Pulsed doppler radar pdf

Also known as data search, find materials and properties of information from technical links. The airborne radar antenna pulse-doppler radar is a radar system that determines the range to the target using pulsed methods and uses the Doppler effect of the returned signal to determine the speed of the target object. It combines the functions of pulsed radars and continuous wave radars, which were previously separated due to the complexity of electronics. The first operational radar of the Pulse Doppler was in the CIM-10 Bomarc, a U.S. long-range supersonic missile powered by ramjet engines, and which was armed with W40 nuclear weapons to destroy entire formations of enemy attack aircraft. The Pulse-Doppler systems were first widely used on fighter jets since the 1960s. Previously, radars used pulsed timing to determine the range and angle of the antenna (or similar means) to determine the bearing. However, this only worked when the radar antenna was not specified; In this case the reflection from the ground is overwhelmed by any return from other objects. As the earth moves at the same speed but the opposite direction of the aircraft, Doppler's methods allow the return of the earth to be filtered out, showing airplanes and vehicles. This gives pulse-doppler radars a look down/shoot down opportunity. A secondary advantage of military radar is the reduction of transferable power when achieving acceptable performance to improve the safety of hidden radars. Pulse-Doppler methods are also widely used in weather radars, allowing radar to detect wind speed at the speed of any precipitation in the air. The Pulse-Doppler radar is also the basis of a synthetic aperture radar used in radar astronomy, remote sensing and mapping. In air traffic control, they are used to discriminate against aircraft from clutter. In addition to the above conventional surveillance applications, Pulse-Doppler radar has been successfully applied in health care, such as drop risk assessment and fall detection, for care or clinical purposes. History The earliest radar systems did not work as expected. The reason has been traced to Doppler effects that impair the performance of systems not designed to account for moving objects. Fast-moving objects cause a phase shift on the transmission pulse, which can cause the signal to be cancelled. Doppler has the greatest detrimental effect on moving target indicator systems, which must use a reverse phase shift to compensate Doppler in the detector. It has also been found that the weather effects of Doppler (precipitation) worsen conventional radar and moving radars of target indicators that can mask aircraft reflections. This is was adapted for use with meteorological radars in the 1950s after declassifying some World War II systems. The Pulse-Doppler radar was developed during World War II to overcome limitations by increasing the pulse Frequency. This required the development of a clystron, a mobile wave tube and solid-fuel devices. Early pulsed Dopplers were incompatible with other high-power microwave amplification devices that are not consistent, but more sophisticated techniques have been developed that record the phase of each transmitted pulse to compare with returned echoes. Early examples of military systems include the AN/SPG-51B, developed in the 1950s specifically for hurricane-related purposes without productivity. The Hughes AN/ASG-18 fire control system was a prototype of the on-board radar/combined system for the planned North American XF-108 Rapier interceptor aircraft for the U.S. Air Force and then for the Lockheed YF-12. The first Pulse-Doppler radar in the United States, the system was able to look down/shoot down and could track one target at a time. Weather, chaff, terrain, flying techniques and stealth are common tactics used to hide aircraft from radar. Pulse-Doppler radar eliminates these flaws. It became possible to use pulse-doppler radar on aircraft after digital computers were incorporated into the design. Pulse-Doppler provided the opportunity to look down/shoot down to support air-to-air rocket systems in most modern military aircraft by the mid 1970s. The principle of the IMP-Doppler radar measurement of a range of pulsed Pulse-Doppler systems measures range to objects by measuring the elapsed time between it sending a pulsed electronic receiver and receiving a reflection of the subject. Radio waves travel at the speed of light, so the distance to the object is the past tense, multiplied by the speed of light, divided into two - there and back. The speed measurement Change in wavelength, caused by the movement of the pulse-doppler radar source, is based on the Doppler effect, where the movement in the range produces a frequency shift on the signal reflected from the target. Doppler frequency 2 × speed × range C. Display style textfrequency Frequency frequency short text transmission frequency times (text) Radial speed is important for the operation of the radar pulse-Doppler. As the reflector moves between each pulse of transmission, the returned signal has a phase difference, or phase change, from pulse to pulse. This results in the reflector modulating the Doppler on the reflected signal. Pulse-Doppler radars use this phenomenon to improve performance. Amplitude of a consistently returning pulse from the same scanned volume - I - I am 0 sin (4 π (x I_{0} Θ Θ 0 - t) 4pi (x_{0}'v'Delta t) , Lambda (right) I_{0} Sin (Theta {0}Delta Theta), where x 0 display x_{0} is the distance to the target, displaystyle Lambda is a radar wavelength, T t display (Delta t) time between the two impulses. So Θ 4 π v t. Display style Delta Feta frak 4pi v'Delta t'lambda. This allows the radar to separate reflections from multiple objects located in the same and volume of space, separating objects using the spectrum of distribution to separate different signals: v - target speed - Θ 4 π tons, Text target speed lambda Delta 4pi Delta t, where Θ the Delta display Theta is a phase shift. The benefits of speed failure are selected on pulse-doppler aircraft detection systems, so nothing below that speed will be detected. The one degree antenna beam illuminates millions of square feet of terrain at the 10 mile (16 km) range, and it produces thousands of detections at or below the horizon if The Doppler is not in use. The Pulse-Doppler radar uses the following signal processing criteria to exclude unwanted signals from slow-moving objects. This is also known as disorder failure. The failure rate is usually set just above the prevailing wind speed (10 to 100 mph or 15 to 150 km/h). The speed threshold is much lower for the weather radar. (6) The frequency of dopplers × C 2 × the frequency of transmission of the speed. Display-style (left) twirl (text) (text) (Doppler frequency) 2 times (text) transmits the frequency right twirl zgt; text speed threshold. In airborne pulse-doppler radar the speed threshold is compensated by the speed of the aircraft relative to the ground. | The frequency of dopplers × C 2 × the transmission of the frequency and speed of the ground × cos Θ qgt; speed threshold, display left (left) (text) (text) frequency Doppler, time C'2'times (text) transmits the frequency Time cbs the ts the right twirl gt; text speed threshold where the Θ display Theta is the angle of bias between the position of the antenna and the flight path of the aircraft. Surface reflections appear in almost all radars. Ground clutter usually appears in a circular area within a radius of about 25 miles (40 km) near ground radar. This distance extends much further in the air and space radars. The disorder is the result of radio-energy reflected from the earth's surface, buildings and vegetation. The mess includes weather in radar designed to detect and communicate aircraft and spacecraft. The disorder creates an area of vulnerability in the radar of the pulse-amplitude domain of time. Non-Doppler radar systems cannot be directed directly to the ground due to excessive false alarms that overwhelm computers and operators. Sensitivity should be reduced near clutter to avoid overload. This vulnerability begins in a low-altitude area several widths above the horizon and extends downwards. It also exists throughout the volume of moving air associated with the weather phenomenon. Radar corrects it as follows. Way. a radar antenna that should be aimed directly at the ground without suppressing the computer or reducing sensitivity. Fills the vulnerability area associated with pulse-amplitude radar to detect small objects near terrain and weather. Increases the detection range by 300% or more compared to moving targets (MTI) by improving visibility south of the clutter. The ability to avoid a mess of about 60 dB is necessary to be able to look/down, and Pulse-Doppler is the only strategy that can satisfy this requirement. This eliminates vulnerabilities associated with low altitude and below the environmental horizon. Pulse compression and moving target indicator (MTI) provide visibility of up to 25 dB. The MTI antenna beam is directed over the horizon to avoid excessive false alarm speed, making the system vulnerable. Planes and some missiles use this weakness using a technique called flying below radar to avoid detection (Nap-of-the-earth). This flying technique is ineffective against the radar pulse-dopplers. Pulse-Doppler provides an advantage when trying to detect missiles and low-observability aircraft flying near terrain, sea surface and weather. Audible Doppler and Target size support passive vehicle type classification when an identification friend or foe is not available from a transponder signal. The average frequency of pulse repetition (PRF) reflects microwave signals falling between 1500 and 15,000 cycles per second that is audible. This means that the helicopter sounds like a helicopter, the jet sounds like a jet, and the propeller of the aircraft sounds like propellers. Planes without moving parts produce tone. The actual size of the target can be calculated with a beep. (quote is necessary) Maximum range of detriments from reflectivity (red) and unambiguous speed range of Doppler (blue) with fixation of the pulse repetition rate. The ambiguity of processing is required when the target range is above the red line on the graph, which increases the scanning time. Scan time is a critical factor for some systems because vehicles moving at speed or above the speed of sound can move one mile (1.6 km) every few seconds like Exocet, Harpoon, Kitchen, and air-to-air rockets. The maximum time to scan the entire volume of the sky should be about a dozen seconds or less for systems operating in this environment. The Pulse-Doppler radar itself may be too slow to cover the entire amount of space above the horizon if a fan beam is not used. This approach is used with AN/SPS 49(V)5 Very Long Range Air Surveillance Radar, which sacrifices altitude measurement to gain speed. The movement of the Pulse-Doppler antenna should be slow enough, so that all Signals from at least 3 different PRFs can be processed up to the maximum expected detection range. This is known as the time of the inhabited time. The motion antenna for pulse-doppler should be as slow as the radar using Radar searches that include pulse-doppler are usually double mode because the best overall performance is achieved when a pulse-doppler is used for areas with high false alarm rates (horizon or lower and weather), while conventional radar will scan faster in free space where the false alarm level is low (above the horizon with clear skies). The type of antenna is an important factor for multi-stage radar, as the undesirable phase shift imposed by the radar antenna can impair performance for sub-disorder visibility. Signal Processing Improves the processing of the pulse-doppler signal allows you to detect small high-speed objects in close proximity to large slow-moving reflectors. To achieve this, the transmitter must be consistent and must produce a low noise phase during the detection interval, and the receiver must have a large instant dynamic range. Pulse-Doppler signal processing a detailed explanation of pulse-Doppler signal processing also includes the resolution of ambiguity to determine the true range and speed. The ambiguity of the resolution is a detailed explanation of the received signals from several PRFs are compared to determine the true range using the range ambiguity resolution process. Resolution of the ambiguity of the range detailed explanation of the received signals is also compared through the process of resolution of frequency ambiguity. Resolution frequency ambiguity is a detailed explanation of the Resolution range Resolution of the minimum range division of the range between two objects traveling at the same speed before the radar can detect two discrete reflections: the resolution of the range - the CPRF × (the number of samples between pulses of transmission). Display (text range resolution) frac (Ctext,PRF)time (textnumber of samples between transmission pulses). In addition to this sampling limit, the duration of the momentum transmitted may mean that the return on the two targets will be derived simultaneously from different parts of the pulse. Speed Resolution resolution is the minimum radial speed difference between two objects traveling in the same range before the radar can detect two discrete reflections: speed resolution and C × PRF to transmit the frequency of × filter size in transmission pulses. Display (resolution of text speed) frac text time (text)PRFtext texttransmission frequency times time text filter size in pulses of transmission. The Pulse-Doppler radar has special requirements that must be met to achieve acceptable performance. Pulse Recurrence Frequency Main article: Pulse-Doppler pulse frequency usually uses medium (PRF) from about 3 kHz to 30 kHz. The range between the pulses of transmission is between 5 km and 50 km. The range and speed cannot be measured directly by the medium PRF, and the ambiguity of the resolution is required to determine the true range and speed. Doppler's signals are usually above 1 kHz, which therefore, sound signals from medium PRF systems can be used for passive target classification. Angular measuring radar systems require angular measurements. Transponders are not usually associated with pulse-doppler radar, so lateral suppression is required for practical work. Radar tracking uses angular error to improve accuracy by producing perpendicular radar beam measurements. Corner measurements are averaged over a period of time and combined with radial motion to develop information suitable for predicting a target position for a short time in the future. The two angle error methods used with the tracking radar are monopulse and conical scanning. Monopulse Radar Conical Scanning Coherent Pulse-Doppler radar requires a coherent oscillator with very little noise. Phase noise reduces the performance of the cluttering visibility, creating a clear movement on stationary objects. The cavity magnetron and the cross field amplifier are not suitable because the noise made by these devices interferes with detection performance. The only amplification devices suitable for pulse-doppler pulse are a clystron, a mobile wave tube, and solid-fuel devices. Scalloping Home article: Radar scalloping Pulse-Doppler signal processing introduces a phenomenon called scallop. The name is associated with a series of holes that are scooped out of detection performance. Scalloping for Pulse-Doppler radar involves blind speeds created by a filter rejection disorder. Each amount of space must be scanned using 3 or more different PRFs. Two PRF detection schemes will have detection gaps with a pattern of discrete ranges, each of which has blind speed. Windowing Ringing artifacts pose a problem with the search, detection and resolution of ambiguity in the pulse-doppler radar. The ring is reduced in two ways. First, the transmission pulse form is adjustable to smooth out the cutting edge and rear edge, so that the RF power increases and decreases without sudden changes. This creates a pulse of transmission with smooth ends instead of a square wave, which reduces the ringing phenomenon that is otherwise associated with the target reflection. Second, the shape of the pulse gets adjusted using a window function that minimizes the ringing that occurs at any time the pulses are applied to the filter. In the digital system, this regulates the phase and/or amplitude of each sample before it is applied to fourier's rapid conversion. The Dolph-Chebyshev window is the most effective because it produces a flat treated floor without a call, which would otherwise cause false alarms. Antenna Pulse-Doppler radar is usually mechanically directed antennas and an active phase grille. Rf mechanical components, such as the wave guide, can modulate Doppler due to the phase shift caused by vibration. This introduces a requirement to perform the full range of operational tests using shake-up tables Can produce high power mechanical vibration at all expected sound frequencies. Doppler is incompatible with most electronically controlled phase antenna. This is due to the fact that the phase elements in the antenna are not reciprocal, and the phase change should be adjusted before and after each pulse of transmission. The spurious phase shift is produced by the sudden impulse of phase shearing, and settling in between pulses transferring the place of Doppler modulation to stationary clutter. This modulation corrupts performance measure for sub-clutter visibility. There is no need to change the time settlement phase by an order of 50ns. The start of the receiver sample should be delayed by at least one phase shift, setting the time-permanent (or more) for every 20 dB of clutter visibility. Most interchangeable phases of antennas running on PRF above 1 kHz introduce a false phase shift unless special provisions are made, such as reducing phase change settlement time to a few dozen nanoseconds. Below is the maximum allowable time for the modules to be settled in phase-changing antenna. T No 1 e SCV 20 × S × PRF , display style Tfrac {1} e-frac text SCV {20} times Stimes (text)PRF, where T SCV - sub-clutter visibility in dB, S - the number of range samples between each impulse transmission, PRF - the maximum frequency of repetition of the momentum of the design design. The type of antenna and the performance of the scan is a practical given multi-stage radar system. Diffraction of Choppy surfaces, like waves and trees, form a diffraction lattice suitable for bending microwave signals. Pulse-Doppler can be so sensitive that diffraction from mountains, buildings or wave peaks can be used to detect fast-moving objects otherwise blocked by continuous obstruction along the line of sight. This is a very unprofitable phenomenon that becomes possible only when the radar has a significant excess of sub-clutter visibility. Refraction and ducts use transmission frequency at or below L-band to expand a horizon that is very different from diffraction. Refraction for the over-the-horizon radar uses variable density in the air column above the Earth's surface to bend RF signals. The inversion layer can produce a transient tropospheric duct that traps radio-frequency signals in a thin layer of air like a wave guide. Subclutter's cluttered visibility visibility includes the maximum power ratio of clutter to target power, which is proportional to the dynamic range. This determines performance in severe weather and near the earth's surface. Dynamic range - min . . . . Displaystyle textdynamic range min start cases tfrac (text) text, noise power text text noise transmission, where bandwidth is tfrac text PRF text filter size Size text receiver dynamic range ultimate cases. The visibility of the clutter is the ratio of the slightest signal that can be detected if there is a larger signal. visibility of the clutter and the dynamic threshold of CFAR detection. Display style textsubclutter visibility frac text dynamic range text CFAR detection threshold. A small fast-moving target reflection can be detected in the presence of large slow-moving chaos reflections when the following is true: the target power of qgt; clutters the visibility of the clutter. Display style text target power zgt; frak text mess of power text sub-subludter visibility. The performance of the Pulse-Doppler radar equation can be used to understand the trade-offs between different design limitations such as energy consumption, detection range and microwave safety threats. This is a very simple form of modeling that allows you to evaluate performance in a sterile environment. The performance of the theoretical range is as follows. R q (P t G A R σ F D 16 π 2 K B T B N) 1 4 , R's display style on the left (P_) G_ t'A_'r'sigma FD'16'pi ({2}K_b)-TBN'right), frak {1}{4}, where R - distance to target, Pt - transmitter power, Gt - increase of transmitting antenna, Ar - effective aperture (area) of the receiving antenna, σ - radar cross-section , or scattering factor, goal, distribution factor of the antenna pattern F, D and Doppler filter size (transmission of pulses in each rapid conversion of Fourier), Kb and Boltzmann in constant, T and absolute temperature, B and bandwidth receiver (band-passing filter), N and noise figure. This equation results by combining the radar equation with the noise equation and accounting in the noise distribution range through multiple detection filters. The D value is added to the standard radar range equation to account for both the processing of the doppler pulse signal and the noise reduction of the FM transmitter. The detection range increases in proportion to the fourth root of the number of filters for this energy consumption. In addition, energy consumption is reduced by the number of filers for this detection range. Pulse-Doppler signal processing integrates all the energy from all the individual reflected pulses that enter the filter. This means that the pulse-doppler signal processing system with 1024 elements provides 30,103 dB improvements due to the type of signal processing that should be used with pulse-doppler radar. The energy of all individual pulses from the object is added together by the filtration process. Signal processing for a 1024-ton filter increases performance by 30,103 dB, provided the transmitter and antenna are compatible. This corresponds to an increase of 562% in the maximum distance. These improvements are Pulse-Doppler is important for the military and astronomy. Aircraft tracking uses the Pulse-Doppler radar to detect the aircraft has two modes. Track track scan mode frequency filtration, threshold amplitude and authorization of ambiguity. After detecting and addressing the reflection, the pulse-doppler radar automatically goes into the mode of tracking the amount of space surrounding the track. Track mode works like a phase loop, where Doppler's speed is compared to the band movement during sequential scanning. The lock indicates that the difference between the two dimensions is below the threshold, which can only occur with an object that satisfies Newtonian mechanics. Other types of electronic signals cannot be blocked. The lock does not exist in any other type of radar. The lock criteria must be met during normal operation. Pulse-Doppler - Lock Lock eliminates the need for human intervention, with the exception of helicopters and electronic interference. The weather phenomenon is subject to the adiabathal process associated with air mass, not Newtonian mechanics, so the locking criteria are not usually used for weather radars. Pulse-Doppler signal processing selectively eliminates low-speed reflections, so there are no detections below the speed threshold. This eliminates terrain, weather, biology and mechanical interference, with the exception of a lure aircraft. Doppler's target signal from detection is converted from a frequency domain back to a time domain sound for a track operator on some radar systems. The operator uses this sound for passively classifying targets such as helicopter recognition and electronic interference. Helicopters special attention is required for aircraft with large moving parts because the Pulse-Doppler radar works like a phase loop. Blade driving tips near the speed of sound produce the only signal that can be detected when the helicopter moves slowly near the terrain and weather. Helicopters appear as a fast-pulsating noise receiver, except for a clear, clutter-free environment. A beep is made for passive identification of the type of airborne object. The microwave change in the frequency of dopplers produced by the motion reflector falls into the sound range for humans (20 - 20,000 Hz), which is used for target classification in addition to the types of conventional radar display used for this purpose, such as A-scope, B-scope, C-scope and RHI indicator. The human ear may be able to tell the difference better than electronic equipment. A special mode is required, as the feedback information about Doppler's speed should not be related to radial motion so that the system can go from scanning to tracking without blocking. Similar methods are needed to develop tracked information to interfere with signals and interference that cannot meet the lock criteria. The Pulse-Doppler radar must be multi-stage to handle the aircraft's rotation and crossing the trajectory. Once in track mode, pulse-doppler radar should include a way to change Doppler filtering for for space surrounding the track when the radial speed drops below the minimum detection rate. The doppler filter adjustment should be related to the radar track function to automatically adjust the Doppler's rejection rate within the amount of space surrounding the track. Tracking will stop without this function because the target signal will otherwise be rejected by the Doppler filter when the radial speed approaches zero because there is no change in frequency. Multidimensional work can also include continuous wave illumination for semi-active radar homing. See also the characteristics of the radar (the basis of radar) Doppler radar (non-pulse; used for navigation systems) Meteorological radar (pulse with doppler processing) Continuous-wave radar (non-pulse, pure Doppler processing) fm-cw radar (non-pulse, swept frequency, range and Dopler processing) which highlights the benefits of using Pulse-Doppler radar handout technology from the Introduction to Principles and Application of Radar Course at the University of Iowa Modern Radar Systems Hamish Meikle (ISBN 1-58053-294-2) Advanced Radar Techniques and Systems edited by Gaspar Galati (ISBN 0-86341-172-X Links Tom 141. P17. Michael Hemsch, American Institute of Aeronautics and Astronautics. American Institute of Aeronautics and Astronautics, 1992 - AN/APH-174/186 Multi-stage radar. Raytheon. Liu Liang; Popescu, Michael; Scobic, Marjorie; Ranz, Marilyn; Yardibi, Tariq; Cuddihi, Paul (2011). Automatic detection of a fall based on the Doppler signature radar movement. 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