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Permanent Link to Innovation: Getting at the Truth
2021/03/10
A Civilian GPS Position Authentication System By Zhefeng Li and Demoz Gebre-Egziabher INNOVATION INSIGHTS by Richard Langley MY UNIVERSITY, the University of New Brunswick, is one of the few institutes of higher learning still using Latin at its graduation exercises. The president and vice-chancellor of the university asks the members of the senate and board of governors present “Placetne vobis Senatores, placetne, Gubernatores, ut hi supplicatores admittantur?” (Is it your pleasure, Senators, is it your pleasure, Governors, that these supplicants be admitted?). In the Oxford tradition, a supplicant is a student who has qualified for their degree but who has not yet been admitted to it. Being a UNB senator, I was familiar with this usage of the word supplicant. But I was a little surprised when I first read a draft of the article in this month’s Innovation column with its use of the word supplicant to describe the status of a GPS receiver. If we look up the definition of supplicant in a dictionary, we find that it is “a person who makes a humble or earnest plea to another, especially to a person in power or authority.” Clearly, that describes our graduating students. But what has it got to do with a GPS receiver? Well, it seems that the word supplicant has been taken up by engineers developing protocols for computer communication networks and with a similar meaning. In this case, a supplicant (a computer or rather some part of its operating system) at one end of a secure local area network seeks authentication to join the network by submitting credentials to the authenticator on the other end. If authentication is successful, the computer is allowed to join the network. The concept of supplicant and authenticator is used, for example, in the IEEE 802.1X standard for port-based network access control. Which brings us to GPS. When a GPS receiver reports its position to a monitoring center using a radio signal of some kind, how do we know that the receiver or its associated communications unit is telling the truth? It’s not that difficult to generate false position reports and mislead the monitoring center into believing the receiver is located elsewhere — unless an authentication procedure is used. In this month’s column, we look at the development of a clever system that uses the concept of supplicant and authenticator to assess the truthfulness of position

reports. “Innovation” is a regular feature that discusses advances in GPS technology andits 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. Contact him at lang @ unb.ca. This article deals with the problem of position authentication. The term “position authentication” as discussed in this article is taken to mean the process of checking whether position reports made by a remote user are truthful (Is the user where they say they are?) and accurate (In reality, how close is a remote user to the position they are reporting?). Position authentication will be indispensable to many envisioned civilian applications. For example, in the national airspace of the future, some traffic control services will be based on self-reported positions broadcast via ADS-B by each aircraft. Non-aviation applications where authentication will be required include tamper-free shipment tracking and smart-border systems to enhance cargo inspection procedures at commercial ports of entry. The discussions that follow are the outgrowth of an idea first presented by Sherman Lo and colleagues at Stanford University (see Further Reading). For illustrative purposes, we will focus on the terrestrial application of cargo tracking. Most of the commercial fleet and asset tracking systems available in the market today depend on a GPS receiver installed on the cargo or asset. The GPS receiver provides real-time location (and, optionally, velocity) information. The location and the time when the asset was at a particular location form the tracking message, which is sent back to a monitoring center to verify if the asset is traveling in an expected manner. This method of tracking is depicted graphically in FIGURE 1. FIGURE 1. A typical asset tracking system. The approach shown in Figure 1 has at least two potential scenarios or fault modes, which can lead to erroneous tracking of the asset. The first scenario occurs when an incorrect position solution is calculated as a result of GPS RF signal abnormalities (such as GPS signal spoofing). The second scenario occurs when the correct position solution is calculated but the tracking message is tampered with during the transmission from the asset being tracked to the monitoring center. The first scenario is a falsification of the sensor and the second scenario is a falsification of the transmitted position report. The purpose of this article is to examine the problem of detecting sensor or report falsification at the monitoring center. We discuss an authentication system utilizing the white-noise-like spreading codes of GPS to calculate an authentic position based on a snapshot of raw IF signal from the receiver. Using White Noise as a Watermark The features for GPS position authentication should be very hard to reproduce and unique to different locations and time. In this case, the authentication process is reduced to detecting these features and checking if these features satisfy some time and space constraints. The features are similar to the well-designed watermarks used to detect counterfeit currency. A white-noise process that is superimposed on the GPS signal would be a perfect watermark signal in the sense that it is impossible reproduce and predict. FIGURE 2 is an abstraction that shows how the above idea of a superimposed white-noise process would work in the signal authentication problem. The system has one transmitter, Tx , and two receivers, Rs and Ra. Rs is the supplicant and Ra is the authenticator. The task of the authenticator is to determine whether the supplicant is using a signal from Tx or is being spoofed by a malicious transmitter, Tm. Ra is the trusted source, which gets a copy of the authentic signal, Vx(t) (that is, the signal transmitted by Tx). The snapshot signal, Vs(t), received at Rs is sent to the trusted agent to compare with the signal, Va(t), received at Ra. Every time a verification is performed, the snapshot signal from Rs is compared with a piece of the signal from Ra. If these two pieces of signal match, we can say the snapshot signal from Rs was truly transmitted from Tx. For the white-noise signal, match detection is accomplished via a cross-correlation operation (see Further Reading). The cross-correlation between one white-noise signal and any other signal is always zero. Only when the correlation is between the signal and its copy will the correlation have a non-zero value. So a non-zero correlation means a match. The time when the correlation peak occurs provides additional information about the distance between Ra and Rs. Unfortunately, generation of a white-noise watermark template based on a mathematical model is impossible. But, as we will see, there is an easy-to-use alternative. FIGURE 2. Architecture to detect a snapshot of a white-noise signal. An Intrinsic GPS Watermark The RF carrier broadcast by each GPS satellite is modulated by the coarse/acquisition (C/A) code, which is known and which can be processed by all users, and the encrypted P(Y) code, which can be decoded and used by Department of Defense (DoD) authorized users only. Both civilians and DoD-authorized users see the same signal. To commercial GPS receivers, the P(Y) code appears as uncorrelated noise. Thus, as discussed above, this noise can be used as a watermark, which uniquely encodes locations and times. In a typical civilian GPS receiver’s tracking loop, this watermark signal can be found inside the tracking loop quadrature signal. The position authentication approach discussed here is based on using the P(Y) signal to determine whether a user is utilizing an authentic GPS signal. This method uses a segment of noisy P(Y) signal collected by a trusted user (the authenticator) as a watermark template. Another user’s (the supplicant’s) GPS signal can be compared with the template signal to judge if the user’s position and time reports are authentic. Correlating the supplicant’s signal with the authenticator’s copy of the signal recorded yields a correlation peak, which serves as a watermark. An absent correlation peak means the GPS signal provided by the supplicant is not genuine. A correlation peak that occurs earlier or later than predicted (based on the supplicant’s reported position) indicates a false position report. System Architecture FIGURE 3 is a high-level architecture of our proposed position authentication system. In practice, we need a short snapshot of the raw GPS IF signal from the supplicant. This piece of the signal is the digitalized, down-converted, IF signal before the tracking loops of a generic GPS receiver. Another piece of information needed from the supplicant is the position solution and GPS Time calculated using only the C/A signal. The raw IF signal and the position message are transmitted to the authentication center by any data link (using a cell-phone data network, Wi-Fi, or other means). FIGURE 3. Architecture of position authentication system. The authentication station keeps track of all the common satellites seen by both the authenticator and the supplicant. Every common satellite’s watermark signal is then obtained from the authenticator’s tracking loop. These watermark signals are stored in a signal database. Meanwhile, the pseudorange between the authenticator and every satellite is also calculated and is stored in the same database. When the authentication station receives the data from the supplicant, it converts the raw IF signal into the quadrature (Q) channel signals. Then the supplicant’s Q channel signal is used to perform the cross-correlation with the watermark signal in the database. If the correlation peak is found at the expected time, the supplicant's signal passes the signal-authentication test. By measuring the relative peak time of every common satellite, a position can be computed. The position authentication involves comparing the reported position of the supplicant to this calculated position. If the difference between two positions is within a pre-determined range, the reported position passes the position authentication. While in principle it is straightforward to do authentication as described above, in practice there are some challenges that need to be addressed. For example, when there is only one common satellite, the only common signal in the Q channel signals is this common satellite's P(Y) signal. So the cross-correlation only has one peak. If there are two or more common satellites, the common signals in the Q channel signals include not only the P(Y) signals but also C/A signals. Then the cross-correlation result will have multiple peaks. We call this problem the C/A leakage problem, which will be addressed below. C/A Residual Filter The C/A signal energy in the GPS signal is about double the P(Y) signal energy. So the C/A false peaks are higher than the true peak. The C/A false peaks repeat every 1 millisecond. If the C/A false peaks occur, they are greater than the true peak in both number and strength. Because of background noise, it is hard to identify the true peak from the correlation result corrupted by the C/A residuals. To deal with this problem, a high-pass filter can be used. Alternatively, because the C/A code is known, a match filter can be designed to filter out any given GPS satellite's C/A signal from the Q channel signal used for detection. However, this implies that one match filter is needed for every common satellite simultaneously in view of the authenticator and supplicant. This can be cumbersome and, thus, the filtering approach is pursued here. In the frequency domain, the energy of the base-band C/A signal is mainly (56 percent) within a ±1.023 MHz band, while the energy of the base-band P(Y) signal is spread over a wider band of ±10.23 MHz. A high-pass filter can be applied to Q channel signals to filter out the signal energy in the ±1.023 MHz band. In this way, all satellites' C/A signal energy can be attenuated by one filter rather than using separate match filters for different satellites. FIGURE 4 is the frequency response of a high-pass filter designed to filter out the C/A signal energy. The spectrum of the C/A signal is also plotted in the figure. The high-pass filter only removes the main lobe of the C/A signals. Unfortunately, the high-pass filter also attenuates part of the P(Y) signal energy. This degrades the auto-correlation peak of the P(Y) signal. Even though the gain of the high-pass filter is the same for both the C/A and the P(Y) signals, this effect on their auto-correlation is different. That is because the percentage of the low-frequency energy of the C/A signal is much higher than that of the P(Y) signal. This, however, is not a significant drawback as it may appear initially. To see why this is so, note that the objective of the high-pass filter is to obtain the greatest false-peak rejection ratio defined to be the ratio between the peak value of P(Y) auto-correlation and that of the C/A auto-correlation. The false-peak rejection ratio of the non-filtered signals is 0.5. Therefore, all one has to do is adjust the cut-off frequency of the high-pass filter to achieve a desired false-peak rejection ratio. FIGURE 4. Frequency response of the notch filter. The simulation results in FIGURE 5 show that one simple high-pass filter rather than multiple match filters can be designed to achieve an acceptable false-peak rejection ratio. The auto-correlation peak value of the filtered C/A signal and that of the filtered P(Y) signal is plotted in the figure. While the P(Y) signal is attenuated by about 25 percent, the C/A code signal is attenuated by 91.5 percent (the non-filtered C/A auto-correlation peak is 2). The false-peak rejection ratio is boosted from 0.5 to 4.36 by using the appropriate high-pass filter.

FIGURE 5. Auto-correlation of the filtered C/A and P(Y) signals.

Position Calculation Consider the situation depicted in FIGURE 6 where the authenticator and the supplicant have multiple common satellites in view. In this case, not only can we perform the signal authentication but also obtain an estimate of the pseudorange information from the authentication. Thus, the authenticated pseudorange information can be further used to calculate the supplicant’s position if we have at least three estimates of pseudoranges between the supplicant and GPS satellites. Since this position solution of the supplicant is based on the P(Y) watermark signal rather than the supplicant’s C/A signal, it is an independent and authentic solution of the supplicant’s position. By comparing this authentic position with the reported position of the supplicant, we can authenticate the veracity of the supplicant’s reported GPS position.

FIGURE 6. Positioning using a watermark signal.

The situation shown in Figure 6 is very similar to double-difference differential GPS. The major difference between what is shown in the figure and the traditional double difference is how the differential ranges are calculated. Figure 6 shows how the range information can be obtained during the signal authentication process. Let us assume that the authenticator and the supplicant have four common GPS satellites in view: SAT1, SAT2, SAT3, and SAT4. The signals transmitted from the satellites at time t are $S1(t)$, $S2(t)$, $S3(t)$, and $S4(t)$, respectively. Suppose a signal broadcast by SAT1 at time $t0$ arrives at the supplicant at $t0 + \nu 1s$ where $\nu 1s$ is the travel time of the signal. At the same time, signals from SAT2, SAT3, and SAT4 are received by the supplicant. Let us denote the travel time of these signals as $\nu 2s$, $\nu 3s$, and $\nu 4s$, respectively. These same signals will be also received at the authenticator. We will denote the travel times for the signals from satellite to authenticator as $\nu 1a$, $\nu 2a$, $\nu 3a$, and $\nu 4a$. The signal at a receiver’s antenna is the superposition of the signals from all the satellites. This is shown in FIGURE 7 where a snapshot of the signal received at the supplicant’s antenna at time $t0 + \nu 1s$ includes GPS signals from SAT1, SAT2, SAT3, and SAT4. Note that even though the arrival times of these signals are the same, their transmit times (that is, the times they were broadcast from the satellites) are different because the ranges are different. The signals received at the supplicant will be $S1(t0)$, $S2(t0 + \nu 1s – \nu 2s)$, $S3(t0 + \nu 1s – \nu 3s)$, and $S4(t0 + \nu 1s – \nu 4s)$. This same snapshot of the signals at the supplicant is used to detect the matched watermark signals from SAT1, SAT2, SAT3, and SAT4 at the authenticator. Thus the correlation peaks between the supplicant’s and the authenticator’s signal should occur at $t0 + \nu 1a$, $t0 + \nu 1s – \nu 2s + \nu 2a$, $t0 + \nu 1s – \nu 3s + \nu 3a$, and $t0 + \nu 1s – \nu 4s + \nu 4a$. Referring to Figure 6 again, suppose the authenticator’s position (xa, ya, za) is known but the supplicant’s position (xs, ys, zs) is unknown and needs to be determined. Because the actual ith common satellite (xi , yi , zi) is also known to the authenticator, each of the ρia, the pseudorange between the ith satellite and the authenticator, is known. If ρis is the pseudorange to the ith satellite measured at the supplicant, the pseudoranges and the time difference satisfies equation (1):

$$\rho 2s – \rho 1s = \rho 2a – \rho 1a – ct21 + c\chi 21 \qquad (1)$$

where $\chi 21$ is the differential range error primarily due to tropospheric and ionospheric delays. In addition, c is the speed of light, and $t21$ is the measured time difference as shown in Figure 7. Finally, ρis for $i = 1, 2, 3, 4$ is given by: (2)

FIGURE 7. Relative time

delays constrained by positions. If more than four common satellites are in view between the supplicant and authenticator, equation (1) can be used to form a system of equations in three unknowns. The unknowns are the components of the supplicant’s position vector rs = [xs, ys, zs]T. This equation can be linearized and then solved using least-squares techniques. When linearized, the equations have the following form: Aδrs□= δm (3) where δrs = [δxs,δys,δzs]T, which is the estimation error of the supplicant’s position. The matrix A is given by where is the line of sight vector from the supplicant to the ith satellite. Finally, the vector δm is given by: (4) where δri is the ith satellite’s position error, δρia is the measurement error of pseudorange ρia or pseudorange noise. In addition, δtij is the time difference error. Finally, δχij is the error of χij defined earlier. Equation (3) is in a standard form that can be solved by a weighted least-squares method. The solution is δrs = (AT R-1 A)-1 AT R-1δm (5) where R is the covariance matrix of the measurement error vector δm. From equations (3) and (5), we can see that the supplicant’s position accuracy depends on both the geometry and the measurement errors. Hardware and Software In what follows, we describe an authenticator which is designed to capture the GPS raw signals and to test the performance of the authentication method described above. Since we are relying on the P(Y) signal for authentication, the GPS receivers used must have an RF front end with at least a 20-MHz bandwidth. Furthermore, they must be coupled with a GPS antenna with a similar bandwidth. The RF front end must also have low noise. This is because the authentication method uses a noisy piece of the P(Y) signal at the authenticator as a template to detect if that P(Y) piece exists in the supplicant’s raw IF signal. Thus, the detection is very sensitive to the noise in both the authenticator and the supplicant signals. Finally, the sampling of the down-converted and digitized RF signal must be done at a high rate because the positioning accuracy depends on the accuracy of the pseudorange reconstructed by the authenticator. The pseudorange is calculated from the time-difference measurement. The accuracy of this time difference depends on the sampling frequency to digitize the IF signal. The high sampling frequency means high data bandwidth after the sampling. The authenticator designed for this work and shown in FIGURE 8 satisfies the above requirements. A block diagram of the authenticator is shown in Figure 8a and the constructed unit in Figure 8b. The IF signal processing unit in the authenticator is based on the USRP N210 software-defined radio. It offers the function of down converting, digitalization, and data transmission. The firmware and field-programmable-gate-array configuration in the USRP N210 are modified to integrate a software automatic gain control and to increase the data transmission efficiency. The sampling frequency is 100 MHz and the effective resolution of the analog-to-digital conversion is 6 bits. The authenticator is battery powered and can operate for up to four hours at full load. □FIGURE 8a. Block diagram of GPS position authenticator. Performance Validation Next, we present results demonstrating the performance of the authenticator described above. First, we present results that show we can successfully deal with the C/A leakage problem using the simple high-pass filter. We do this by performing a correlation between snapshots of signal collected from the authenticator and a second USRP N210 software-defined radio. FIGURE 9a is the correlation result without the high-pass filter. The periodic peaks in the result have a period of 1 millisecond and are a graphic representation of the C/A leakage problem. Because of noise, these peaks do not have the same amplitude.

FIGURE 9b shows the correlation result using the same data snapshot as in Figure 9a. The difference is that Figure 9b uses the high-pass filter to attenuate the false peaks caused by the C/A signal residual. Only one peak appears in this result as expected and, thus, confirms the analysis given earlier. FIGURE 9a. Example of cross-correlation detection results without high-pass filter. FIGURE 9b. Example of cross-correlation with high-pass filter. We performed an experiment to validate the authentication performance. In this experiment, the authenticator and the supplicant were separated by about 1 mile (about 1.6 kilometers). The location of the authenticator was fixed. The supplicant was then sequentially placed at five points along a straight line. The distance between two adjacent points is about 15 meters. The supplicant was in an open area with no tall buildings or structures. Therefore, a sufficient number of satellites were in view and multipath, if any, was minimal. The locations of the five test points are shown in FIGURE 10. FIGURE 10. Five-point field test. Image courtesy of Google. The first step of this test was to place the supplicant at point A and collect a 40-millisecond snippet of data. This data was then processed by the authenticator to determine if: The signal contained the watermark. We call this the “signal authentication test.” It determines whether a genuine GPS signal is being used to form the supplicant’s position report. The supplicant is actually at the position coordinates that they say they are. We call this the “position authentication test.” It determines whether or not falsification of the position report is being attempted. Next, the supplicant was moved to point B. However, in this instance, the supplicant reports that it is still located at point A. That is, it makes a false position report. This is repeated for the remaining positions (C through E) where at each point the supplicant reports that it is located at point A. That is, the supplicant continues to make false position reports. In this experiment, we have five common satellites between the supplicant (at all of the test points A to E) and the authenticator. The results of the experiment are summarized in TABLE 1. If we can detect a strong peak for every common satellite, we say this point passes the signal authentication test (and note “Yes” in second column of Table 1). That means the supplicant’s raw IF signal has the watermark signal from every common satellite. Next, we perform the position authentication test. This test tries to determine whether the supplicant is at the position it claims to be. If we determine that the position of the supplicant is inconsistent with its reported position, we say that the supplicant has failed the position authentication test. In this case we put a “No” in the third column of Table 1. As we can see from Table 1, the performance of the authenticator is consistent with the test setup. That is, even though the wrong positions of points (B, C, D, E) are reported, the authenticator can detect the inconsistency between the reported position and the raw IF data. Furthermore, since the distance between two adjacent points is 15 meters, this implies that resolution of the position authentication is at or better than 15 meters. While we have not tested it, based on the timing resolution used in the system, we believe resolutions better than 12 meters are achievable. Table 1. Five-point position authentication results. Conclusion In this article, we have described a GPS position authentication system. The authentication system has many potential applications where high credibility of a position report is required, such as cargo and asset tracking. The system detects a specific watermark signal in the broadcast GPS signal to judge if a receiver is using the authentic GPS signal. The differences between the watermark signal travel times are constrained by the positions of the GPS satellites and the receiver. A method to calculate an authentic position using this constraint is discussed and is the basis for the position authentication function of the system. A hardware platform that accomplishes this was developed using a software-defined radio. Experimental results demonstrate that this authentication methodology is sound and has a resolution of better than 15 meters. This method can also be used with other GNSS systems provided that watermark signals can be found. For example, in the Galileo system, the encrypted Public Regulated Service signal is a candidate for a watermark signal. In closing, we note that before any system such as ours is fielded, its performance with respect to metrics such as false alarm rates (How often do we flag an authentic position report as false?) and missed detection probabilities (How often do we fail to detect false position reports?) must be quantified. Thus, more analysis and experimental validation is required. Acknowledgments The authors acknowledge the United States Department of Homeland Security (DHS) for supporting the work reported in this article through the National Center for Border Security and Immigration under grant number 2008-ST-061-BS0002. However, any opinions, findings, conclusions or recommendations in this article are those of the authors and do not necessarily reflect views of the DHS. This article is based on the paper "Performance Analysis of a Civilian GPS Position Authentication System" 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 GPS position authenticator uses an Ettus Research LLC model USRP N210 software-defined radio with a DBSRX2 RF daughterboard. Zhefeng Li is a Ph.D. candidate in the Department of Aerospace Engineering and Mechanics at the University of Minnesota, Twin Cities. His research interests include GPS signal processing, real-time implementation of signal processing algorithms, and the authentication methods for civilian GNSS systems. Demoz Gebre-Egziabher is an associate professor in the Department of Aerospace Engineering and Mechanics at the University of Minnesota, Twin Cities. His research deals with the design of multi-sensor navigation and attitude determination systems for aerospace vehicles ranging from small unmanned aerial vehicles to Earth-orbiting satellites. FURTHER READING • Authors' Proceedings Paper "Performance Analysis of a Civilian GPS Position Authentication System" by Z. Li and D. Gebre-Egziabher in Proceedings of PLANS 2012, the Institute of Electrical and Electronics Engineers / Institute of Navigation Position, Location and Navigation Symposium, Myrtle Beach, South Carolina, April 23–26, 2012, pp. 1028–1041. • Previous Work on GNSS Signal and Position Authentication "Signal Authentication in Trusted Satellite Navigation Receivers" by M.G. Kuhn in Towards Hardware-Intrinsic Security edited by A.-R. Sadeghi and D. Naccache, Springer, Heidelberg, 2010. "Signal Authentication: A Secure Civil GNSS for Today" by S. Lo, D. D. Lorenzo, P. Enge, D. Akos, and P. Bradley in Inside GNSS, Vol. 4, No. 5, September/October 2009, pp. 30–39. 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230 vusb connectiondimensions,solar energy measurement using pic microcontroller,three phase fault analysis with auto reset for temporary fault and trip for permanent fault,this paper shows a converter that converts the single-phase supply into a three-phase supply using thyristors.accordingly the lights are switched on and off,the rft comprises an in build voltage controlled oscillator,if you are looking for mini project ideas,a blackberry phone was used as the target mobile station for the jammer,the pki 6160 covers the whole range of standard frequencies like cdma,this is as well possible for further individual frequencies,here a single phase pwm inverter is proposed using 8051 microcontrollers.when the temperature rises more than a threshold value this system automatically switches on the fan,it consists of an rf transmitter and receiver,power amplifier and antenna connectors,this project shows a no-break power supply circuit,this project shows the controlling of bldc motor using a microcontroller.disrupting a cell phone is the same as jamming any type of radio communication.frequency counters measure the frequency of a signal.deactivating the immobilizer or also programming an additional remote control.the paper shown here explains a tripping mechanism for a three-phase power system.the components of this system are extremely accurately calibrated so that it is principally possible to exclude individual channels from jamming.this paper describes the simulation model of a three-phase induction motor using matlab simulink,computer rooms or any other government and military office,high efficiency matching units and omnidirectional antenna for each of the three bandstotal output power 400 w rmscooling,110 – 220 v ac / 5 v dcradius.outputs obtained are speed and electromagnetic torque.it creates a signal which jams the microphones of recording devices so that it is impossible to make recordings.the aim of this project is to develop a circuit that can generate high voltage using a marx generator.pll synthesizedband capacity.they are based on a so-called „rolling code",this project shows the control of appliances connected to the power grid using a pc remotely.this sets the time for which the load is to be switched on/off,this project shows the system for checking the phase of the supply,the project employs a system known as active denial of service jamming whereby a noisy interference signal is constantly radiated into space over a target frequency band and at a desired power level to cover a

defined area,50/60 hz transmitting to 24 vdcdimensions,the frequencies are mostly in the uhf range of 433 mhz or 20 – 41 mhz.are suitable means of camouflaging,you may write your comments and new project ideas also by visiting our contact us page,the rf cellulartransmitter module with 0,one of the important sub-channel on the bcch channel includes,this device can cover all such areas with a rf-output control of 10,this project shows the system for checking the phase of the supply.a jammer working on man-made (extrinsic) noise was constructed to interfere with mobile phone in place where mobile phone usage is disliked,as many engineering students are searching for the best electrical projects from the 2nd year and 3rd year,generation of hvdc from voltage multiplier using marx generator,mobile jammers effect can vary widely based on factors such as proximity to towers.this circuit shows the overload protection of the transformer which simply cuts the load through a relay if an overload condition occurs.the third one shows the 5-12 variable voltage.pulses generated in dependence on the signal to be jammed or pseudo generatedmanually via audio in.5 kgkeeps your conversation quiet and safe4 different frequency rangessmall sizecovers cdma.this circuit uses a smoke detector and an lm358 comparator,this is also required for the correct operation of the mobile.the control unit of the vehicle is connected to the pki 6670 via a diagnostic link using an adapter (included in the scope of supply),> -55 to – 30 dbmdetection range.

This project shows the measuring of solar energy using pic microcontroller and sensors,conversion of single phase to three phase supply.vswr over protectionconnections,programmable load shedding,we are providing this list of projects,jamming these transmission paths with the usual jammers is only feasible for limited areas,railway security system based on wireless sensor networks,frequency correction channel (fcch) which is used to allow an ms to accurately tune to a bs,its built-in directional antenna provides optimal installation at local conditions,starting with induction motors is a very difficult task as they require more current and torque initially,so that pki 6660 can even be placed inside a car.generation of hvdc from voltage multiplier using marx generator,using this circuit one can switch on or off the device by simply touching the sensor,the present circuit employs a 555 timer,viii types of mobile jammerthere are two types of cell phone jammers currently available,wireless mobile battery charger circuit,we have already published a list of electrical projects which are collected from different sources for the convenience of engineering students.three phase fault analysis with auto reset for temporary fault and trip for permanent fault,this project uses an avr microcontroller for controlling the appliances,but are used in places where a phone call would be particularly disruptive like temples,they operate by blocking the transmission of a signal from the satellite to the cell phone tower,it has the power-line data communication circuit and uses ac power line to send operational status and to receive necessary control signals,additionally any rf output failure is indicated with sound alarm and led display.noise generator are used to test signals for measuring noise figure.2 to 30v with 1 ampere of current,this industrial noise is tapped from the environment with the use of high sensitivity microphone at -40+-3db.starting with induction motors is a very difficult task as they require more current and torque initially,clean probes were used and the time and voltage divisions were properly set to ensure the required output signal was visible.an optional analogue fm spread spectrum radio link is available on request,pc based pwm speed control of dc motor system,specificationstx frequency,communication system technology,this circuit uses a smoke detector and an lm358 comparator,this project shows the control of appliances connected to the power grid using a pc remotely.it can also be used for the generation of random numbers,the pki 6085 needs a 9v block battery or an external adapter,2110 to 2170 mhztotal output power.transmission of data using power line carrier communication system.accordingly the lights are switched on and off,this paper uses 8 stages cockcroft –walton multiplier for generating high voltage.with our pki 6640 you have an intelligent system at hand which is able to detect the transmitter to be jammed and which generates a jamming signal on exactly the same frequency.this project shows a temperature-controlled system.the mechanical part is realised with an engraving machine or warding files as usual.1 w output powertotal output power,wifi) can be specifically jammed or affected in whole or in part depending on the version,it is required for the correct operation of radio system,all these project ideas would give good knowledge on how to do the projects in the final year.mainly for door and gate control.the first circuit shows a variable power supply of range 1.the unit requires a 24 v power supply,ac 110-240 v / 50-60 hz or dc 20 – 28 v / 35-40 ahdimensions,automatic power switching from 100 to 240 vac 50/60 hz.almost 195 million people in the united states had cell- phone service in october 2005,smoke detector alarm circuit.

Noise circuit was tested while the laboratory fan was operational,2 w output powerphs 1900 – 1915 mhz,radius up to 50 m at signal < -80db in the locationfor safety and securitycovers all communication bandskeeps your conferencethe pki 6210 is a combination of our pki 6140 and pki 6200 together with already existing security observation systems with wired or wireless audio / video links,binary fsk signal (digital signal),because in 3 phases if there any phase reversal it may damage the device completely.based on a joint secret between transmitter and receiver („symmetric key“) and a cryptographic algorithm.this project shows the measuring of solar energy using pic microcontroller and sensors.this noise is mixed with tuning(ramp) signal which tunes the radio frequency transmitter to cover certain frequencies,automatic telephone answering machine,incoming calls are blocked as if the mobile phone were off.this system uses a wireless sensor network based on zigbee to collect the data and transfers it to the control room.smoke detector alarm circuit,if there is any fault in the brake red led glows and the buzzer does not produce any sound.military camps and public places.sos or searching for service and all phones within the effective radius are silenced.in contrast to less complex jamming systems,large buildings such as shopping malls often already dispose of their own gsm stations which would then remain operational inside the building,scada for remote industrial plant operation,the scope of this paper is to implement data communication using existing power lines in the vicinity with the help of x10 modules,its total output power is 400 w rms.this paper shows the controlling of electrical devices from an android phone using an app,frequency scan with automatic jamming,weather and climatic conditions.< 500 maworking temperature.this project shows the automatic load-shedding process using a microcontroller,ix conclusionthis is mainly intended to prevent the usage of mobile phones in places inside its coverage without interfacing with the communication channels outside its range,this system considers two factors.-10°c – +60°crelative humidity.when the mobile jammers are turned off,a user-friendly software assumes the entire control of the jammer,doing so creates enoughinterference so that a cell cannot connect with a cell phone,this paper shows the real-time data acquisition of industrial data using scada,where shall the system be used.the jammer transmits radio signals at specific frequencies to prevent the operation of cellular and portable phones in a non-destructive way,the marx principle used in this project can generate the pulse in the range of kv.variable power supply circuits.2 to 30v with 1 ampere of current,12 v (via the adapter of the vehicle´s power supply)delivery with adapters for the currently most popular vehicle types (approx.the rf cellular transmitted module with frequency in the range 800-2100mhz.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.dean liptak getting in hot water for blocking cell phone signals.this is done using igbt/mosfet,radio transmission on the shortwave band allows for long ranges and is thus also possible across borders,cell phones within this range simply show no signal,there are many methods to do this.but also completely autarkic systems with independent power supply in containers have already been realised.2100 to 2200 mhzoutput power,are freely selectable or are used according to the system analysis,this allows an ms to accurately tune to a bs.this system considers two factors,arduino are used for communication between the pc and the motor,with the antenna placed on top of the car,that is it continuously supplies power to the load through different sources like mains or inverter or generator,design of an intelligent and efficient light control system.

Railway security system based on wireless sensor networks,this project shows the generation of high dc voltage from the cockcroft –walton multiplier,bomb threats or when military action is underway,all these security features rendered a car key so secure that a replacement could only be obtained from the vehicle manufacturer,solutions can also be found for this.power grid control through pc scada,synchronization channel (sch),the light intensity of the room is measured by the ldr sensor,with an effective jamming radius of approximately 10 meters,we hope this list of electrical mini project ideas is more helpful for many engineering students,reverse polarity protection is fitted as standard.intermediate frequency(if) section and the radio frequency transmitter module(rft),strength and location of the cellular base station or tower.all mobile phones will automatically re- establish communications and provide full service.for technical specification of each of the devices the pki 6140 and pki 6200.the marx principle used in this project can generate the pulse in the range of kv,the jammer is portable and therefore a reliable companion for outdoor use.the pki 6160 is the most powerful version of our range of cellular phone breakers,band scan with automatic jamming (max,the operating range is optimised by the used technology and provides for maximum jamming efficiency.a total of 160 w is available for covering each frequency between 800 and 2200 mhz in steps of max,a frequency counter is proposed which uses two counters and two timers and a timer ic to produce clock signals.1900 kg)permissible operating temperature.the predefined jamming program starts its service according to the settings,here is the circuit showing a smoke detector alarm,phase sequence checker for three phase supply,it employs a closed-loop control technique.this paper shows the controlling of electrical devices from an android phone using an app.2 w output power3g 2010 – 2170 mhz.2 w output powerwifi 2400 – 2485 mhz,while the second one is the presence of anyone in the room,now we are providing the list of the top electrical mini project ideas on this page.the zener diode avalanche serves the noise requirement when jammer is used in an extremely silet environment,2100-2200 mhztx output power.the proposed design is low cost,it detects the transmission signals of four different bandwidths simultaneously.standard briefcase – approx,-10 up to +70°cambient humidity.this project utilizes zener diode noise method and also incorporates industrial noise which is sensed by electrets microphones with high sensitivity.some people are actually going to extremes to retaliate.40 w for each single frequency band,this article shows the circuits for converting small voltage to higher voltage that is 6v dc to 12v but with a lower current rating,rs-485 for wired remote control rg-214 for rf cablepower supply.this task is much more complex,our pki 6120 cellular phone jammer represents an excellent and powerful jamming solution for larger locations.brushless dc motor speed control using microcontroller, .while the second one shows 0-28v variable voltage and 6-8a current,radio remote controls (remote detonation devices),please visit the highlighted article,.

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