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An Approach of Computer Simulator for Integrating with Radar Data Encoder by using Basic Platforms

Saniya Taskeen[1], Inchara.K[2], Rumana Sadiya[3], Mohammed Elahi[4]
[1, 2, &3]Students, Dept of ECE, Ghousia College of Engineering, Ramanagaram, Karnataka
[4]Asst. Professor, Dept. of ECE, Ghousia College of Engineering, Ramanagaram, Karnataka
Email id: saniyataskeen96@gmail.com[1], inchararmg@gmail.com[2], sadiyarumana8@gmail.com[3], mdfazaleelahi@gmail.com[4]

Abstract: **Radar (Radio Detection And Ranging) is an object – detection system that uses radio waves to determine the range, angle or Velocity of objects. It can be used to detect aircraft, ships, guide missiles, motor vehicles, weather formations and terrain. In addition, the radar system can also guide the missile towards the hostile target which is called the GUIDANCE RADAR. In this radar, the hostile target continuously tracked with the minimum error variance and accordingly the data is presented to the battery control officer for launching the missiles. After the launch, the encoded commands are transmitted from radar to guide the missile towards target. The Computer is the heart of Radar system which computes schedules and synchronizes all the system for the radar processing. It guides the missile based on the target and missile data which is then forwarded for Radar Data Encoder (RDE). RDE mainly encodes the data coming out from the computer and then converts the received data in a particular required format and then sends the converted data to Power Module. In this project, the implementation of RDE is carried on a cyclone –V-FPGA board and along the RC simulator is developed to validate the stand alone RDE unit.**
Index Terms:- Radar, Radar Data Encoder, Field Programmable Gate Arrays, Computer Simulator.

I)INTRODUCTION:

RADAR is an acronym for Radio Detection And Ranging. Radar is an electromagnetic sensor system used for detection, location tracking, space imagining and classification of targets such as man-made objects like aircraft, ships, ground moving vehicle and natural environment including ground features and moving men. The first observation of radar effect made in 1922 by Dr. Albert Taylor of Naval Research Laboratory in Washington D.C. Taylor observed that ship passing between transmitter and receiver reflects some of the waves back to the transmitter. In 1930 further tests at Naval Research Laboratory observed that plane flying through a beam from transmitting antenna caused a fluctuation in the signal. In 1941 radar had beam employed to track aircraft automatically in azimuth and elevation and later to track targets automatically in range. Radar is used for both military as well as civilian. Radars have been operated at frequency from a few megahertz to the ultraviolet region of spectrum. Radar measurement of range, or distance, is made possible because of the properties of radiated electromagnetic energy. Radar sets use the echo to determine the direction and distance of the reflecting object. Radar can perform its function at long or short distances , it can operate in darkness, haze, fog, rain and snow .The radar systems can be broadly classified into two types:1.Continous or Doppler radars 2.Pulse radars. Doppler radar which utilizes Doppler Effect, if there is any relative motion between the radar and target, the shift in the carrier frequency of the reflected wave is a measure of the targets relative velocity. In Pulse radar, a pulse waveform modulating a sine wave carrier is transmitted. The range or distance to the target is determined by measuring the time T taken and return back to the radar station..

FPGA: Field Programmable Gate Arrays (FPGAs) were first introduced almost two and a half decades ago. The FPGAs (Field Programmable Gate Array) are programmable digital logic chips. It means that the FPGA is useful to do the program on to them to do almost any digital functionality containing array of logic Blocks with programmable interconnections, input/output blocks, programmable interconnects, Memory blocks and other resources such as buffers, global clock buffers, dedicated multiplier. It is Large then Complex Programmable Logic Devices (CPLDs) and reconfigurable. It is also called Reconfigurable Processing Unit (RPU). Normally FPGAs comprise of a) Programmable logic blocks which implement logic functions. b) Programmable routing that connects these logic functions. c) I/O blocks that are connected to logic blocks through routing interconnect and that make off-chip connections.

1.1) BLOCK DIAGRAM OF RADAR

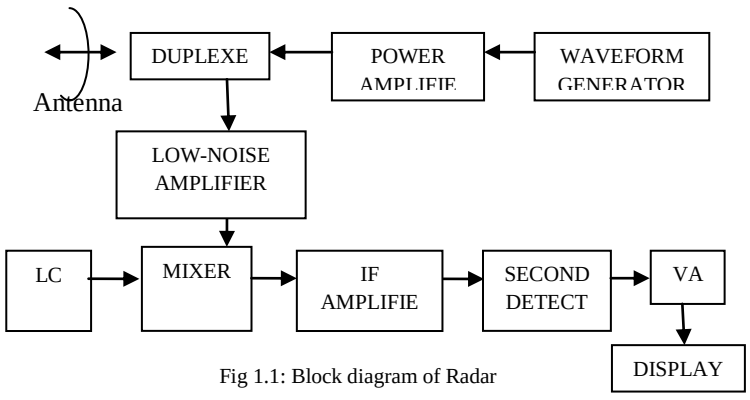

Fig 1.1: Block diagram of Radar

Basic parts of radar system

1) **Antenna:** the transmitter power is radiated into space by a directive antenna which concentrates the energy into a narrow beam and receives any echoes or reflection of transmitter pulses from targets and passes these echoes to the receiver.

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2) **Duplexer:** The duplexer acts as a rapid switch to protect the receiver from damage when the high-power transmitter is on. On reception, with the transmitter off, the duplexer directs the weak received signal to the receiver rather than to the transmitter.
3) **Low noise amplifier:** The receiver will be super heterodyne, the function of the receiver is to amplify or increase the strength of very weak radio frequency echoes.
4) **Local oscillator:** The super heterodyne receiver utilizes local oscillators and mixers to convert the echo to intermediate frequency that is convenient for filtering and processing operation.
5) **IF amplifier:** The mixer of the super heterodyne receiver translates the receiver radio signals to an intermediate frequency, the gain of IF amplifier results in an increase of
the receiver signal level.
6) **Second detector:** The second detector in the receiver is an envelope detector which eliminates the IF carrier and passes the modulation envelope.
7) **Video amplifier:** The video amplifier raises the signal power to a level where it is convenient to display the information it contains.
8) **Transmitter:** Transmitter is shown as a power amplifier, such as klystron,travelling-wave tube, crossed-field amplifier, or solid state device. A power oscillator such as a magnetron also can be used as the transmitter, but the magnetron usually is of limited average power compared with power amplifiers, especially the klystron, which can produce much larger average power that can a magnetron and is more stable. Transmitters not only must be able to generate high power with stable waveforms, but they must often operate over a wide bandwidth, with high efficiency and with long, trouble-free life.
9) **Display:** The display for surveillance radar is usually a cathode-ray tube with a PPI (plan position indicator) format. The PPI is an intensity modulated, map like presentation that provides the target location in polar coordinates (range and angle).

II) Overview of FPGA

2.1) FPGA

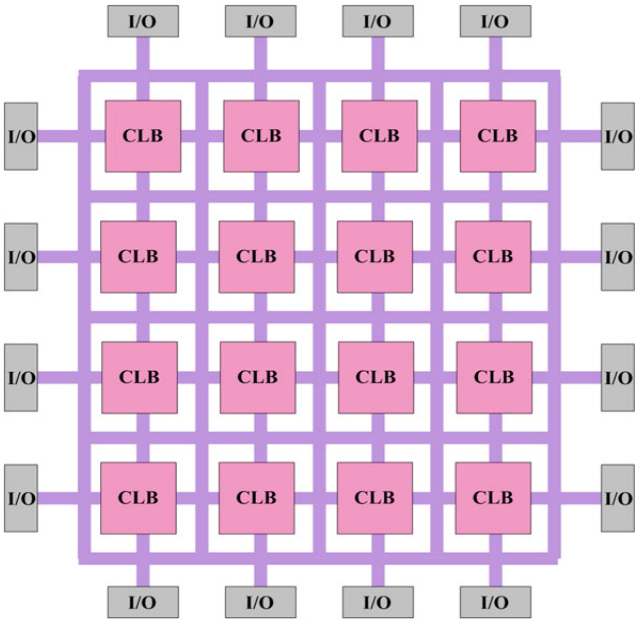


Fig 2.1: An overview of basic FPGA architecture

2.2) FPGA Generic Flow:

- Design Entry: Create design files using hardware description language (VHDL, Verilog) or schematic editor.
- Design "Implementation" on FPGA: Partition, place, and route to create bit-stream file, called bit file.
- Design Verification: Used Simulator to check function, Load onto FPGA.
- Device (cable connects PC to development board) and test the operation at full speed in real environment.


Fig2.2: FPGAboard

2.3) How FPGAs work:

- The FPGAs are built from one basic "logic-cell", a logic cell is composed of a small lookup table (LUT), some gates and a D-flip-flop. Each logic-cell then can be connected to other logic-cells

through interconnect resources (wires/muxes placed around the logic-cells). The complex logic functions can be created from each logic cell.

- FPGAs have fast-dedicated lines in between neighbouring logic cells, these fast-dedicated lines are called as carry chains. The carry chains allow creating arithmetic functions very efficiently. FPGAs have internal memories, writing to RAM usually done through synchronously and reading is done through asynchronously. The RAM blocks are usually dedicated memory block ("block rams").
- The configurable "pins" have divided in to two parts in to FPGAs – Dedicated Pins and User pins. Here configurable pins means - The pins are used to configure the logic cells or blocks.

2.4) Applications of FPGAs

FPGAs have gained rapid acceptance and growth over the past decade because they can be applied to a very wide range of applications. A list of typical applications includes: random logic, integrating multiple SPLDs, device controllers, communication encoding and filtering, small to medium sized systems with SRAM blocks, and many more. Other interesting applications of FPGAs are prototyping of designs later to be implemented in gate arrays, and also emulation of entire large hardware systems. The former of these applications might be possible using only a single large FPGA (which corresponds to a small Gate Array in terms of capacity), and the latter would entail many FPGAs connected by some sort of

Interconnect; for emulation of hardware, Quick Turn [Wolff90] (and others) has developed products that comprise many FPGAs and the necessary software to partition and map circuits. Another promising area for FPGA application, which is only beginning to be developed, is the usage of FPGAs as custom computing machines. This involves using the programmable parts to "execute" software, rather than compiling the software for execution on a regular CPU.

III) BLOCK DIAGRAM of RDE:

The computer simulator (CS) is a program that is run on a computer and that uses step-by-step methods to explore the approximate behavior of a mathematical model. Usually this is a model of a real-world system. Such a computer program is a computer simulation model.

The CS basically used at the test bed facility. In case of non-availability of computer and for trouble shooting RDE, CS is been implemented CS sends a LAN packet to RDE in UDP formats at the speed of 1Gbps same as actual computer data the main functionality of RDE is to encode and generate the command data in the different pulse format based on timing information of each dwell as received from the CS.

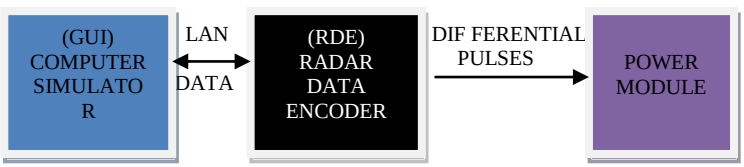


Fig 3: RDE Block diagram

The output of RDE is to send to antenna power module for radiating the encoded data and carry out the target and missile tracking functionalities respectively. CS is developed in .NET platform using C# programming language. The data is then encoded in the FPGA and corresponding differential signals are generated. The encoded radar data signals are monitored at the output of the CRO.

3.1) Local area network (LAN)

A network providing data communication between computer stations, usually limited to a single building or complex of buildings. A LAN is a data communication network that pulls together computing resources such as PCs, printers, mainframes, and mainframes. These elements are linked by a transmission cable or other transmission media. It is common to find LANs consisting entirely of PCs, with some serving in roles traditionally restricted to minicomputers (sometimes called "mainframes") and mainframes. Modern networks often include **modems** and other remote communication devices to support Internet access, remote user access, and remote LAN connectivity.

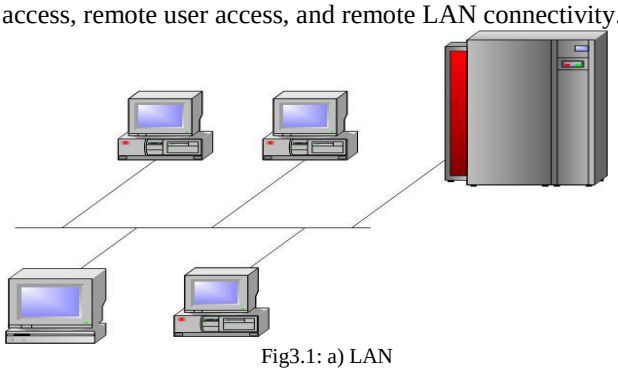
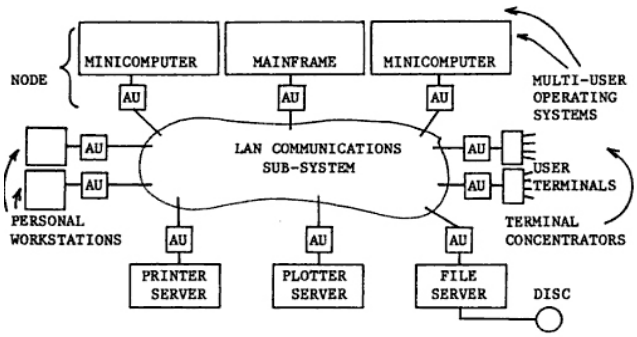


Fig3.1: a) LAN



b) Example of LAN configuration

3.2) Components of a Local Area Network

Like any other data communication network, a local area network is composed of three basic hardware elements: a transmission medium**,** often twisted pair, coaxial cable, or fibres optics; a mechanism for control of transmission over the medium; and an interface to the network for the host computers or other devices-the nodes of the network-that are connected to the network. In addition, local area networks share with long-haul packet communication networks a fourth basic element: a set of software protocol, implemented in the host computers or other devices connected to the networks, which control the transmission of information from one host or device to another via the hardware elements o f the network. These software protocols function at various levels, from low level packet

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transport protocols to high-level application protocols, and are an integral part of both local area networks and their close relatives, long-haul packet communication networks. A LAN is a combination of hardware and software.

3.2.1) Hardware

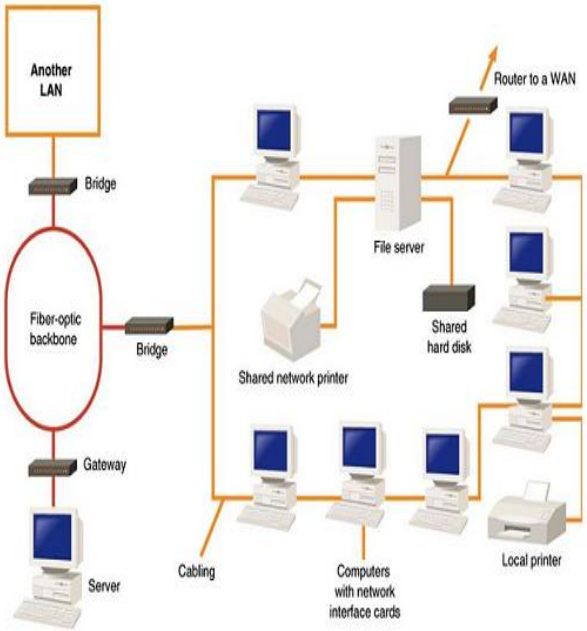
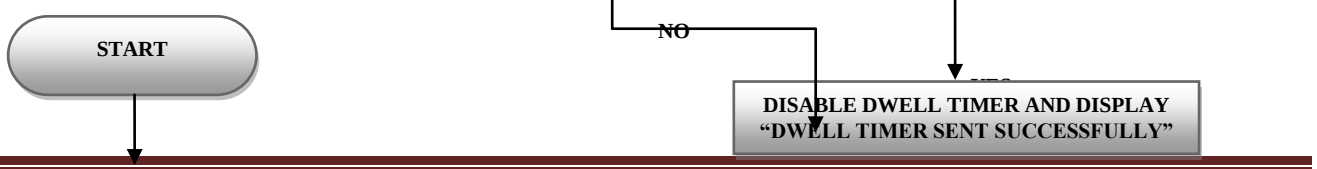


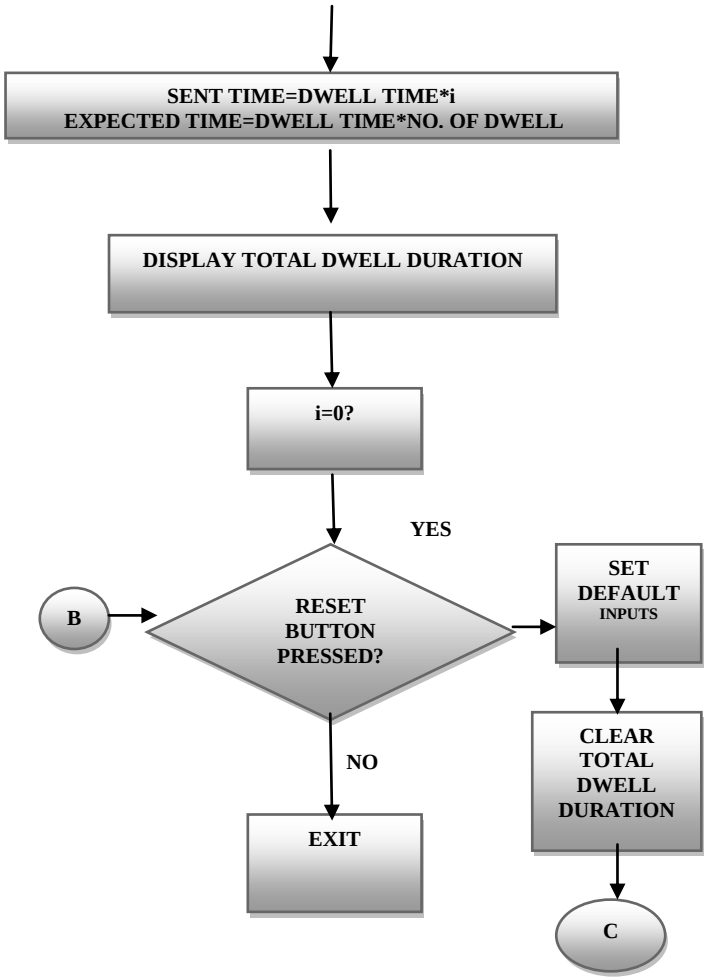
Fig 3.2.1: components of LAN

The hardware consists of stations, transmission media, and connecting devices.

- Stations: Stations are actual devices that connect to the network. These can be computers, printers etc.
- Transmission Media: The transmission media is the stuff through which signals travel. It can be guided as in the case of a wire, or unguided as in the case of air (wireless).
- Connecting Devices: Besides the wires and stations, there are also connecting devices. There are two 'types':
  - Transceivers and all the other stuff that's used to connect a station to the medium.
  - Bridges, repeaters, etc., stuff that's used to connect segments of a LAN.
- The Software: There are two primary categories of software, the Operating System, and Application Programs.
- Network Operating System: There needs to be some software at the operating system level that manages the network connection. Most modern operating systems are capable of using the network.
- Application Programs: The primary purpose of having a LAN is to allow several application programs to talk to each other.

IV) FLOW CHART





V) EXPECTED OUTCOMES

The approach of computer simulator for integrating with Radar Data Encoder, with the help of computer simulator the testing can be done before it is sent. Since we are planning to design the programming code for the implementation of computer simulator using GUI and Microsoft VC# programming language based on .NET platform for missile tracking can be done.

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