PROJECT REPORT ON

PULSE RADAR PROPOSED BY

Girisuta Mohanty (B219025) Nanda Srikanth S K Nanda (B219035) D Chandana Reddy (B219021) Santoshini Pradhan(B219049)

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY, BHUBANESWAR -751003

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INTRODUCTION:

Pulse radar emits short and powerful pulses and in the silent period receives the echo signals. In contrast to the continuous wave radar, the transmitter is turned off before the measurement is finished. This method is characterized by radar pulse modulation with very short transmission pulses. The distance of the reflecting objects is determined by runtime measurement (at a fixed radar) or by comparison of the characteristic changes of the Doppler spectrum. Pulse radars are mostly designed for long distances and transmit a relatively high pulse power.

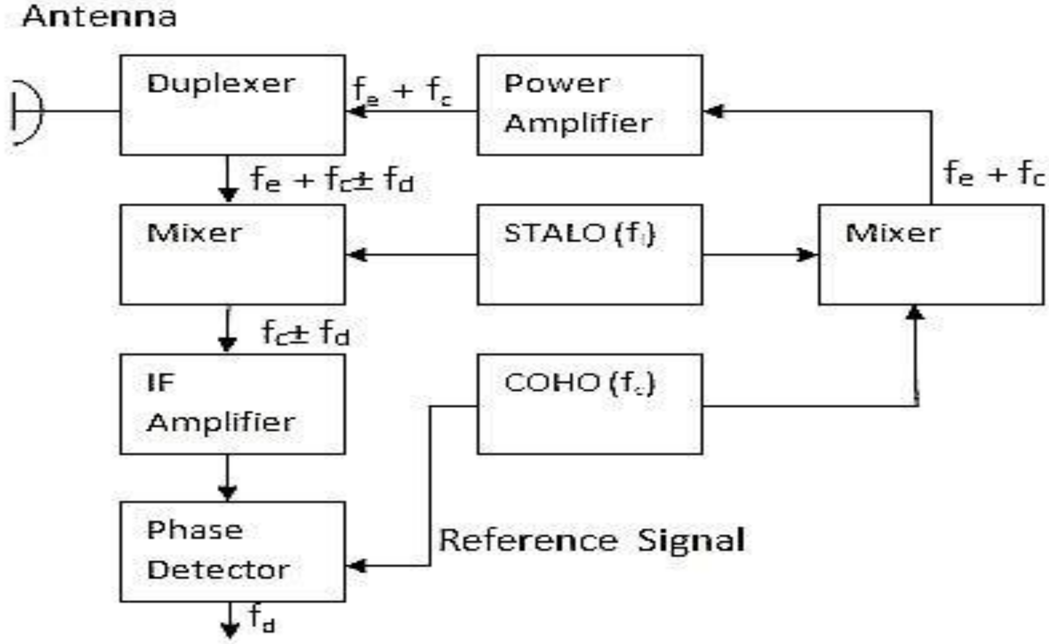
MOTIVATION:

Important distinguishing feature to other radar method is the necessary time control of all processes inside the pulse radar. In pulse radar, multiple pulses are transmitted to cover search patterns, to track moving targets, to integrate several target returns to improve detection. Pulse radar also provides greater measurement range as compared to other radar systems. In pulse radar the transmitter is in an "off" state.

Although the transmitter is not powered and active so that it is able to detect any signals reflected by radar targets or returned by transmitters.

In our paper,phase noise is enabled in receiver local oscillator. The effect of the phase noise from the Local oscillator is observed in the varying strength of the detected pulses. This varying pulse strength can have an impact on the probability of detection and will result in the target being detected only at certain times.

BLOCK DIAGRAM WITH EXPLANATION:



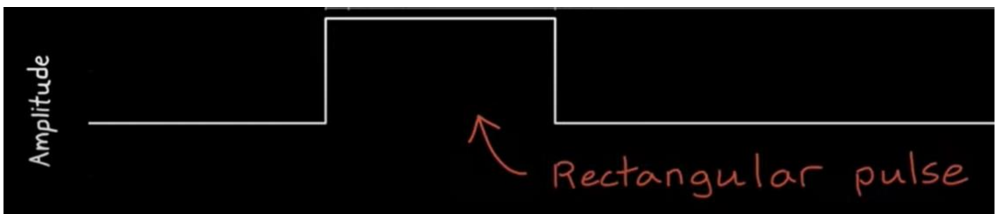
Pulse radar employs a power amplifier as a transmitter.It has high stability and it is capable of transmitting high power.The pulse modulator turns the amplifier “ON” and “OFF” to generate radar pulses.Klystron and the travelling wave tube are usually used as a type of vacuum tube amplifier for pulse radar.

To employ Doppler if the phase of the local oscillator where to change significantly between pulses and an uncancelled clutter residue can result at the output of the delay line canceller which might be mistaken for a moving target even though only clutter were present. To recognize the need for high stability,the local oscillator of a pulse radar receiver is called stable local oscillator.

The IF stage is designed as matched filter. Instead of an amplitude detector there is a phase detector following the IF stage.This is a mixer like device that combines the received signal and the reference signal to produce the difference between the received signal and reference signal frequencies.This difference is the Doppler frequency.Coherent oscillator is used to signify the reference signal that has same phase with transmitted signal The coherency is obtained by the sum of coho and stalo signals as the input signal to the power amplifier.The transmitter frequency is fc+fl.The output of the phase detector is theinput to the Delay Line Canceller that acts as High pass filter to separate the Doppler shifted echo signals of moving target from unwanted echoes.

WORKING PRINCIPLE:

As the name suggests, pulse radar systems sends out short pulses of energy waves followed by long periods of silence where the receiver is listening for the reflected signal. At first, there is a period where the transmitter is silent and no signals are
being sent, and then at the beginning of the pulse, it starts to transmit the signals, and there are different modulation schemes that can be used within the pulse. Here, a frequency of 2.1 GHz is used, so during the pulse, a constant 2.1 GHz is being transmitted.
The radar transmits for a certain amount of time called the pulse width, and in our design we are using a pulse width of 2 ms. In a pulse radar system, the pulse is to radiate out the reflection of an object and return to the radar before the next pulse is sent. This is so that there is no ambiguity as to which pulse the other echo belongs to.

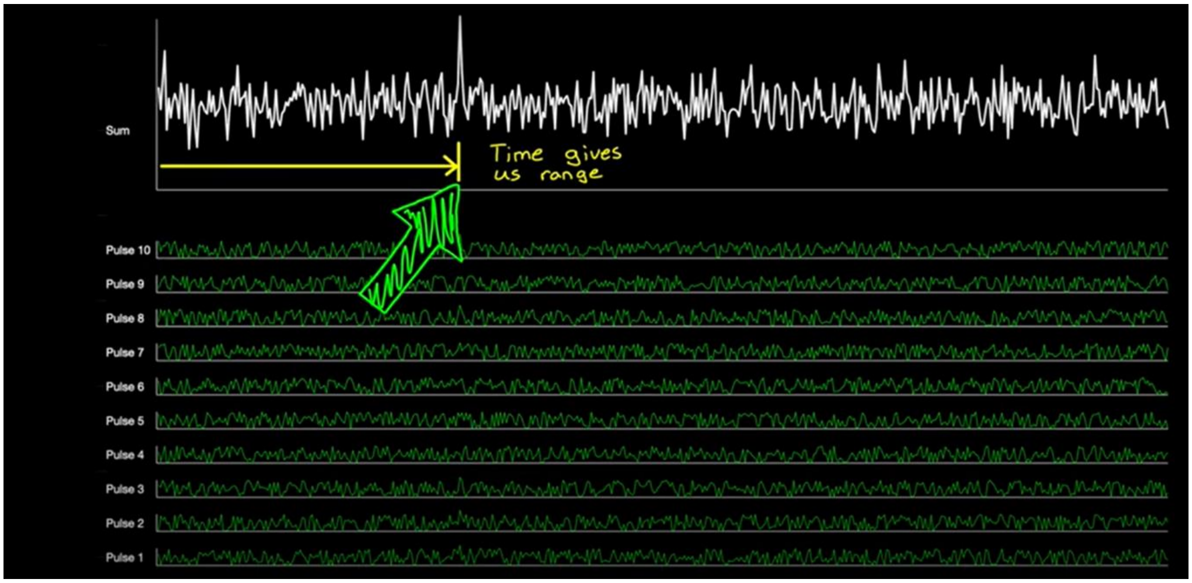


In our design, a pulse repetition frequency (PRF) of 0.01 kHz is used. The maximum unambiguous range for this system is :

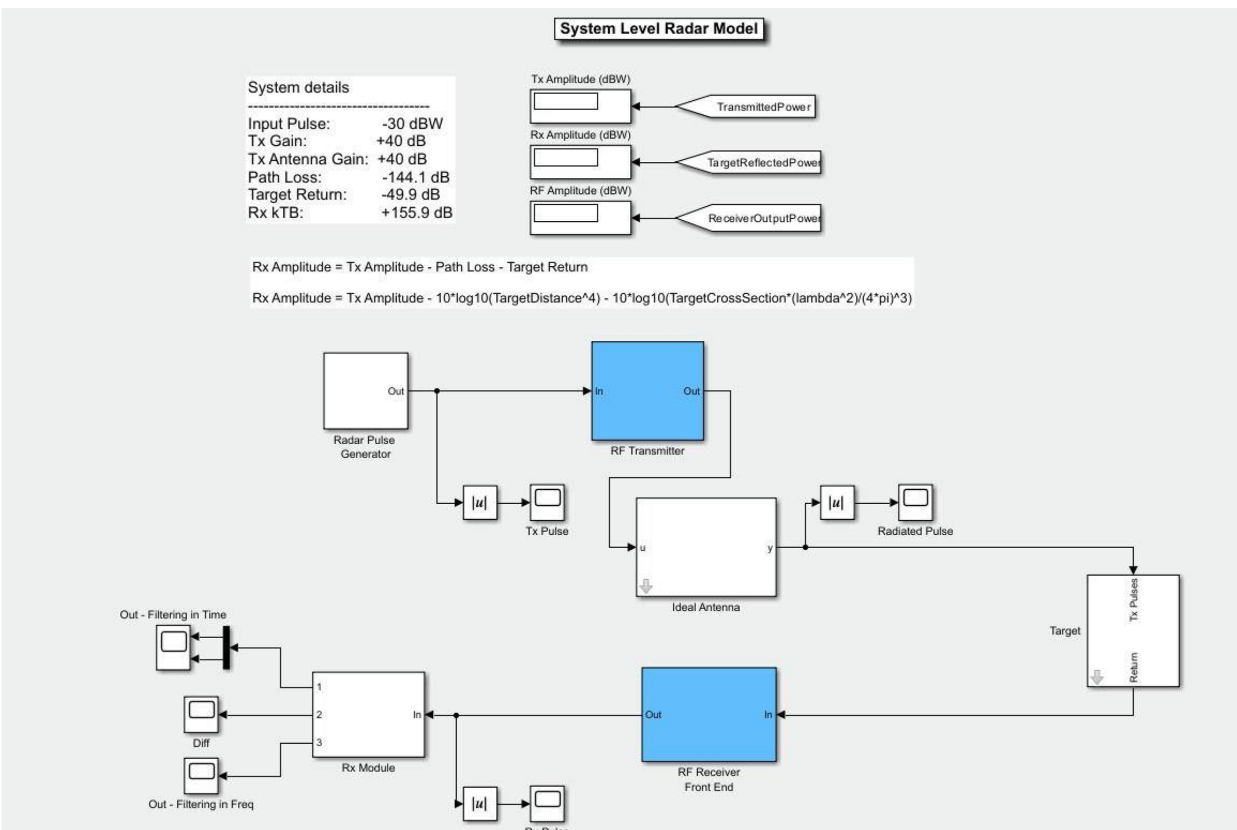
Max Range = (C/2)* (100 ms)= 15000 Km

After the pulse is sent, the receiver starts listening, and even before the pulse returns, there is some amount of noise power from environment. When the reflected signal returns, hopefully it is much greater than the noise, and we can determine the time between when the pulse was sent and when it returned. Now the range to the object is calculated by determining the round-trip distance that light would have travelled in that amount of time. We know signal power drops by the distance to the object raised to the power 4 .So as the object gets further away, it becomes more difficult to pull it out of the noise, which brings us to the second thing that the signal to noise ratio and the threshold at which an object is detectable. We set this detectability threshold such that the probability of a false detection is low enough to not constantly claim random noise spikes as objects and not so high as to miss the signal completely. The constant false alarm rate or cfar a common form of adaptive algorithm that's used to set this threshold in order to acheive the required probability of false alarm.To increase the probability of detection and decrease the probability of false alarm, we need to find a way to amplify the signal relative to the noise, and one way that can be achieved is with a matched filter.

After passing through a matched filter, this has the effect of amplifying the signal and making the signal more narrow by turning that wide rectangle into a single-peaked triangle. This is called pulse compression. This type of filter amplifies the signal more than the noise since there is a correlation between the pulse and the received signal, whereas there is going to be a lower correlation with random noise. Most importantly, it gives an improved SNR.



IMPLEMENTATION:



The system consists of:

- A radar pulse generator, which outputs a chirp with a power of 1 mW at a 2% duty cycle (On time = 2 ms, period = 100 ms).

- An RF transmitter section consisting of a filter and an Amplifier implemented using RF Blockset Circuit Envelope library blocks. Since the filter is a linear device and the amplifier is a non-linear device, they are split into two separate independent subsystems. This separation allows the use of different simulation frequency sets in each subsystem. This separation also permits a trade-off between faster simulation speed and the loss of inter-stage loading effects available in a cascaded chain.

- An ideal antenna element with specified bore sight gain operating at 2.1 GHz.

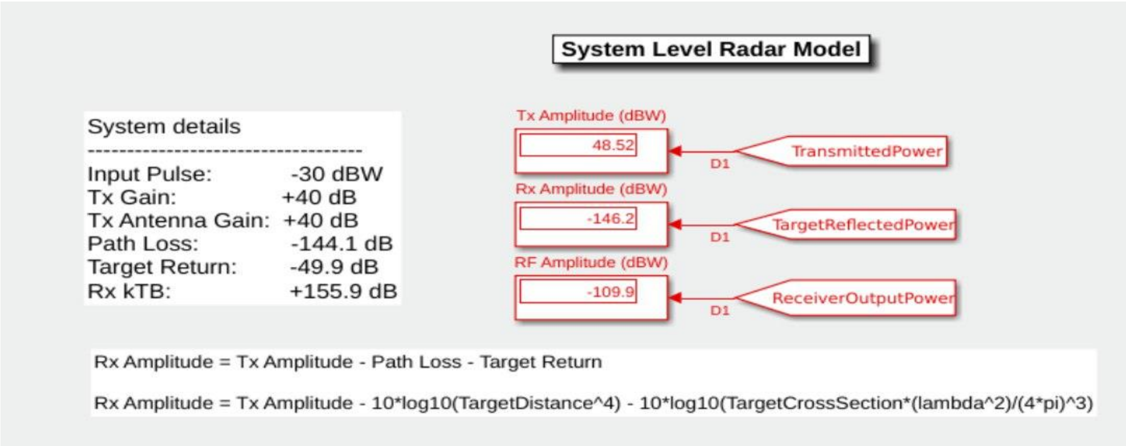
- A moving target implementation that reflects the entire incident signal from its cross-sectional surface. The target surface is perpendicular to the incident radar pulse direction of travel.

- An RF Receiver built using the RF Blockset Circuit Envelope library. The direct conversion structure is implemented in the receiver together with LNA and matching networks. The LNA is describing in a touchstone file and the local oscillator includes a phase noise model. Similar to the RF transmitter section, the receiver is split into independent linear and non-linear subsystems. The matching networks, LNA and filter are in the linear section, while the Mixer and final stage amplifiers are in the non-linear section.

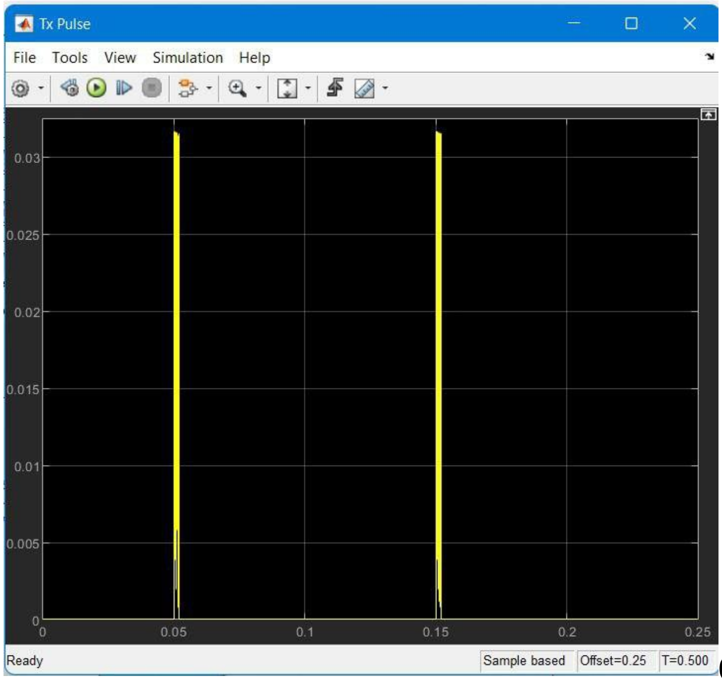
The Receive Module in this example serves two purposes. First, the module contains a matched filter detector for target detection. Second, the module serves as a test bench where a theoretical filter implementation is realized via Simulink blocks. The output of each of these filters is compared and their differences plotted.

OBSERVATION

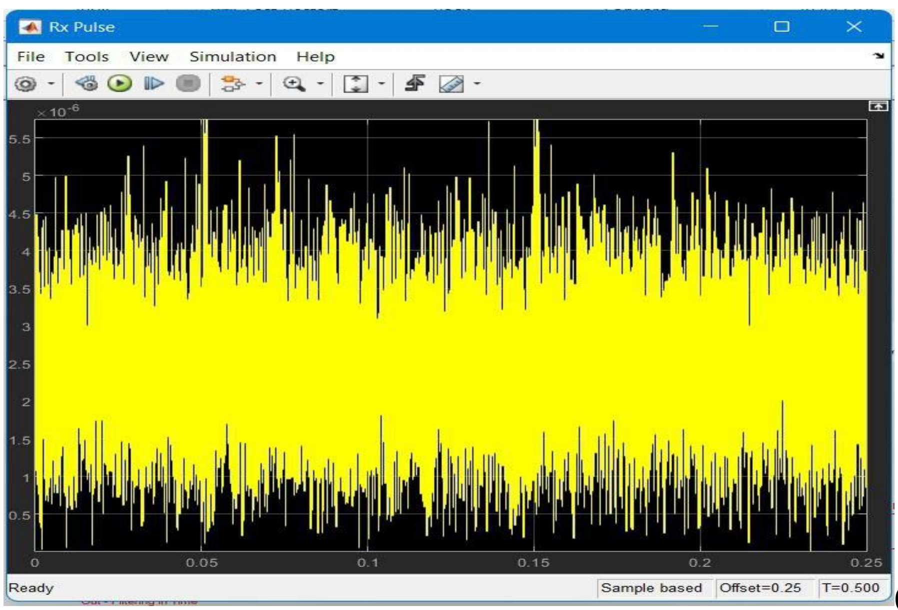
SIMULATED RESULT:



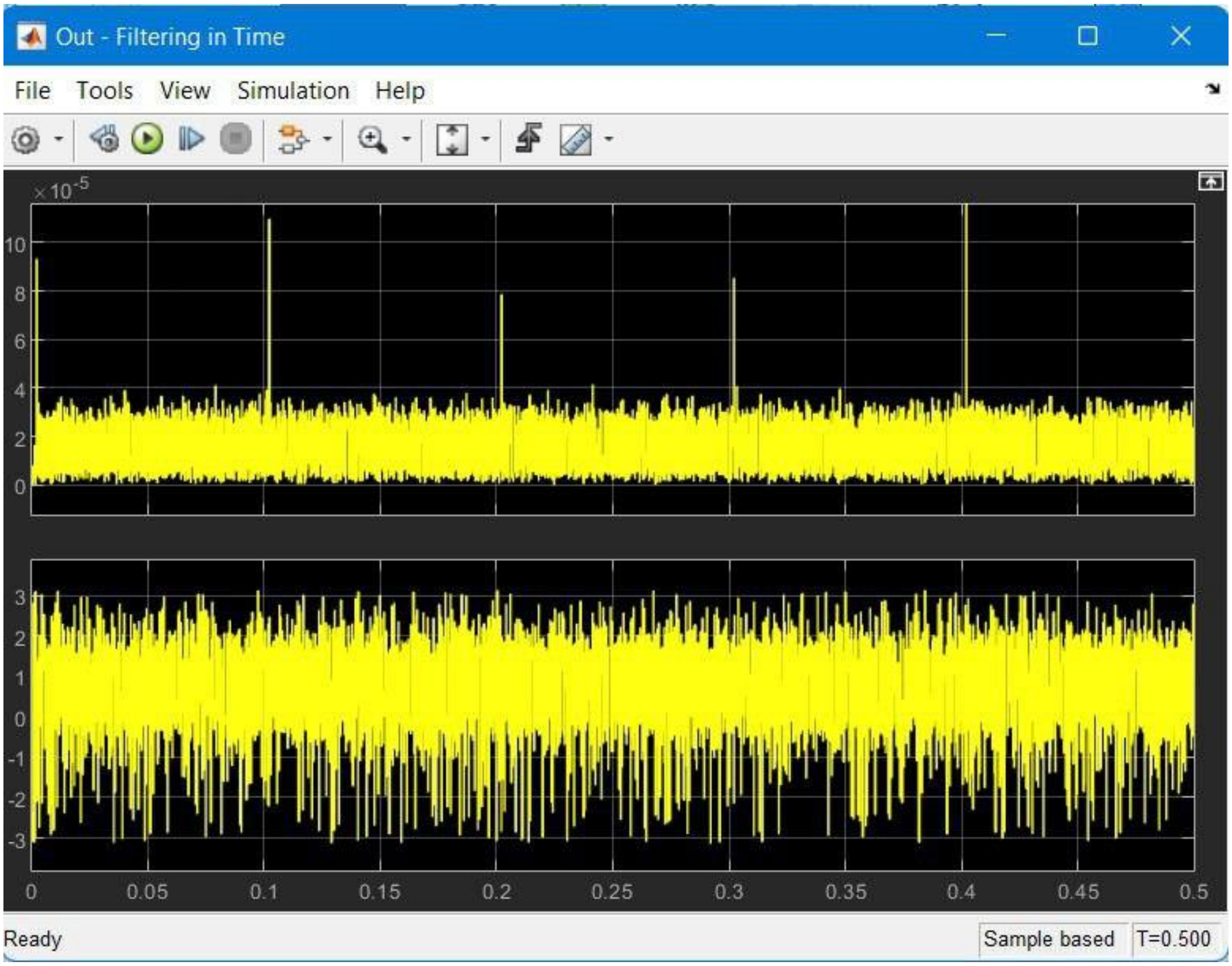
OUTPUT:



(Tx Pulse Graph)



(Rx Pulse)



(Time Graph)

From time graph the range of the target can be calculated as:

$\Delta T = 0.1s$

Unambiguous range= (c* ΔT)/2 = (3*10^8 *0.1)/2=15000km

Path loss=-144.1dB

Noise at Rx KTB=155.9dB

Transmitted power = 48.52dBw

Target reflected power= transmitted power- 10*log(range^4)-10*log(rcs*(lamda)^2/(4*pi)^3)

= -156.48dBw

Here, simulated value is -146.1 dBw and calculated value is -156.48 dBw

Error percentage= 6.63%

To calculate power from radar equation we have mentioned only path loss . but there might be some kind of environmental losses. Hence, we are getting the percentage error.

CONCLUSION:

We have implemented the pulse radar system, simulated it using Simulink. The outputs are displayed and results are calculated. Pulse radars are designed mainly for long distances. The main application is still the military area. Other applications include air traffic control, weather observation (especially precipitation radar) as well as the satellite-based remote sensing of the earth's surface.