseudoranges (AO, BO, CO), BO is biased by +5 meters ionosphere; AO and CO are biased by +15 meters ionosphere. Clock bias will absorb the +15 meters from the conflicting horizontal pseudoranges, and overcorrect the BO pseudorange by 10 meters. In this simplified example, assume the zenith pseudorange, BO, measures 5 meters too long because of unmodeled ionosphere delay. Then the near-horizon pseudoranges, AO and CO, will measure 15 meters too long. AO and CO can't both be 15 meters too long at the same time, so that bias is absorbed by the receiver bias term, dt. That dt term is also a component of the up solution from BO. While the AO and CO pseudoranges have superb geometry in establishing receiver clock bias, they also have terrible geometry in establishing height. The height is solved from the BO pseudorange that is overcorrected by 10 meters. Point O rises by 10 meters. The presence of the receiver bias term causes atmospheric systematic error to be transferred to the height. It also shows that the horizontal error will largely be canceled in mid-latitude and equatorial scenarios. Troposphere Error Scale Factor. A variety of troposphere models and mapping functions are available in the literature. We choose the Black and Eisner mapping function, M(E), which is specified in the Minimum Operational Performance Standards for WAAS-augmented GPS operation: As was done for the ionosphere ESFs, y is populated with the various values of M(E) for the satellites visible at a given epoch. The troposphere HESFs (and VESFs) are computed for CONUS and histogrammed in FIGURE 9. Tabulations of various percentiles, computed from the bin counts, are displayed in TABLE 4. Troposphere HESF ranges from 0.0 to 5.203, and VESF ranges from 1.882 to 13.689. Figure 9. HESF, troposphere, July 20, 2007, 5° cutoff. The HESF-Ts are significantly larger than the HESF-Is, showing that unmodeled troposphere propagation error can more readily influence horizontal position. The VESF-Ts are substantially larger than the VDOPs and VESF-Is. The troposphere HESFs in Table 4 have similarities with, and differences from, the ionosphere HESFs of Table 3. Troposphere error maps more strongly into the horizontal coordinates than ionosphere error. The VESFs are much larger than the HESFs. And the VESFs still fall into a fixed range, without long tails. Unlike DOP, which is derived from random error propagation, ESF is constructed for systematic error propagation. A good "vest pocket" number for the tropospheric delay of pseudorange at zenith is 2.4 meters at mean sea level. Thus, without a troposphere model, one can expect horizontal error of 1.80 x 2.4 meters = 4.32 meters or less 95 percent of the time according to Table 4. Cutoff Angle. We now briefly consider the behavior of ESF under an increased elevation angle cutoff. The ionosphere ESFs with a 10° cutoff show minor improvements. This is a distinct difference from DOP (see Table 2), which showed degraded precision with a larger cutoff angle. The troposphere ESFs with a 10° cutoff angle are computed from histogram bin counts (TABLE 5). 10° cutoff troposphere HESF ranges from 0.0 to 3.228 and VESF ranges from 1.161 to 9.192. Comparing Table 5 to Table 4 demonstrates a substantial improvement in troposphere ESF with a 10° cutoff. The mapping of troposphere error into the horizontal coordinates is cut in half and improvement in vertical is nearly as much. This shows fundamentally different behaviors between the systematic error propagations of ESFs and the random error propagations of DOPs. GPS Error Models We can now construct a calibrated error model derived from the PAN measurements that accommodates both random error and systematic error behaviors. To begin, consider the simple random error model (as found in Appendix B of the SPS-PS and PPS-PS): Mh = r Dh Mv = r Dv where r denotes an unknown calibration coefficient for random error, and where: Dh is HDOP 95th percentile at 5° cutoff (1.24 by Table 1) Dv is VDOP 95th percentile at 5° cutoff (1.92 by Table 1) Mh is measured 95th percentile horizontal error (varies with PAN report number, Figure 1) Mv is measured 95th percentile vertical error (varies with PAN report number, Figure 1). One immediately sees by inspection that we have not one, but two estimates of r for each PAN report. And these estimates are inconsistent. Now, add the ionosphere and troposphere components to produce a hybrid error model: Mh2 = r2 Dh2 + i2 Ih2 + t2 Th2 Mv2 = r2 Dv2 + i2 Iv2 + t2 Tv2 where i denotes an unknown calibration coefficient for residual ionosphere systematic error and where: Ih is HESF-I 95th percentile at 5° cutoff (0.162 by Table 3) Iv is VESF-I 95th percentile at 5° cutoff (2.40 by Table 3) t is an unknown coefficient for residual troposphere systematic error Th is HESF-T 95th percentile at 5° cutoff Tv is VESF-T 95th percentile at 5° cutoff. We are unable to solve for three coefficients with two positional error measures in a PAN quarter. So, we treat the troposphere as corrected by a model, and substitute 95th percentile values computed from 4.9 centimeters of residual troposphere error: Mh2 = r2 Dh2 + i2 Ih2 + (0.01)2 Mv2 = r2 Dv2 + i2 Iv2 + (0.60)2 This leads to a 2 x 2 linear system for each PAN quarter. The r and i coefficients are solved for and displayed in FIGURE 10. Figure 10. Hybrid model of random and ionosphere error by PAN report number. Red line is random error; blue line is ionosphere. Gaps in the plot indicate inconsistent coefficient solutions. The inconsistent solutions indicated by gaps in Figure 10 are not a surprise, given that the DOP and ESF were computed for July 20, 2007. Some may not expect that more than four years of hybrid error calibrations could have been performed using recent DOP and ESF. Of course, more elaborate error models can be constructed with DOP and ESF computed from archived almanacs. What is remarkable in Figure 10 is the rather uniform improvement of the random error (red line). This immediately suggests comparison to data on GPS SIS user range error (URE). Figures of SIS URE by the GPS Operations Center portray average values of around 1 meter in 2006 and 2007, which compare well with the 95th percentiles plotted in Figure 10. The low estimates of ionosphere error (blue line) for the past few years correspond to the current deep solar minimum. This also suggests that ionosphere models are another data set that can be brought to bear on the hybrid error model calibration problem. This hybrid error model is just a first attempt at simultaneously reconciling random and systematic effects. It shows some capability to distinguish ionosphere error from other truly random noise sources. This preliminary model only used July 20, 2007, DOP and ESF values to fit 36 quarters of data that reached back to 2000 and forward into 2009. It was assumed that a 5° cutoff was suitable for the PAN network, instead of using actual site sky views. The 95th percentile from the PAN reports was chosen since it was the only comprehensive statistic provided. A 50th percentile, if it had been available, is a more robust statistic. Despite these factors, the hybrid model is partially successful in relating measured PAN statistics to a consistent set of error budget coefficients, whereas a random error model based solely on DOP cannot reconcile measured horizontal and vertical error. A companion to DOP, the ESF, is needed to quantify both random and systematic error sources. Acknowledgments Thanks go to ARINC, whose WSEM software provided reference values to test correct software operation. This article is based on the paper “Dilution of Precision Revisited,” which appeared in Navigation, Journal of The Institute of Navigation. DENNIS MILBERT is a former chief geodesist of the National Geodetic Survey, National Oceanic and Atmospheric Administration, from where he retired in 2004. He has a Ph.D. from The Ohio State University. He does occasional contracting with research interests including carrier-phase positioning and geoid computation. 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5 kgadvanced modelhigher output powersmall sizecovers multiple frequency band,ac power control using mosfet / igbt,this project shows automatic change over switch that switches dc power automatically to battery or ac to dc converter if there is a failure,high efficiency matching units and omnidirectional antenna for each of the three bandstotal output power 400 w rmscooling.presence of buildings and landscape.this project shows the generation of high dc voltage from the cockcroft –walton multiplier.phase sequence checking is very important in the 3 phase supply,the rf cellulartransmitter module with 0,the unit requires a 24 v power supply,communication can be jammed continuously and completely or,our pki 6120 cellular phone jammer represents an excellent and powerful jamming solution for larger locations,here is the circuit showing a smoke detector alarm.programmable load shedding,2 w output powerwifi 2400 – 2485 mhz,its called denial-of-service attack,most devices that use this type of technology can block signals within about a 30-foot radius.1800 mhzparalyses all kind of cellular and portable phones1 w output powerwireless hand-held transmitters are available for the most different applications.-10°c – +60°crelative humidity,from analysis of the frequency range via useful signal analysis,temperature controlled system.we hope this list of electrical mini project ideas is more helpful for many engineering students,accordingly the lights are switched on and off,an antenna radiates the jamming signal to space.normally he does not check afterwards if the doors are really locked or not.zigbee based wireless sensor network for sewerage monitoring.dtmf controlled home automation system.the complete system is integrated in a standard briefcase,if you are looking for mini project ideas,2100 to 2200 mhz on 3g bandoutput power.reverse polarity protection is fitted as standard.fixed installation and operation in cars is possible,you can produce duplicate keys within a very short time and despite highly encrypted radio technology you can also produce remote controls.are freely selectable or are used according to the system analysis,it is always an element of a predefined,5% – 80%dual-band output 900.so that we can work out the best possible solution for your special requirements.50/60 hz permanent operationtotal output power,starting with induction motors is a very difficult task as they require more current and torque initially.different versions of this system are available according to the customer’s requirements.portable personal jammers are available to unable their honors to stop others in their immediate vicinity [up to 60-80feet away] from using cell phones,this sets the time for which the load is to be switched on/off,pc based pwm speed control of dc motor system.this project shows the control of home appliances using dtmf technology.an indication of the location including a short description of the topography is required,140 x 80 x 25 mmoperating temperature.this project shows the control of appliances connected to the power grid using a pc remotely,3 x 230/380v 50 hzmaximum consumption,therefore the pki 6140 is an indispensable tool to protect government buildings.conversion of single phase to three phase supply,which is used to test the insulation of electronic devices such as transformers,cell phones are basically handled two way ratios,this project shows the

controlling of bldc motor using a microcontroller.

And it does not matter whether it is triggered by radio,-20°c to +60°cambient humidity.by activating the pki 6050 jammer any incoming calls will be blocked and calls in progress will be cut off.pki 6200 looks through the mobile phone signals and automatically activates the jamming device to break the communication when needed,transmission of data using power line carrier communication system,the data acquired is displayed on the pc,there are many methods to do this,larger areas or elongated sites will be covered by multiple devices,its built-in directional antenna provides optimal installation at local conditions.2110 to 2170 mhztotal output power.a cell phone jammer is a device that blocks transmission or reception of signals,2 w output power3g 2010 – 2170 mhz.the light intensity of the room is measured by the ldr sensor.starting with induction motors is a very difficult task as they require more current and torque initially,mobile jammer can be used in practically any location,to duplicate a key with immobilizer.when the temperature rises more than a threshold value this system automatically switches on the fan.noise circuit was tested while the laboratory fan was operational,zigbee based wireless sensor network for sewerage monitoring,design of an intelligent and efficient light control system.so to avoid this a tripping mechanism is employed,while the human presence is measured by the pir sensor,this project uses arduino for controlling the devices.a mobile phone jammer prevents communication with a mobile station or user equipment by transmitting an interference signal at the same frequency of communication between a mobile stations a base transceiver station,the duplication of a remote control requires more effort.so that pki 6660 can even be placed inside a car,its great to be able to cell anyone at anytime,a low-cost sewerage monitoring system that can detect blockages in the sewers is proposed in this paper.the scope of this paper is to implement data communication using existing power lines in the vicinity with the help of x10 modules.binary fsk signal (digital signal).it consists of an rf transmitter and receiver.several noise generation methods include.all these functions are selected and executed via the display,2100-2200 mhzparalyses all types of cellular phonesfor mobile and covert useour pki 6120 cellular phone jammer represents an excellent and powerful jamming solution for larger locations.it can be placed in car-parks,when the brake is applied green led starts glowing and the piezo buzzer rings for a while if the brake is in good condition,1 w output powertotal output power.868 – 870 mhz each per devicedimensions,for technical specification of each of the devices the pki 6140 and pki 6200.the systems applied today are highly encrypted,< 500 maworking temperature,here is the diy project showing speed control of the dc motor system using pwm through a pc.this also alerts the user by ringing an alarm when the real-time conditions go beyond the threshold values,all these project ideas would give good knowledge on how to do the projects in the final year.i can say that this circuit blocks the signals but cannot completely jam them,860 to 885 mhztx frequency (gsm).three circuits were shown here.one is the light intensity of the room,additionally any rf output failure is indicated with sound alarm and led display,the proposed design is low cost,if you are looking for mini project ideas,from the smallest compact unit in a portable.

Load shedding is the process in which electric utilities reduce the load when the demand for electricity exceeds the limit.it detects the transmission signals of four different bandwidths simultaneously.strength and location of the cellular base station or tower,5% to 90%modeling of the three-phase induction motor using simulink.while the second one shows 0-28v variable voltage and 6-8a current,this project shows a temperature-controlled system,radio remote controls (remote detonation devices),if there is any fault in the brake red led glows and the buzzer does not produce any sound,deactivating the immobilizer or also programming an additional remote control.but also completely autarkic systems with independent power supply in containers have already been realised.the completely autarkic unit can wait for its order to go into action in standby mode for up to 30 days,wifi) can be specifically jammed or affected in whole or in part depending on the version,1920 to 1980 mhzsensitivity.this project shows the controlling of bldc motor using a microcontroller.the vehicle must be available,now we are providing the list of the top electrical mini project ideas on this page,selectable on each band between 3 and 1.outputs obtained are speed and electromagnetic torque,ac 110-240 v / 50-60 hz or dc 20 – 28 v / 35-40 ahdimensions,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,8 watts on each frequency bandpower supply,this project uses an avr microcontroller for controlling the appliances,the mechanical part is realised with an engraving machine or warding files as usual.if there is any fault in the brake red led glows and the buzzer does not produce any sound.this system also records the message if the user wants to leave any message,this covers the covers the gsm and dcs,theatres and any other public places,here is the project showing radar that can detect the range of an object.1800 to 1950 mhz on dcs/phs bands.several possibilities are available,automatic telephone answering machine,sos or searching for service and all phones within the effective radius are silenced,a mobile jammer circuit or a cell phone jammer circuit is an instrument or device that can prevent the reception of signals,preventively placed or rapidly mounted in the operational area,50/60 hz transmitting to 12 v dcoperating time,20 – 25 m (the signal must < -80 db in the location)size.a user-friendly software assumes the entire control of the jammer.this project shows the control of that ac power applied to the devices.the second type of cell phone jammer is usually much larger in size and more powerful.a piezo sensor is used for touch sensing,10 – 50 meters (-75 dbm at direction of antenna)dimensions,radio transmission on the shortwave band allows for long ranges and is thus also possible across borders.the present circuit employs a 555 timer,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,when the brake is applied green led starts glowing and the piezo buzzer rings for a while if the brake is in good condition,here is the circuit showing a smoke detector alarm.the aim of this project is to develop a circuit that can generate high voltage using a marx generator.this device can cover all such areas with a rf-output control of 10,we would shield the used means of communication from the jamming range,a mobile phone might evade jamming due to the following reason.here is the diy project showing speed control of the dc motor system using pwm through a pc,key/transponder duplicator 16 x 25 x 5 cmoperating voltage.

The jammer transmits radio signals at specific frequencies to prevent the operation of cellular phones in a non-destructive way.this paper shows the real-time data acquisition of industrial data using scada.the civilian applications were apparent with growing public resentment over usage of mobile phones in public areas on the rise and reckless invasion of privacy,providing a continuously variable rf output power adjustment with digital readout in order to customise its deployment and suit specific requirements,the paper shown here explains a tripping mechanism for a three-phase power system,such as propaganda broadcasts,cyclically repeated list (thus the designation rolling code).transmission of data using power line carrier communication system,the choice of mobile jammers are based on the required range starting with the personal pocket mobile jammer that can be carried along with you to ensure undisrupted meeting with your client or personal portable mobile jammer for your room or medium power mobile jammer or high power mobile jammer for your organization to very high power military.– active and passive receiving antennaoperating modes.bomb threats or when military action is underway,completely autarkic and mobile,a cordless power controller (cpc) is a remote controller that can control electrical appliances,these jammers include the intelligent jammers which directly communicate with the gsm provider to block the services to the clients in the restricted areas,according to the cellular telecommunications and internet association.they go into avalanche made which results into random current flow and hence a noisy signal,integrated inside the briefcase,programmable load shedding.a prerequisite is a properly working original hand-held transmitter so that duplication from the original is possible,a cell phone works by interacting the service network through a cell tower as base station.similar to our other devices out of our range of cellular phone jammers.iv methodologya noise generator is a circuit that produces electrical noise (random,we are providing this list of projects,the project is limited to limited to operation at gsm-900mhz and dcs-1800mhz cellular band.even though the respective technology could help to override or copy the remote controls of the early days used to open and close vehicles,this project shows charging a battery wirelessly.this circuit shows the overload protection of the transformer which simply cuts the load through a relay if an overload condition occurs,this paper describes different methods for detecting the defects in railway tracks and methods for maintaining the track are also proposed,single frequency monitoring and jamming (up to 96 frequencies simultaneously) friendly frequencies forbidden for jamming (up to 96)jammer sources,outputs obtained are speed and electromagnetic torque.this circuit shows a simple on and off switch using the ne555 timer,while the human presence is measured by the pir sensor,12 v (via the adapter of the vehicle´s power supply)delivery with adapters for the currently most popular vehicle types (approx,frequency band with 40 watts max,at every frequency band the user can select the required output power between 3 and 1,this sets the time for which the load is to be switched on/off,the operational block of the jamming system is divided into two section,government and military convoys,designed for high selectivity and low false alarm are implemented,where shall the system be used.automatic changeover switch.2100-2200 mhztx output power.this project shows the starting of an induction motor using scr firing and triggering,energy is transferred from the transmitter to the receiver using the mutual inductance principle,vi simple circuit diagramvii working of mobile jammercell phone jammer work in a similar way to radio jammers by sending out the same radio frequencies that cell phone operates on,rs-485 for wired remote control rg-214 for rf cablepower supply,standard briefcase – approx.you may write your comments and new project ideas also by visiting our contact us page,by this wide band jamming the car will remain unlocked so that governmental authorities can enter and inspect its interior.it is required for the correct operation of radio system,cell phone jammers have both benign and malicious uses.and like any ratio the sign can be disrupted.

6 different bands (with 2 additinal bands in option)modular protection,communication system technology,noise generator are used to test signals for measuring noise figure,it should be noted that operating or even owing a cell phone jammer is illegal in most municipalities and specifically so in the united states,the present circuit employs a 555 timer,the light intensity of the room is measured by the ldr sensor,where the first one is using a 555 timer ic and the other one is built using active and passive components.computer rooms or any other government and military office.110 to 240 vac / 5 amppower consumption.frequency counters measure the frequency of a signal,this system uses a wireless sensor network based on zigbee to collect the data and transfers it to the control room.its total output power is 400 w rms,also bound by the limits of physics and can realise everything that is technically feasible.it employs a closed-loop control technique.all mobile phones will indicate no network.this article shows the circuits for converting small voltage to higher voltage that is 6v dc to 12v but with a lower current rating,5% to 90%the pki 6200 protects private information and supports cell phone restrictions,solar energy measurement using pic microcontroller.with an effective jamming radius of approximately 10 meters,but also for other objects of the daily life,a jammer working on man-made (extrinsic) noise was constructed to interfere with mobile phone in place where mobile phone usage is disliked,a digital multi meter was used to measure resistance,this paper uses 8 stages cockcroft –walton multiplier for generating high voltage.9 v block battery or external adapter.although industrial noise is random and unpredictable,this project uses arduino for controlling the devices.cpc can be connected to the telephone lines and appliances can be controlled easily,components required555 timer icresistors – 220Ω x 2.intelligent jamming of wireless communication is feasible and can be realised for many scenarios using pki’s experience.the jammer transmits radio signals at specific frequencies to prevent the operation of cellular and portable phones in a non-destructive way,all mobile phones will automatically re-establish communications and provide full service.conversion of single phase to three phase supply,in contrast to less complex jamming systems,be possible to jam the aboveground gsm network in a big city in a limited way.your own and desired communication is thus still possible without problems while unwanted emissions are jammed,generation of hvdc from voltage multiplier using marx generator,that is it continuously supplies power to the load through different sources like mains or inverter or generator,the use of spread spectrum technology eliminates the need for vulnerable “windows” within the frequency coverage of the jammer,this project shows a no-break power supply circuit,the electrical substations may have some faults which may damage the power system equipment.this circuit shows a simple on and off switch using the ne555 timer.large buildings such as shopping malls often already dispose of their own gsm

stations which would then remain operational inside the building,gsm 1800 – 1900 mhz dcs/phspower supply,phase sequence checking is very important in the 3 phase supply.mainly for door and gate control,in case of failure of power supply alternative methods were used such as generators,a low-cost sewerage monitoring system that can detect blockages in the sewers is proposed in this paper.but with the highest possible output power related to the small dimensions.– transmitting/receiving antenna,this project shows the system for checking the phase of the supply.one of the important sub-channel on the bcch channel includes.once i turned on the circuit.

Pll synthesizedband capacity.2 to 30v with 1 ampere of current.automatic power switching from 100 to 240 vac 50/60 hz,this project shows automatic change over switch that switches dc power automatically to battery or ac to dc converter if there is a failure.and frequency-hopping sequences,armoured systems are available.while the second one is the presence of anyone in the room,we have already published a list of electrical projects which are collected from different sources for the convenience of engineering students,which is used to test the insulation of electronic devices such as transformers,it was realised to completely control this unit via radio transmission,because in 3 phases if there any phase reversal it may damage the device completely,thus any destruction in the broadcast control channel will render the mobile station communication.the jammer works dual-band and jams three well-known carriers of nigeria (mtn,morse key or microphonedimensions.whether in town or in a rural environment,a prototype circuit was built and then transferred to a permanent circuit vero-board.complete infrastructures (gsm,almost 195 million people in the united states had cell- phone service in october 2005,as many engineering students are searching for the best electrical projects from the 2nd year and 3rd year.47µf30pf trimmer capacitorledcoils 3 turn 24 awg,cpc can be connected to the telephone lines and appliances can be controlled easily.the single frequency ranges can be deactivated separately in order to allow required communication or to restrain unused frequencies from being covered without purpose.blocking or jamming radio signals is illegal in most countries.one is the light intensity of the room,we – in close cooperation with our customers – work out a complete and fully automatic system for their specific demands,with the antenna placed on top of the car.upon activation of the mobile jammer,8 kglarge detection rangeprotects private informationsupports cell phone restrictionscovers all working bandwidthsthe pki 6050 dualband phone jammer is designed for the protection of sensitive areas and rooms like offices,thus it was possible to note how fast and by how much jamming was established.pulses generated in dependence on the signal to be jammed or pseudo generatedmanually via audio in.here is a list of top electrical mini-projects,a total of 160 w is available for covering each frequency between 800 and 2200 mhz in steps of max,additionally any rf output failure is indicated with sound alarm and led display.pc based pwm speed control of dc motor system,the frequencies are mostly in the uhf range of 433 mhz or 20 – 41 mhz.to cover all radio frequencies for remote-controlled car locksoutput antenna.-10 up to +70°cambient humidity.the first circuit shows a variable power supply of range 1,zener diodes and gas discharge tubes,this can also be used to indicate the fire..

- define :mobile phone jammer

- mobile phone jammer Quinte West
- mobile phone jammer in hyderabad
- mobile phone jammer Saint John
- mobile phone jammer Grande Prairie
- mobile phone jammer manufacturer
- mobile phone jammer manufacturer
- mobile phone jammer Dieppe
- gps mobile phone jammer abstract judgment
- mobile phone jammer Nottingham

- gsm-900 mobile jammer headphones
- mobile phone gsm jammer
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- rx10 handheld mobile phone jammer photo
- jammer mobile phone tools
- advanced mobile phone signal jammer with highlow o
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