Sudan University of Science

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Collage of Graduate Studi

Design of Borders Surveillance System Using Radar and Camera

تصميم نظام مراقبة الحدود باستخدام الرادار والكاميرا

A thesis Submitted in Partial Fulfillment of the Requirement for the Degree of M.Sc. in Electronics Engineering (Computer and Network Engineering)

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بسم الله الرحمن الرحيم

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(وَقُلْ رَبِّ زِدْنِي عِلْماً)

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Abstract

It is very important to protect country's borders from intruders who carry out illegal activities such as terror attacks or smuggling of people or their properties. Borders should be monitored to avoid the above-mentioned risks by using border surveillance system which consists of ground surveillance radar and camera to achieve this mission. To perform the monitoring, signals are sent from radar to the microcontroller, according to target location, in order to move the camera to capture the target by using two servo motors, horizontally according to pan angle, and vertically according to tilt angle. As a result the movement of a camera is the same as target's location on the radar. A camera is interfaced to a computer to record a video signal and displays the target's location captured on a computer monitor.

المستخلص

من المهم للغاية حماية حدود الدولة من المتسللين الذين يقومون بأنشطة غير قانونية مثل الهجمات الإرهابية أو تهريب الأشخاص أوالتغول علي ممتلكاتهم. لذلك يجب مراقبة الحدود لتجنب المخاطر المذكورة أعلاه عن طريق استخدام نظام مراقبة الحدود الذي يتكون من رادار مراقبة ارضية وكاميرا لتحقيق هذه المهمة. و لإجراء المراقبة ، يتم إرسال الإشارات التي تحوي موقع الهدف من الرادار إلى المتحكم الدقيق وذلك لتحريك الكاميرا لتصوير الهدف باستخدام محركين معززين ، احدهما أفقيًا وفقًا لزاوية التدوير ، والاخرعموديًا وفقًا لزاوية الميل. ونتيجة لذلك تكون حركة الكاميرا مماثلة لموقع الهدف من الرادار. ويتم ربط الكاميرا بالكمبيوتر لتسجيل اشارة فيديو وعرض موقع الهدف الذي تم التقاطه على شاشة الكمبيوتر.

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LIST OF ABBREVIATIONS

AC	Alternating current
CCTV	Close –Circuit Television
DC	Direct Current
DVR	Digital Video Recorder
EEPROM	Electrically Erasable Programmable Read-Only Memory
FMCW	Frequency Modulated Continuous Wave
GSR	Ground Surveillance Radar
ICSP	In-Circuit Serial Programming
IDE	Integrated Development Environment
ISS	Intelligent Surveillance System
Mpd	Microsecond per degree
PC	Personal Computer
PCIDVR	Payment Card Industry Digital Video Recode
PPI	Plan Position Indicator
PPM	Pulse Proportional Modulation
PROTEUS	PROcesssor TExt to USe
PTZ	Pan Tilt Zoom
PWM	Pulse Wave Modulation
RADAR	RAdio Detection And Ranging
SRAM	Static Random-Access Memory
TTL	Transistor-Transistor Logic
USB	Universal Serial Bus

Chapter One
Introduction

1.1 Background

Surveillance is the monitoring of behavior, activities, or other changing information for the purpose of influencing, managing, directing or protecting people[1].Surveillance is used by governments for intelligence gathering, prevention of crime, the protection of a process, person, group or object, or the investigation of crime. The main aim of a border surveillance system is to protect the country's borders against intruders who attempt to conduct illegal or criminal activities, as well as the protection of oil platforms or oil pipelines.

Border security means different things: border control, border management, border monitoring, border protection, etc. Usually, border .security has been used to mean border control, which seeks to facilitate or limit the movements of people, animals, plants, and goods in and out of a country [2].

In this research of border surveillance system using ground surveillance radar (GSR) and pan- tilt –zoom camera (PTZ) to be explained follows:

For wide-area surveillance was found with a new generation of ground surveillance radars (GSRs). By design, these radars can fast and continuously scan a full 360 degrees and detect movement in any lighting and virtually any weather condition. Significant advances in radar technology have made them more affordable and easier to operate. Security professionals now have the solution they've needed for wide-area surveillance Ground Surveillance. Radars can build a virtual wall around facilities, a border or be used for force protection.

They give operators and agents more response time to access, prioritize and apprehend intruders than a traditional system. The extra response time is one of the important features of the wide-area surveillance concept, along with added benefits for both the operators and the response teams [3].

The radars are unable to distinguish between friend and foe, only able to detect and classify moving targets by type [4].

The pan, tilt, zoom cameras (PTZ) are devices that can be moved left and right (pan), up and down (tilt), and zoom in and out. First of all, it can be remotely controlled to pan, tilt and zoom; it can easily adjust the camera toward the area you want to monitor without going to the site where the camera is. Furthermore, the preset functions allow you to monitor multiple areas as long as the camera can point to the right direction. This function greatly increases the flexibility of your video surveillance system.

Pan-tilt-zoom cameras have the ability to acquire high-resolution imagery and allow tracking events over a wide range in the environment. The positioning, setting of pan and tilt angles. Surveillance with fully calibrated pan-tilt-zoom cameras involves not only video processing but also controlling the pan and tilt angles collecting real data in which to perform experiments. Using real data, i.e. images acquired by a pan-tilt-zoom camera, Simulation multiple simultaneous events, e.g. multiple persons moving around [5]. Here, in this research, we used the simulation of ground surveillance radar with the PTZ camera to surveillance the border of any target type. This was done by scan the radar and recording all the events on the camera PTZ.

1.2 Problem Statement

The problem of open border ports affected the country economic in addition national security, such as risks as attacks and smuggling of persons or weapons and explosives or drug or properties.

1.3 Objectives

The general aims of this thesis to offer the border port security. And addition to the following objectives**:**

- To provide modern electronic surveillance to the entire borderline and important buildings.
- To provide early detection of any operation aimed to the security of the country.
- To designed and implemented border's surveillance system using radar and camera.
- To reduce risks of attacks and decrease smuggling of weapons or drug or property.

1.4 Methodology

Border's surveillance system is controlled by using radar and a camera. The system control is containing two parts:

First part the radar simulator by simulink matlab program to give the range and azimuth angle of target position.

Second part control system circuit consists of Arduino and servo motor, which moved the camera to monitor the borders.

The control system implemented by sending signal from radar simulator to the microcontroller, in order to move servo motors, as the result the camera move according radar's location and tested the control system design.

1.5 Research Outline

The research contained five chapters as follows:

Chapter two gives the concept of border surveillance, radar and camera surveillance, components of system design and the previous studies.Chapter three gives system design, software and hardware design. Chapter four gives the results for circuit designs and discussion.Chapter five gives the conclusions and recommendation.

Chapter Two
Background and Literature Review

2.1 Background

Border security and control on reducing the occurrence of access and illegal immigration from one country to another, and deter attempts to infiltrate terrorist groups from the neighboring state sponsors of this phenomenon, as they provide the States concerned early signs of aggressive action were not taken into account.

Surveillance systems have become important systems and have many benefits, including like the spreading an air of calm in the controlled places, help reduce sabotage, detecting the details of subversive acts, in case they occur, helping smart management of various enterprises through integration with other systems.

Surveillance systems are used in almost every aspect of life-like control and management of industrial, commercial, banking, health and educational establishments, monitoring traffic in cities, public roads, and air and sea ports, Scientific, military and space research, Many home applications such as house monitoring and monitoring of children and the elderly .

The surveillance systems are implemented in this research by radar, and camera will be explained follow:

2.1.1 Surveillance Cameras

Surveillance cameras are one of the most important requirements of the day for the availability to the highest degree of security and full control of many of the places without the need for an individual to monitor them throughout the day and thus save a lot of cost and effort in addition to the many features that are available surveillance cameras recording events. Goal is the surveillance camera system could be followed:

- To reduce and fear crime.
- To improve public safety and property security.
- To create a safe and vibrant place for the leisure and pleasure of people.
- To ensure that persons such as the elderly, the disabled, women and indigenous peoples, can use the public space safely.

That mean in general, surveillance camera systems aim to observe given area in order to increase safety and security. Surveillance cameras can be classified according to several characteristics:

First: In terms of locating to

1/ Indoor Surveillance cameras

Are cameras that can't withstand weather factors such as soil, heat, sun, water and rain, so they are installed in closed places such as companies of income, classrooms, closed offices and room.

2/ Outdoor Surveillance cameras

They are surveillance cameras that withstand weather and weather changes such as high and low temperatures, rain, light and heat of the sun.

Second: In terms of connecting

1/ Analog Surveillance cameras

They are surveillance cameras are connected directly to a device called a DVR and are used for recording or are connected to a computer to a PCI DVR card.

2/ IP Surveillance Cameras

A kind of surveillance camera uses IP address technology, surveillance camera equipped with microprocessor and memory are a small computer so it is one of the most expensive surveillance cameras. It is considered one of the easiest surveillance cameras in the installation, as it is equipped with a network card such as network cards located in computers.

Third: In terms of moving to

1/ Fixed surveillance cameras

They are surveillance cameras that can only be moved by the way they are installed, which can't be controlled remotely.

2/ Mobile Surveillance Cameras

Pan Tilt Zoom (PTZ) the camera is moving right and left and up and down (meaning circular camera) in addition to the zoom featured quality cameras are expensive but used to cover huge places.

Pan-tilt-zoom (PTZ) cameras are one of the advanced security cameras in the market. These cameras have the ability to cover a very far field and can acquire high resolution of images. These cameras are deployed mainly for perimeter surveillance applications where the security guards have to monitor the intruders from a long distance. Although there are intrinsic advantages of using pan-tilt-zoom cameras, their application in automatic surveillance systems is still scarce. The advantage of using PTZ cameras over the static cameras is that they can cover a larger area as compared to passive cameras. Only cover a specified field of view, and multiple cameras are required to track a person in a particular area. Such multi-camera systems are very costly to use. Therefore, a system utilizing a single pan-tilt-zoom (PTZ) camera can be much more efficient if it is properly designed to work well [6].

PTZ (Pan/Tilt/Zoom) security cameras provide many benefits over standard stationary security cameras. The Benefits of Pan/Tilt/Zoom Security Cameras PTZ Security Camera:

1/ Large Field of View: Depending on the mounting location, they can cover a full 360 degree area. Most models allow the installer to set several surveillance modes based on the viewing angle you need at pre-determined times. Both pan and tilt are can be pre-programmed.

2/ Resolution defines how clear the image from your camera will be the visible image is very helpful when trying to identify faces or items in the images your camera records.

3/ Built-in Motion Tracking: All of our PTZ Cameras come with it, which can be set to detect motion and tracks the person or object, automatically panning, tilting or zooming to follow the person or object as it moves.

4/ Night vision is a very important benefit when you need to provide surveillance in any area with poor lighting conditions. The amount of light is critical to capturing a high-quality image.

5/ Weatherproof: Pan Tilt Zoom cameras are made to live in even the harshest of elements. Our PTZ cameras are built for extreme outdoor reconnaissance. Wind, rain, snow and even heat won't affect performance.

6/ Powerful Zoom: PTZ Cameras are available regarding the detection ability of 150 feet on the low end and up to 1,000 feet on the more expensive models. The ability to zoom in on a person or object is from around 12X to 36X.

2.1.2 Ground Surveillance Radar

Radar is very complex electronic systems. The term RADAR is an abbreviation for the RAdio Detection and Ranging. Radars exploited electromagnetic energy to detect objects. It is classified as air bone, ground based, ship based radar system [7].

There are no fundamental bounds on radar frequency. Any device that detects and locates a target by radiating electromagnetic energy and utilizes the echo scattered from a target can be classed as radar, no matter what its frequency. Radars have been operated at frequencies from a few megahertz to the ultraviolet region of the spectrum. The basic principles are the same at any frequency, but the practical implementation is widely different. In practice, most radar operates at microwave frequencies, but there are notable exceptions [8].

The first task a certain radar system has to accomplish continuously scans a specified volume in space searching for targets of interest. Once detection is established, target information such as range, angular position, and possibly target velocity are extracted by the radar signal and data processors. Depending on the radar design and antenna, different search patterns can be adopted [9].

There is two primary Ground surveillance radars (GSR) technology's Frequency Modulated Continuous Wave (FMCW) and Pulse Doppler. Most pulse Doppler radars are derivatives of legacy military battlefield radar technology being applied for wide-area surveillance, while a new generation of FMCW radar technology has been developed for this type of surveillance, applied to high-value site security, airports, military bases, ports.

FMCW radars operate on the imaging principle; that is, they break up the background into small segments, or resolution cells, and then measure. Changes to the signal return from each cell to detect small targets. Typical resolutions for long-range FMCW radar are less than 1 meter in range and less than 1 degree in azimuth. FMCW operation is independent of the speed or direction of travel of the intruder.

Pulse Doppler Radars operate on the Doppler principle, which states that all moving objects will display a frequency shift from the transmitted signal to the received signal, which is proportional to the speed to the target in the direction from the radar. It was using in wide-area surveillance systems [3]. And in desert, area is of paramount importance. Radar can detect targets located at long distances over low-altitude terrain, a rocky plateau, or sandy plains, but its efficiency is affected by the presence of dust in the atmosphere and high temperatures in these areas.

For example, the ground surveillance radar such as The GR40 is radar that operates 24 hours a day under any atmosphere GR40 is easily deployed user friendly reliable and cost effective. The radar is also capable of supporting artillery fire correction by detection of the impact location of shells. A GR40 automatically detects moving target such as walking persons, vehicles and flying object (low-flying aircraft, flying aircraft, hovering helicopters and gliders) at ranges of up to 60 km.

The feature of GR40 is real-time accurate detection and acquisition of moving targets up to 60 km and 360 degree, target display on digital map, detection of ground target, maritime, helicopters and shell's impact, high resolution. Standard interface searched sensors. The GR40 is applications in border surveillance and protection; field artillery fired correction, critical infrastructure protection and harbor surveillance .the specifications of radar GR40 in a data sheet in [Appendix A]

2.2 Components of System Design

In this research, the border surveillance system is designed by ground surveillance radar and camera. The system consists of several parts as follows:

2.2.1 Radio Detection and Ranging

Radar is an acronym for the RAdio Detection and Ranging, and is used to describe systems that utilized electromagnetic energy to detect distant objects. Radar is designed continuously to scan a volume of space to provide initial detection of all targets. Search radar is generally used to detect and determine the position of new targets for later by tracking radar.

Tracking radar provides continuous range, bearing, and elevation data on one or more targets.

Ground Surveillance Radar Applications GSR systems can be used in a variety of applications, including urban warfare maneuvers, covert stakeout surveillance, counter terrorism, maritime surveillance, border patrol and security, observation and protection of remote areas, airport security, nuclear facility security, and tactical battle field applications[4]. the simulation of radar to detect the target it tracked in 2D can be determined from a surveillance radar Plan Position Indicator (PPI) display by plotting the target coordinates as they move when measured from scan to scan.

For example, the GS40 is a type of border surveillance and protection. It's easily deployed, reliable and cost effective. The radar operates 24 hours a day even under poor weather the GS40 automatically detects moving target [appendix A].

2.2.2 Serial Port RS232

The common serial interface can be used to transfer data and commands between microcontrollers or a personal computer and a microcontroller. The protocol RS232 defines signals used in communication, and properties of the hardware to transfer signals between devices. There are two signal lines: a TX line is used to output a signal from a device, and the RX line is used to input the signal. There is also a common ground line for both devices, Figure (2.1) left. The timing diagram of the typical signal used to transfer character 'A' (ASCII: 6510 or 0x41) from device, A to device B is given in Figure (3.2), and would appear on the upper line TX -> RX between devices.

The standard defines voltage levels V(0) to be at least +5V at the transmitting end of the line TX, and is allowed to degrade along the line to become at least +3V at the receiving and of the line. Similarly, voltages level V (1) must be at least -5V at TX, and at least -3V at RX. The standard also defined the upper limit for these voltages to be up to ±15V. Logic high is transferred as V (0). The microcontroller cannot handle such voltage levels, so typically a voltage level translator is inserted between the microcontroller and the connector where the RS232 signals are available; the microcontroller implements so-called TTL (Transistor-Transistor Logic) version of RS232 standard.

The standard defines the number of bits to be transferred within one pack, Figure (2.1) right, as eight for regular transmission, and nine for special purposes. The duration Tb of each bit defines the speed of transmission and is called the baud-rate. The typical baud-rate is 9600 bits per second (Baud, Bd), and the time Tb equals 104.16us other baud rates are: 19200 Bd, 38400 Bd, 57600 Bd, and 115200Bd. These are defined in standard, but used less frequently. The beginning of the pack of bits is signaled by a so called ‘START bit’, which has value 0 by definition. Its duration is equal to Tb. The pack of bits is terminated by so called ‘STOP bit’ with a typical duration of Tb, bat can also last either 0.5, 1.5 or 2 Tb, depending on the configuration. The complete transmission of a byte at a typical baud rate of 9600 Bd takes 1.0416 ms [10]

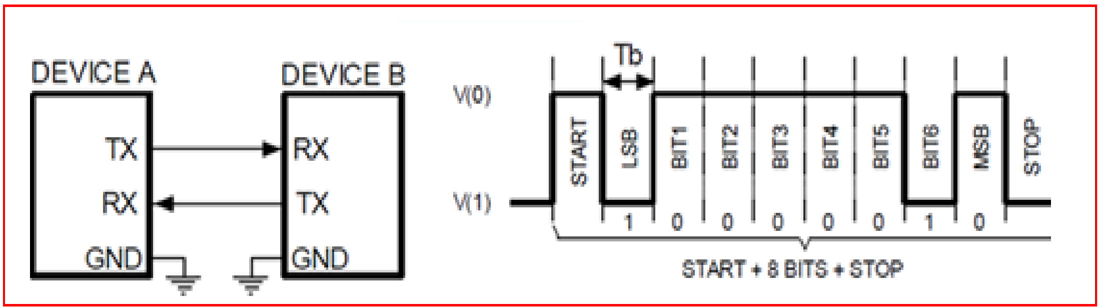

Figure (2.1) A serial communication conforming to RS232 protocol

2.2.3 Arduino

Arduino is a small microcontroller board with a USB plug to connect to your computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones, etc. They can either be powered through the USB connection from the computer or from a 9V battery. They can be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently show in figure (2.2) below [11].

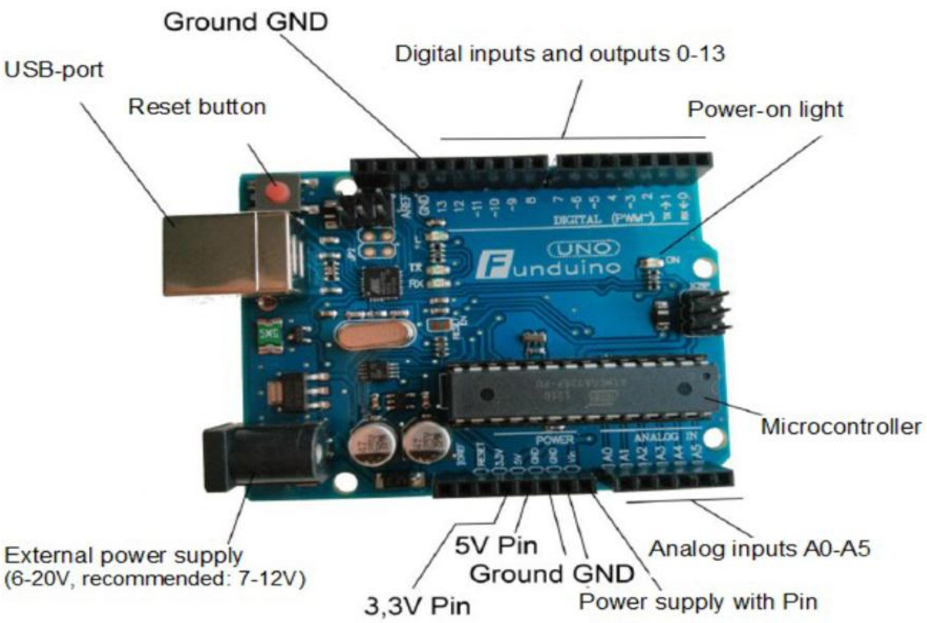

Figure (2.2) Arduino UNO

The Arduino hardware is a so-called micro controlling board (Following called "board"). Basically, it is a circuit board with many electronic parts around the actual microcontroller. On the edge of the board are many pins with whom it is possible to connect different components. There are different kinds of boards that can be used with the Arduino software. Different sized "official" boards, with the official "Aduino" name on it, but also many, mostly cheaper, but equivalent Arduino “fitting” boards. Typical official boards are called Arduino UNO, Arduino MEGA, Arduino Mini, etc.

The software that is used to program the microcontroller is open-source software and can be downloaded for free on www.arduino.cc. With this “Arduino software," you can write little programs which the micro controller should perform. Programs are called “Sketch." In the end, the sketches are transferred to the microcontroller by USB cable.

The Arduino Uno is a microcontroller board on the ATmega328. It is consisted of 14 digital input/output pins (of which 6 can be used as PWM outputs), six analog inputs, a 16 MHz ceramic resonator, a power jack, a USB connection, an ICSP header (you can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) and a reset button. It has everything required to support the microcontroller; just connect it to a computer with a USB cable or power it with an AC-to-AC adapter or battery to get started. Show technical specification of Arduino UNO in table (2.1) [12].

Table (2.1) technical specification of Arduino UNO

Microcontroller	ATmega328
Operating Voltage	5V
Input voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Analog Input Pins	6
DC Current per I/O Pin	40Ma
DC Current for 3.3 V Pin	50Ma
Digital I/O Pin	14 (of which 6 provide PWM output)
Flash Memory	32KB (ATmega328) of which 0.5 KB used by boot loader
SRAM	2KB (ATmega328)
EEPROM	1KB (ATmega328)

2.2.4 Servo Motor

A servo motor is defined as a motor that can be controlled precisely in terms of rotary and angular position [13] .This type of motor is controlled with a specific angular rotation with the help of an additional servomechanism. In general, this type of motor consisted of a simple electric motor, attached to servomechanism that affects the performance of the motor. There are three types of servo motor:

1. The positional rotation servo is the most common type of servo motor used where the servo output shaft can be controlled to rotate in the angular range of 0 to 180 degrees only. This type of servo is found in many electronic applications such as small scaled robots [14].

2. The continuous rotation servo motor works almost similar to the positional rotation servo motor; however, the angular range for the rotation is in the range of 0 to 360 degrees. Furthermore, this type of servo motor has a different approach in the control signal; where rather than setting the static position of the servo, the signal is interpreted as the direction and speed of rotation [15].The range of command signal causes the servo to rotate in the direction of a clock wise or counterclockwise at a varying speed based on the desired command signals. So far, this type of servo motor is commonly used in mobile robots or small-scaled robotic arm.

3. The Linear servo motor, its working principle is also similar to the positional rotation servo motor but instead of circular rotation, this type of servo movement is back and forth. Commonly, this type of servo is applied in the heavy-duty systems such as actuators in a large model to the airplane system[16] .

Servo is a DC motor equipped with an electronic circuit to accurately control the direction of rotation and position of the engine shaft, and equipped with a gearbox. Components of the servo show in figure (2.3):

1. Gearbox, its function doubles the speed and increased the momentum.
2. Control circuit, its function is to receive the control signal from the microcontroller's turn on the motor.
3. Motor, function and movement.
4. Variable resistance, its function is given a voltage corresponding to the position of the engine shaft based on the value of its resistor; it moves with the motor shaft.

Figure (2.3) Components of servo motor

There are three wires out of the engine are black, red and yellow:

1. The ground is connected to 0 volts. Color is black wire.
2. Connect to 5 volts. Color is Red wire.
3. The control signal is the control group of the yellow wire at 50Hz and not 60Hz with varying PWM pulse widths Pulse according to desired rotation direction figure (2.4).

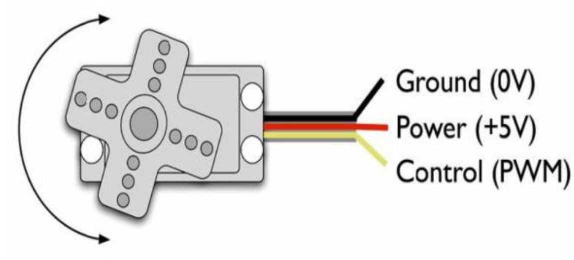

Figure (2.4) Wires of servo motor

An external controller (such as the Arduino) tells the servo where to go with a signal known as pulse proportional modulation (PPM) or pulse code modulation, not to be confused with pulse width modulation, PWM A control wire communicates the desired angular movement to the servo. The angle is determined by the duration of the pulse applied the control wire.

Servos can be mysterious, but in fact they are very simple. Servos use a simple electronic pulse to tell them what angle you want them to go to. It is electronic not digital, but there are digital servos and they are different than standard servos. Pulses are electronic, but they are part of our digital world. Microseconds are us. Milliseconds are ms.

Features of servo motor are: Strong strength, the ease and accuracy of control, Availability of different sizes to suit all applications and the possibility of working through long periods without rising in the heat.

A servo motor is the use in Applications radar detectors, satellite dishes, wings, Aircraft, some types of printing equipment.

All of these applications are characterized by very slow speeds. Servo motors are typically used for angular positioning, such as in radio control airplanes. They have a movement range of 0 up to 180 degrees like Servo motor SG90 in Figure (2.5). Typically, a potentiometer measures the position of the output shaft at all times so the controller can accurately place and maintain its position.

Figure (2.5) Servo motor SG9

2.2.5 Pan/Tilt/Zoom Camera

Pan/tilt/zoom cameras are very versatile. PTZ cameras can pan (move left and right), tilt (move up and down), and zoom in or out. Additionally, PTZ cameras can rotate 360 degrees to view an object directly below them. Indoor and outdoor options are available.

Pan-tilt-zoom (PTZ) cameras are one of the advanced security cameras in the market. These cameras have the ability to cover a very far field and can acquire high resolution of images. These cameras are deployed mainly for perimeter surveillance applications where the security guards have to monitor the intruders from a long-distance [6] .

A pan–tilt–zoom camera (PTZ camera) in figure (2.6) could be a camera that's capable of remote directional and zoom of management. Associate in nursing innovation to the PTZ camera could be an intrinsically microcode program that monitors the amendment of pixels generated by the video clip within the camera. Once the pixels' amendment owing to movement among the cameras' field of read, the camera will really target the element variation and move the camera in a shot to center the element fluctuation on the video chip. This method ends up in the camera following movement.

Figure (2.6) PTZ camera

The program permits the camera to estimate the dimensions of distance of the movement the camera. With this estimate, the camera will alter the camera's lens in and enter a shot to stabilize the dimensions of element fluctuation as a proportion of total viewing space. Once the movement exits the camera's field of read the camera mechanically returns to a pre-programmed or "parked" position until it senses element variation and therefore, the method starts another time. It involves three operations like Panning, Tilting and Zooming [17]

2.2.6 The Webcam

The webcam used instead of PTZ camera because it is cheap; but in simulation designed equivalent circuit of the PTZ camera.by connecting the webcam with two servo motors for a horizontal and vertical movement .the webcam Show in figure (2.7).

Figure (2.7) The webcam

The new-generation digital webcam works with a USB port to be connected with PC. It is an ideal webcam for its plug and play and real-time transmission. Its mini size, easily carrying, high resolution and high speed make your life more colorful and make your long-distance communications fresh.

An integral microphone, the ability to pan and tilt, In-built sensors can detect movement and start recording and A light when on, will let you know that the camera is in use. There's a wide range of things that you can do with a webcam .the features of webcam in [appendix B].

2.3 Previous Studies

The previous studies include the following papers:

Kaur [6] said The PTZ camera includes a camera tracking algorithm and a camera calibration. A PTZ camera is used to capture video data and detect human location. The infrastructure includes PTZ Camera, video, site analysis components, and user interface element. The video analysis component retrieves the live video stream from the camera and the site component retrieves the object's information and estimates its position finally, the widget displays the information.

System tracks the person with the help of motion detection algorithm to detect the location of the person in the particular area. The position of the person is obtained and used to control the PTZ camera in the specified region. Calibration, object detection in the image and passing control commands to cameras are three key modules in Auto- PTZ tracking algorithm. Object detection is done by using motion cue. Algorithm detects the moving object and obtains its coordinates and computes the pan, tilt and zoom values using calibration modules and these values are sent to servo motor, this in turn pans, tilts the camera accordingly and camera zooms as per the computed zoom value. The main challenge in detecting moving object in PTZ camera is non- availability of sufficient frames for background modeling. Algorithm has to detect the moving object with limited number of frames. An algorithm is developed to detect moving object with lesser number of frames with appropriate post processing techniques.

de Sousa Leite[5] said Although there are intrinsic advantages of using pan-tilt-zoom cameras their application in automatic surveillance systems is still scarce. The difficulty of creating background models for moving cameras and the difficulty of keeping fitted pose and optical geometrical projection models are key reasons for the limited use of pan-tilt-zoom cameras. Geometric calibration is a useful tool to overcome these difficulties. Once developed the background and projection models, it is possible to design system simulators and surveillance methodologies similarly to the ones commonly available for fixed cameras. In this work we propose a method for PTZ camera auto-calibration over the camera's zoom range.

This method is based on the minimization of re-projection errors of feature points detected in images captured by the camera at different orientations and zoom levels. Results obtained over both synthetic and real data show that a full zoom range, complete field of view, pan-tilt-zoom camera calibration is possible.

Also in this work, a simulator capable of generating highly flexible, real data only, test scenarios with multiple events having ground truth motion is proposed. The final contribution of the present work is a new methodology for automatic surveillance control that resorts to tracking and prediction of targets' trajectories to enhance event presence awareness performance. This methodology is presented and compared with existing ones, through experiments conducted over real data testing scenarios with multiple events generated through our simulator. The results obtained reveal a great efficiency and potential of our proposed method in event presence awareness in a given scenario.

Foresti [18] said is a survey of the main technological aspects of advanced visual-based surveillance systems. A brief historical view of such systems from the origins to nowadays is given together with a short description of the main research projects in Italy on surveillance applications in the last twenty years. The paper then describes the main characteristics of an advanced visual sensor network that (a) directly processes locally acquired digital data, (b) automatically modifies intrinsic (focus, iris) and extrinsic (pan, tilt, zoom) parameters to increase the quality of acquired data and (c) automatically selects the best subset of sensors in order to monitor a given moving object in the observed environment[18]

Ibrahim, S.W [19] said is Intelligent surveillance system (ISS) has received growing attention due to the increasing demand on security and safety. ISS is able to automatically analyze image, video, audio or other type of surveillance data without or with limited human intervention. The recent developments in sensor devices, computer vision, and machine learning have an important role in enabling such intelligent system. This paper aims to provide general overview of intelligent surveillance system and discuss some possible sensor modalities and their fusion scenarios such as visible camera (CCTV), infrared camera, thermal camera and radar. This paper also discusses main processing steps in ISS: background-foreground segmentation, object detection and classification, tracking, and behavioral analysis.

Chapter Three
System Design and Implementation

3.1 Design and Simulation

The borders surveillance system was built by radar simulator and control system circuit through serial port in the block diagram shown in figure (3.1).

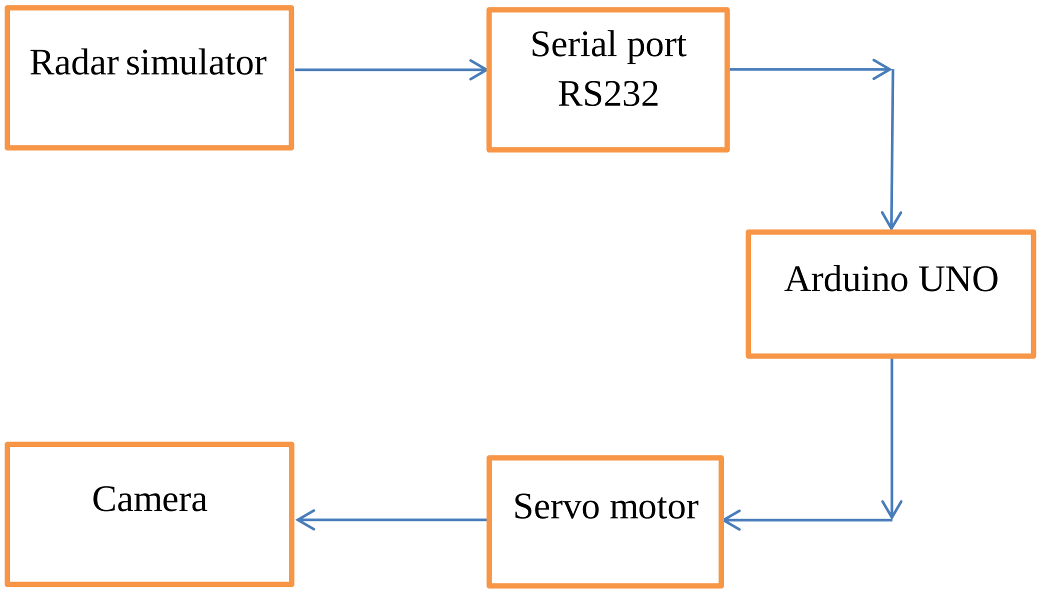

Figure (3.1) System design block diagram

3.1.1 Radar Simulator

Radar detection and tracking operations use Simulink MATLAB software to designed simulation radar. Radar system use modulated waveforms and directive antennas to transmit electromagnetic energy into a specific volume in space to search for targets. Objects (targets) within a search volume will reflect portions of this energy (radar returns or echoes) back to the radar. These echoes are then processed by the radar receiver to extract target information such as range, Velocity, angular position, and other target identifying characteristics.

The simulink Matlab program is used to scan targets which captured by a radar instead of the real radar for its ease. The program determined the location of the target angle and distance from the radar site to the midpoint. This was done as follow in figure (3.2):

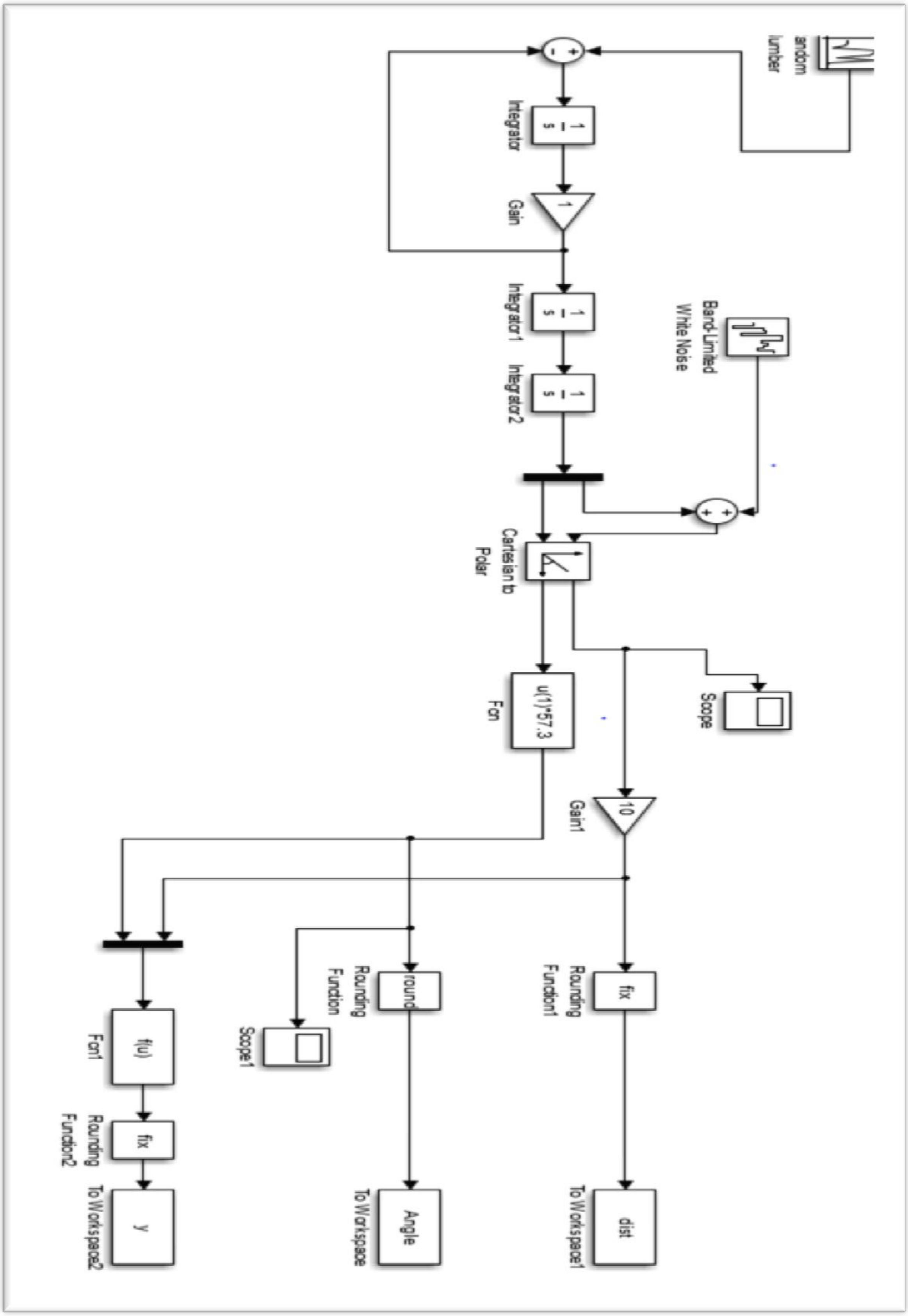

Figure (3.2) Radar simulator

The simulink Matlab program steps:-

- The model of target is composed of an acceleration model.
- The acceleration equation is used to generate the velocity and position to the target, by integrating.
- The first integration over the time will give velocity while the second integration will give the target position.
- To make the model more realistic, a noise is added to data of target position.
- The position data is demultiplexed by a demultiplexer from Simulink library.
- Then a transformation from Cartesian to polar coordination is done using a block of transformation from Simulink library.
- The output data represent the dynamic of the target is the bearing angle and distance as position coordinates.
- Interface radar simulator with Arduino through serial port by matlab function.

3.1.2 Control System Circuit

The control system circuit consisted of Arduino and two servo motors and used the Proteus program in figure (3.3) and in Table (3.1) the output of control system simulator.

Table (3.1) the output of control system simulator

Pan Angle of radar simulator	Tilt angle of design simulator
0.43°	0.43°
6.30°	6.30°
104°	95.4°
42.3°	62.30°
29.3°	13.4°
45.3°	16.3°

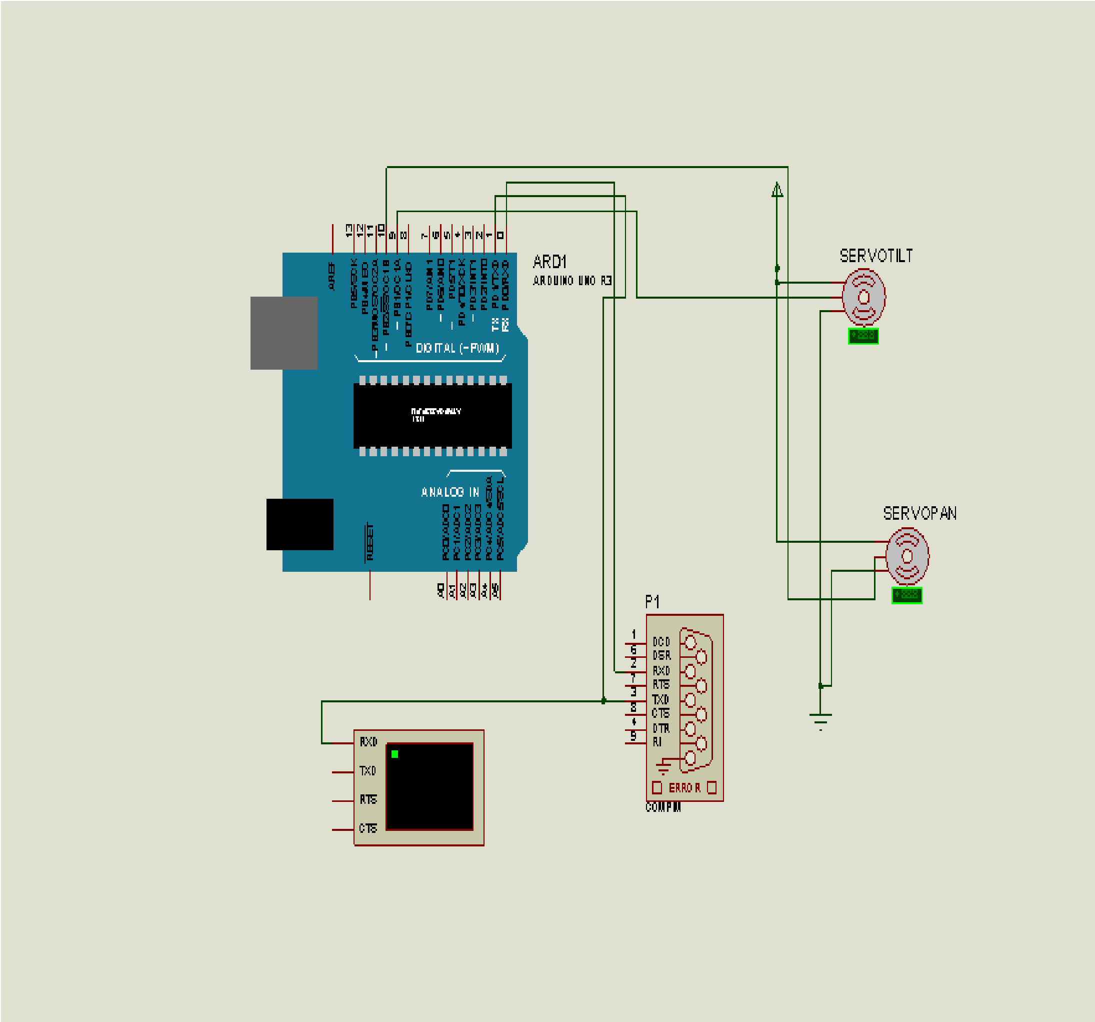

Figure (3.3) Control system simulator

3.1.2.1 Flow Chart of the Control Program

The flow chart of the control program figure (3.4)

- ❖Serial port received signal from radar simulator.
- ❖If input of serial port > 0.
- ❖Converts value pan angle to microsecond equal pulse width1.
- ❖The pan servo turns on.
- ❖Calculate the tilt angle.
- ❖ Converts value tilt angle to microsecond equal pulse width2.
- ❖ The tilt servo turns on.
- ❖ Returning to serial port. [Appendix C]

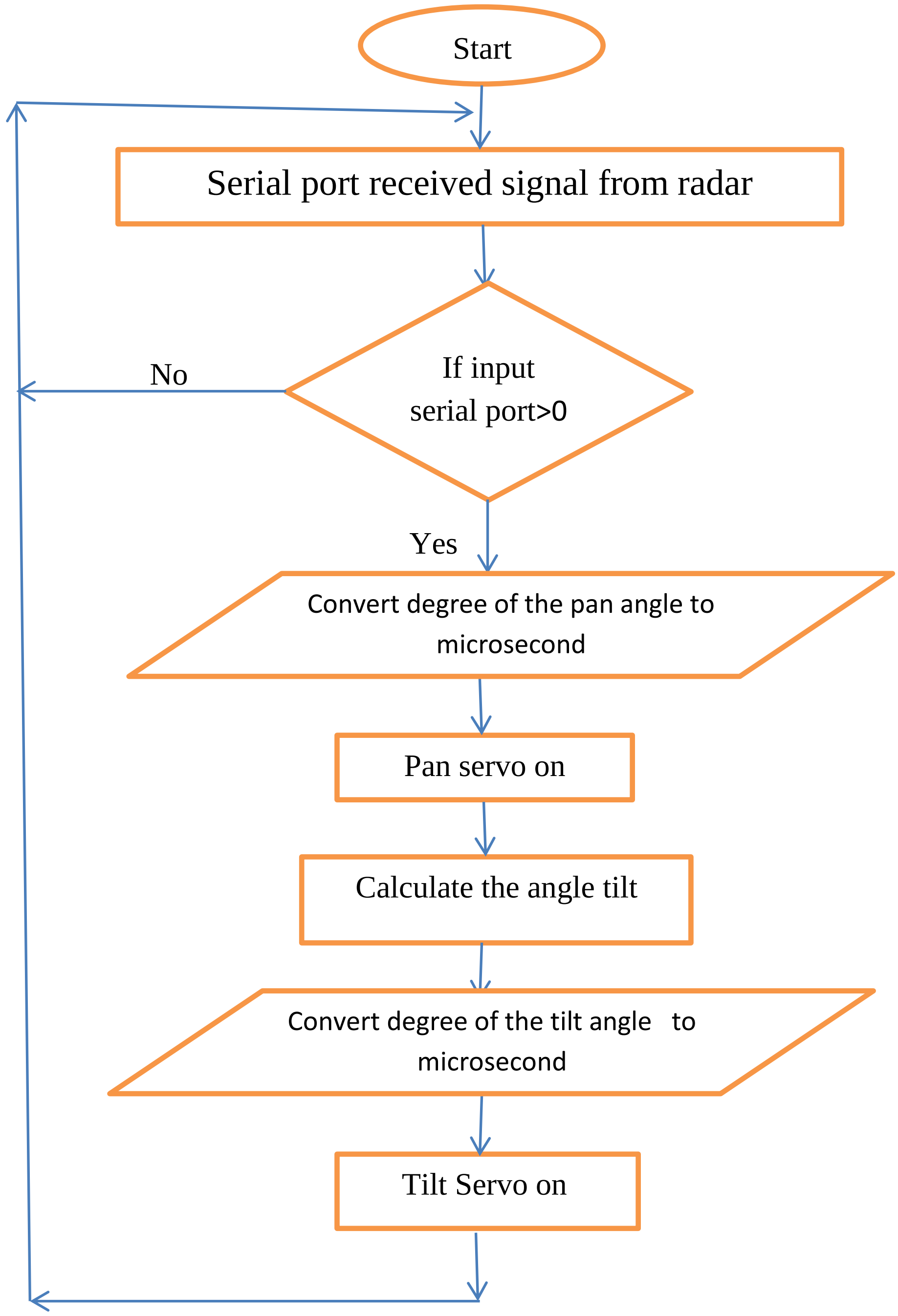

Figure (3.4) Flow chart of control program

3.1.2.2 Integrated Development Environment for Arduino

Software programs, called sketches, are created on a computer using the Arduino Integrated Development Environment (IDE).the enables you to write and edit code and convert this code into instructions that Arduino hardware understands. The IDE also transfers those instructions to the Arduino board (a process called uploading).The development environment of Arduino is simple and easy to deal with. It is almost devoid of complexities and contains what the programmer needs to start developing programs in the language of Arduino C. It is the use simultaneously to upgrade the operational programs to the microcontroller.

3.1.2.3 Proteus

Proteus (PROcessor for TExt Easy to USe) is a fully functional, procedural programming language created in 1998 by Simone Zanella. Proteus incorporates many functions derived from several other languages: C, BASIC, and Assembly.

3.1.2.4 Servo Motor Control

Each servo has a built-in processor who responds to electric pulses sent to it. If creates an electric pulse by sending voltage to one of its pins for a very specific amount of time. The micro controller cannot control how much voltage is sent it simply turns the voltage on or off. When voltage is on +5V is output. When the voltage is off, 0V is output. It can turn the output voltage on and off rapidly, thereby creating pulses of high and low voltages. The duration of these pulses is known as the pulse width. The longer the voltage is applied, the larger the pulse width. The pulse width is measured in seconds, but we often use milliseconds (ms) to describe them because the pulse duration can be very short. The servo's control board interprets pulse widths as positions and rotates its shaft either clockwise or counterclockwise based on the pulse widths [20].

In this, research servo motor SG90 used and the most important advantage of knowing the pulse width because it controls to movement of the servo motor according to the pulse width you enter it and here by knowing the relationship to the angle with pulse width, find the pulse width of Servo SG90 is 500 to 2400 μs [Appendix D].

This is calculated the range by the difference between the lowest pulse width and the highest pulse width

Range = upper – lower (3.1)

Range = 2400 – 500=1900 μs

Range divided by servo max angle

(Microsecond per degree)Mpd = Range/180 (3.2)

Mpd= 1900/180 =10.56 μs

Calculate the microsecond for each degree by dividing the range on the highest angle that the servo moves. To calculate pulse width of servo angle because the servo controlled the position by pulse width.

Pulse width of servo angle = (angle * Mpd) + lower pulse width (3.3)

For example if angle =0 degree

Pulse width of 0 degree = (0*10. 56) + 500= 500 μs

If angle =90 degree

Pulse width of 90 degree = (90*10.56) + 900= 1450 μs

If angle =180 degree

Pulse width of 180 degree = (180*10.6) + 900= 2400 μs

3.2 Hardware Design

The Arduino received the signal of the target angle location from the radar simulator to move the servo motors according to the received signal angle figure (3.5), figure (3.6)

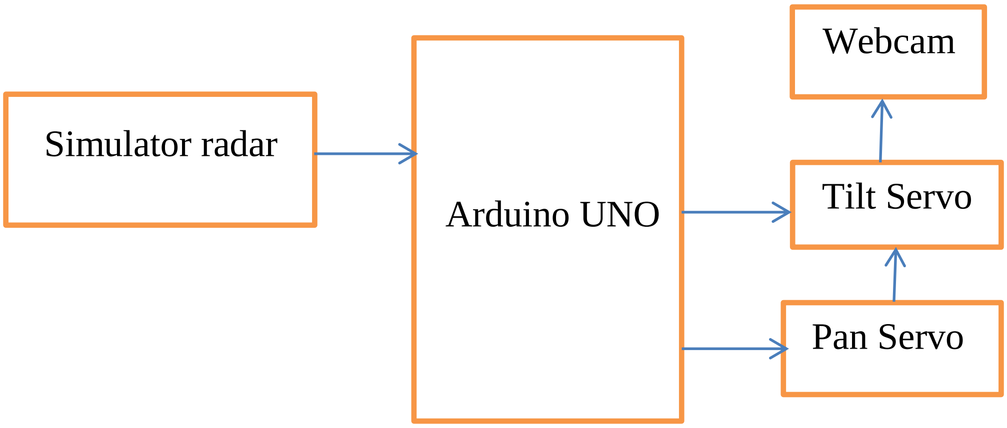

Figure (3.5) Control system block diagram

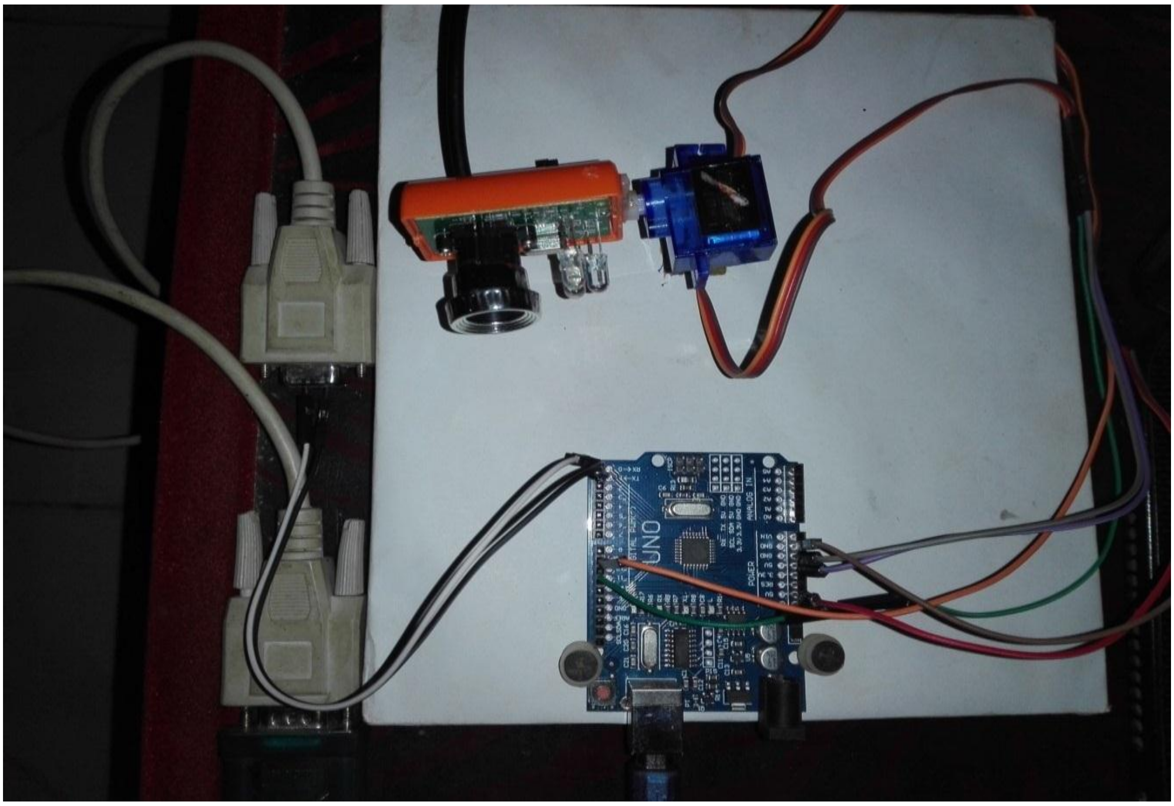

Figure (3.6) Hardware of control system

Chapter Four
Results and Discussion

4.1 Results and Discussion

Control system is designed by radar control of camera movement according to the target location. In table (4.1) below radar sent values within the angle target and since the servo motor moved with a pulse, the angle value converted to a microsecond by equation (3.3).

Table (4.1) pan and tilt angle values.

Pan Angle (degree)	Pan Pulse Width (microsecond)	Tilt Angle (degree)	Tilt Pulse Width (microsecond)
0	500	0	0
6	542.24	6	542.24
104	2012.08	98	1967.83
42	890.72	62	1619.36
29	647.84	13	742.88
45	964.64	16	816.8
34	668.96	11	795.68
41	785.12	7	616.16
47	1091.36	6	806.24
42	837.92	5	753.44

There are two servo motors to move the webcam, horizontally according to pan angle, vertically according to tilt angle.

In table (4.2) to discussion, the result which compared the radar angle with webcam angle.

Table (4.2) the radar's angle and webcam's angle

Angle Output of radar simulator	angle Output of design simulator
0°	0°
6°	6.3°
104°	104°
42°	42.3°
29°	29.3°
45°	45.3°
34 °	34.3°
41°	41.3°
47°	47.3°

In Figure (4.1) to (4.9) the radar output is displayed by the matlab drawing function and the simulation output of the control circuit which represents the camera movement .When compared to the radar and camera movement, the result that coordinates of camera and radar as approximately equal, with small difference.

As the result the control system designs for a certain area using radar which controlled the camera movement.

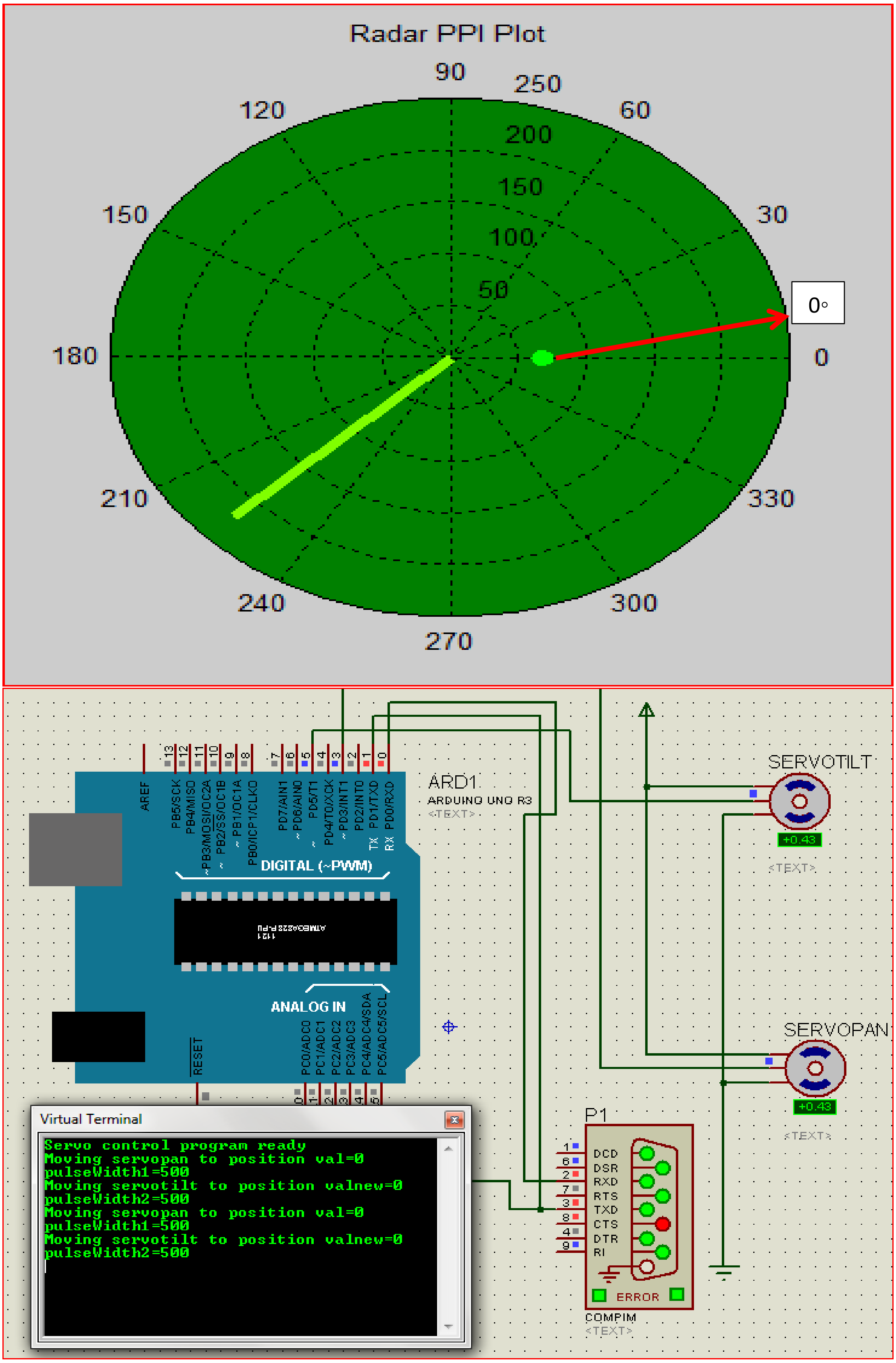

Figure (4.1) Target location zero° east

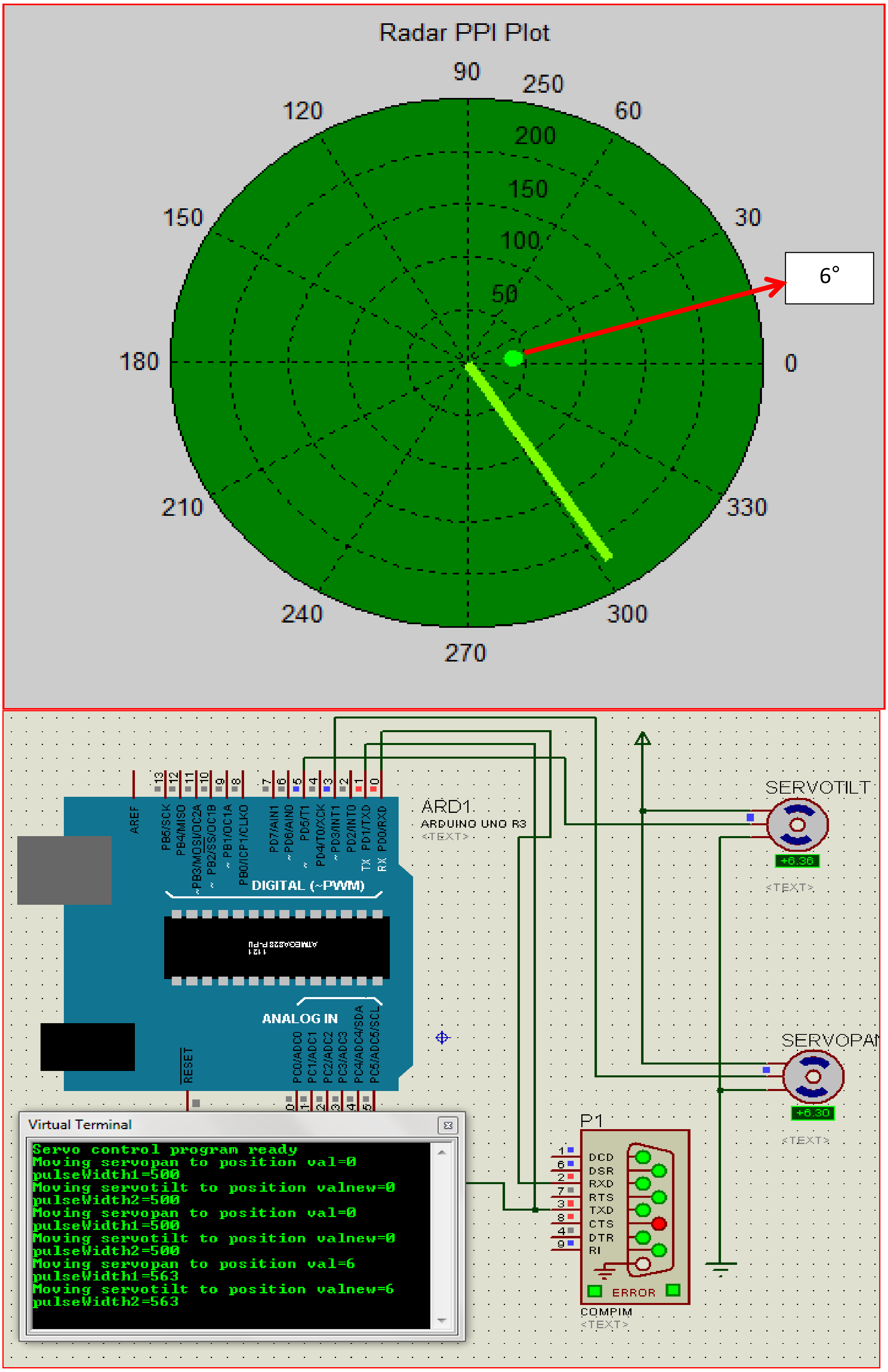

Figure (4. 2) Target location 6° North East

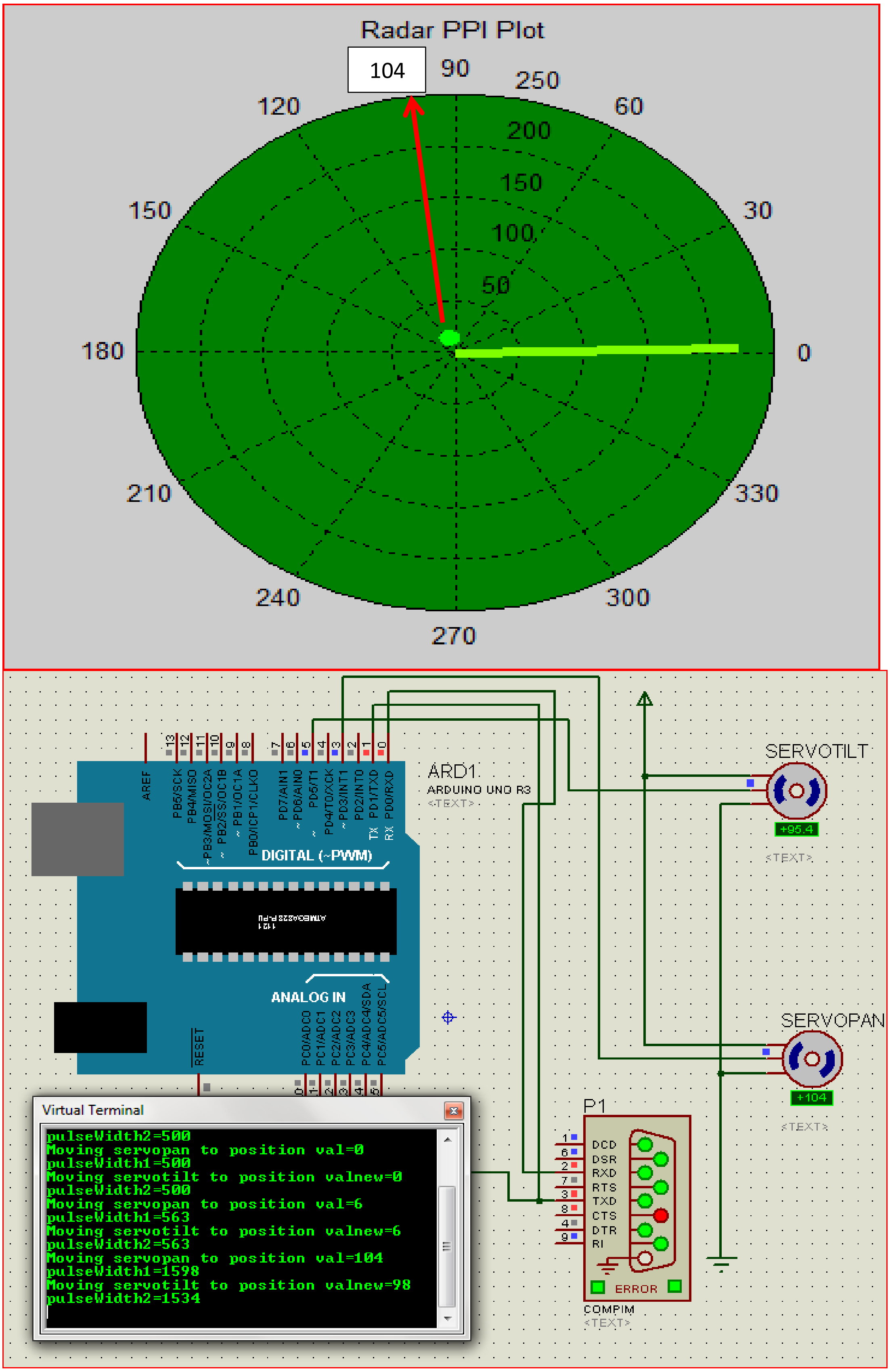

Figure (4. 3) Target location 104° North West

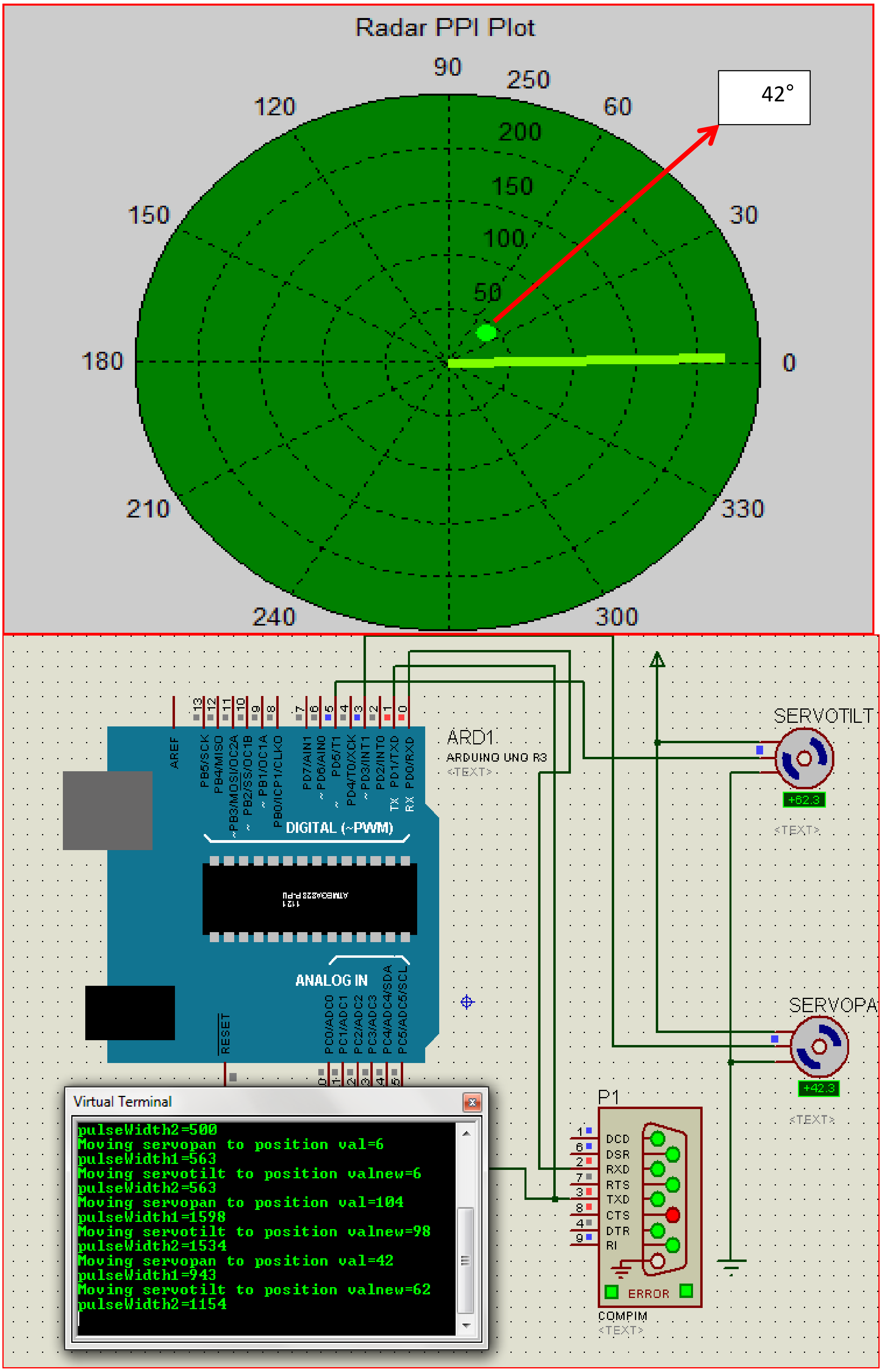

Figure (4. 4) Target location 42° North East

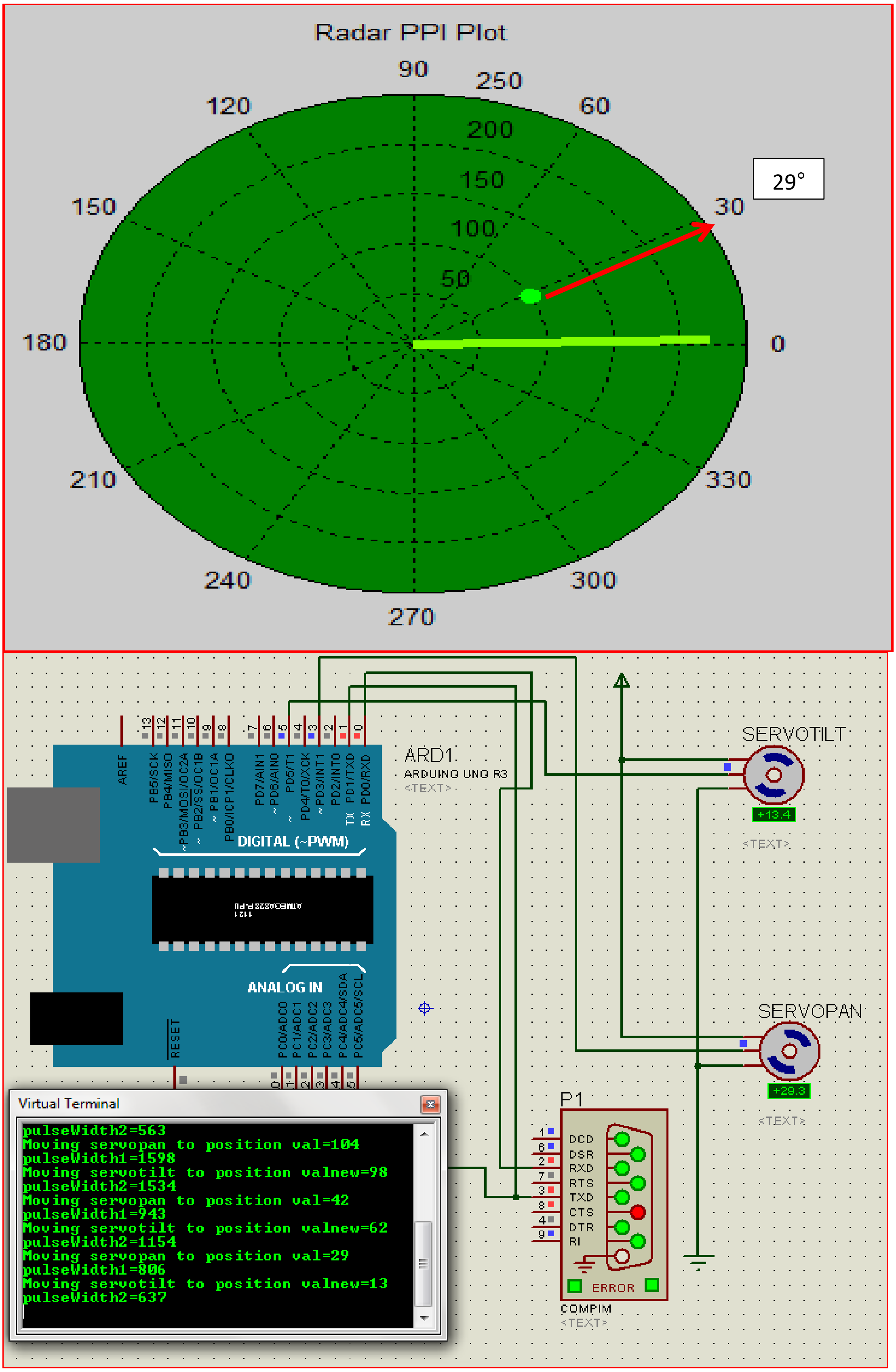

Figure (4. 5 Target location 29° North East

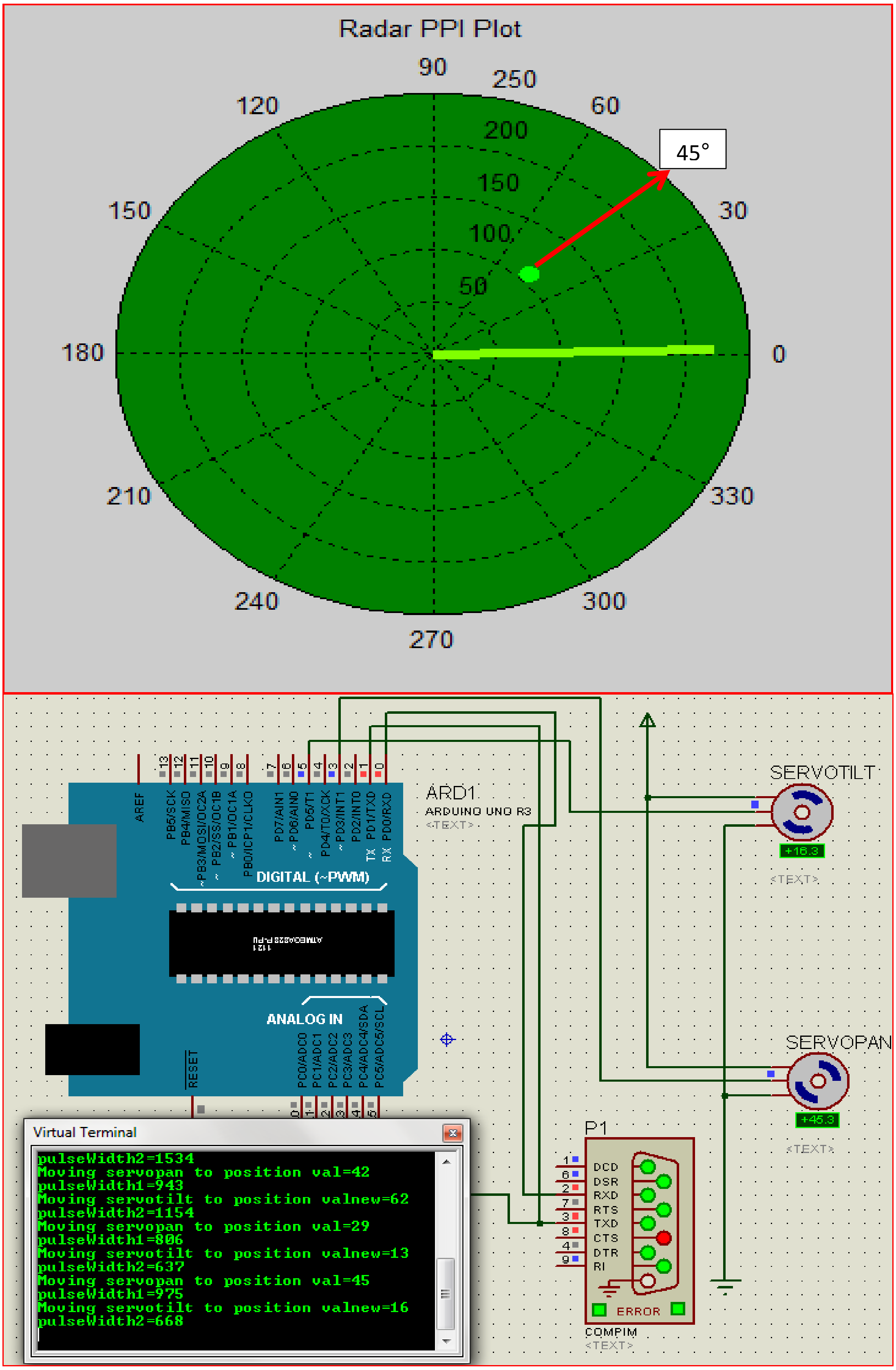

Figure (4. 6) Target location 45° North East

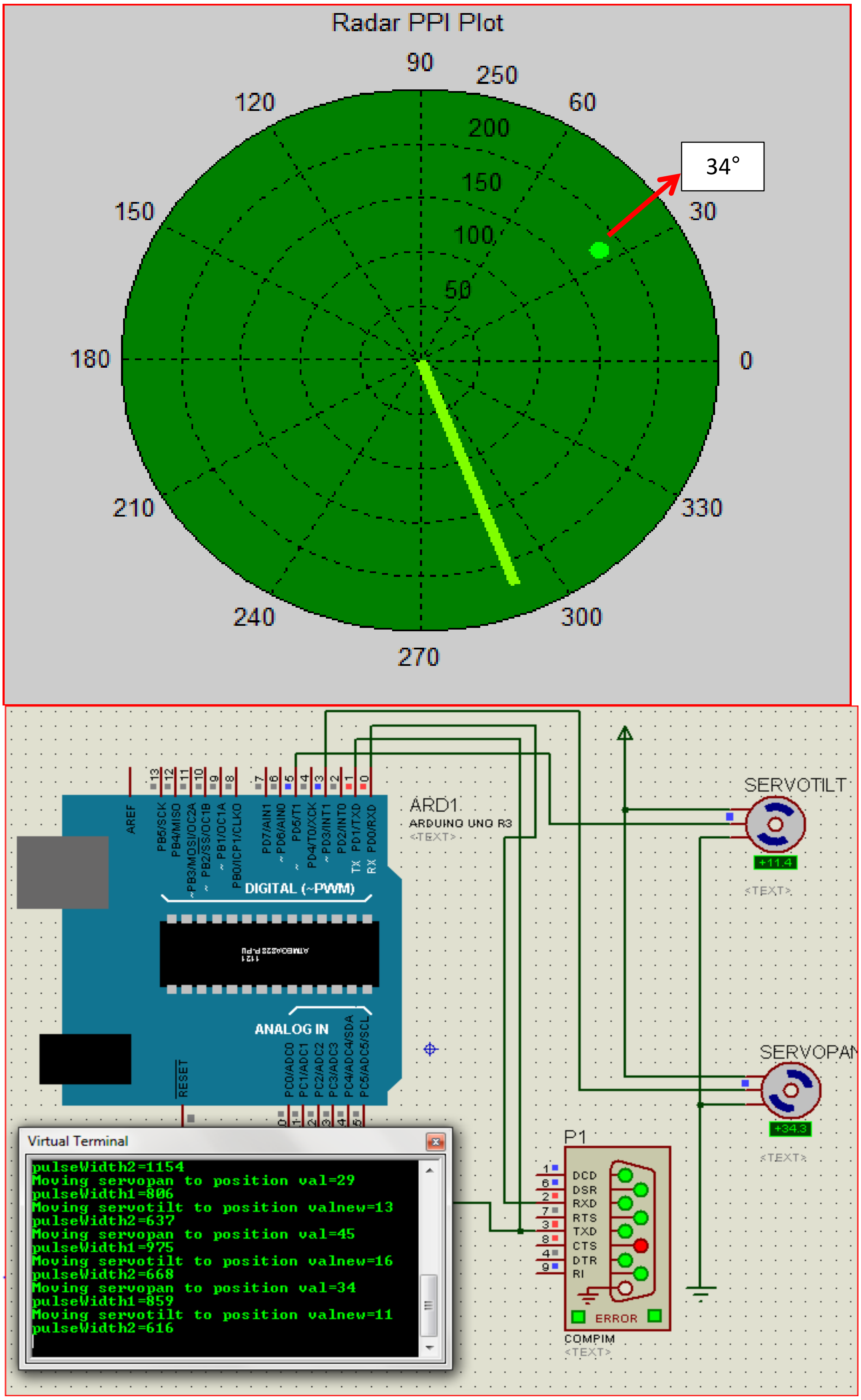

Figure (4. 7) Target location 34° North East

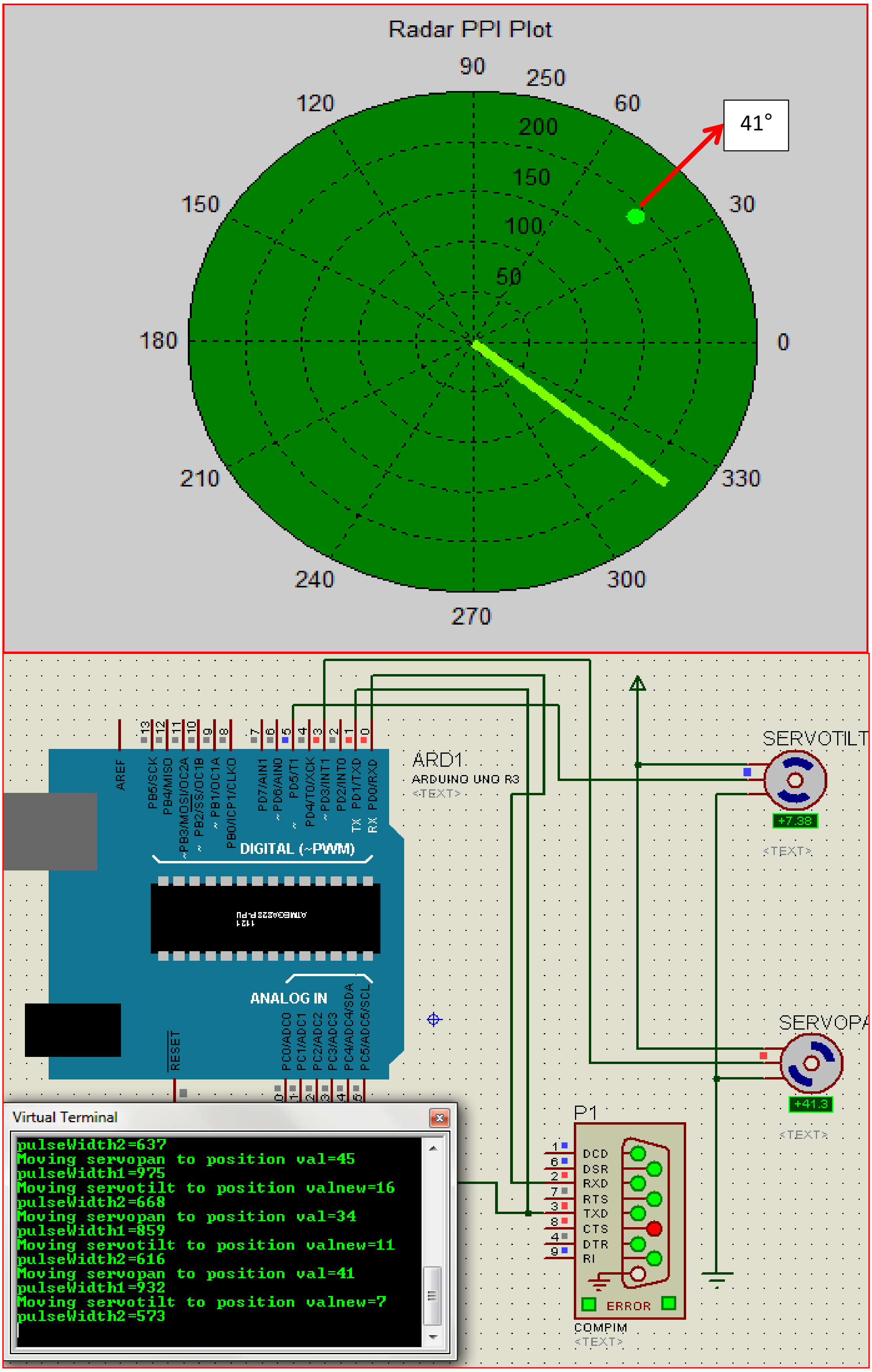

Figure (4. 8) Target location 41° North East

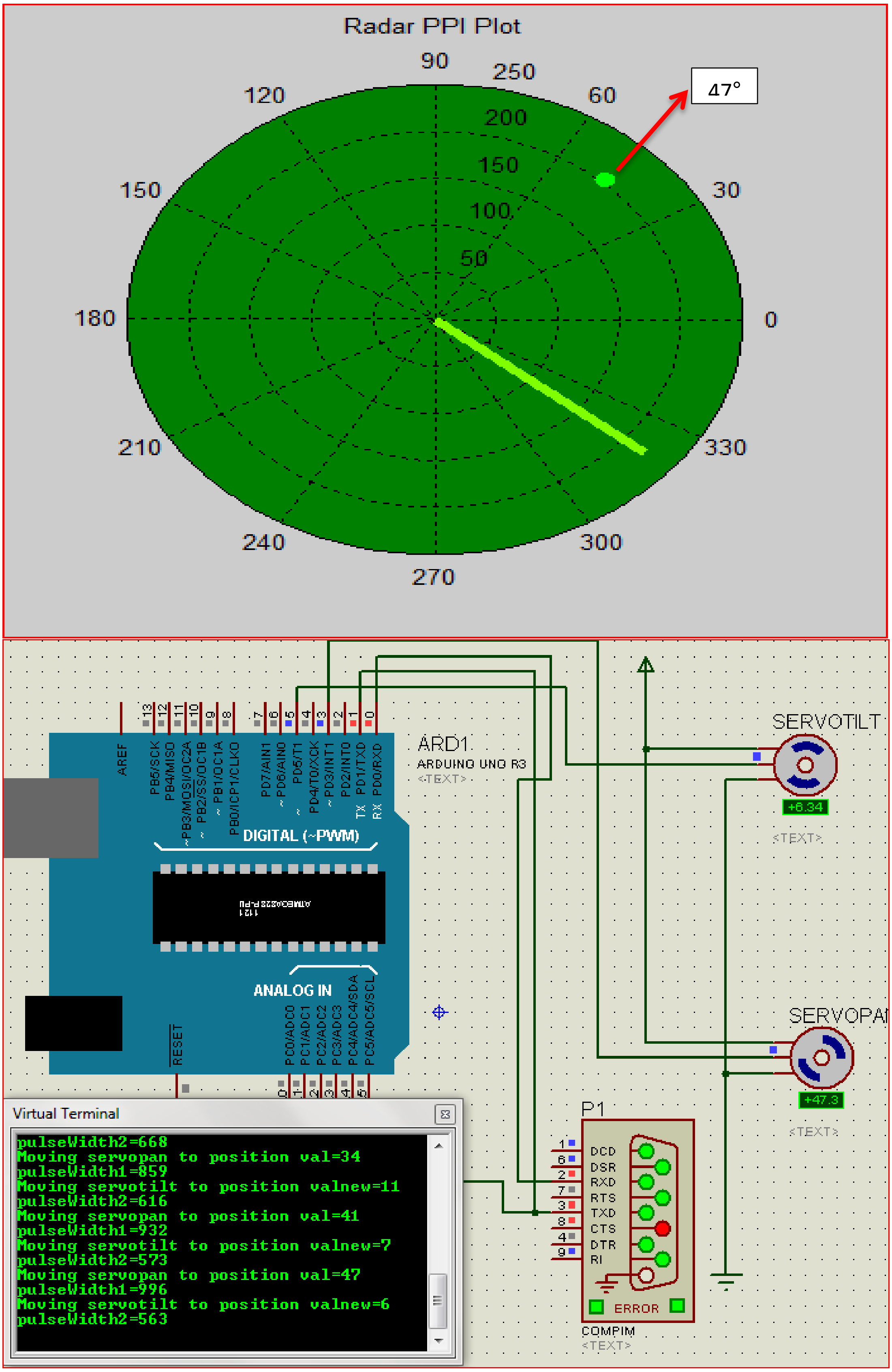

Figure (4. 9) Target location 47° North East

Chapter Five
Conclusions and Recommendations

5.1 Conclusions

To protected countries avoid risks using border surveillance systems by ground surveillance radar and camera of control borders.

The simulink Matlab program is used to scan targets, which captured by a radar instead of the real radar. The program determined the location of the target angle.

To design the simulator of PTZ camera by using webcam, two servo motors and Arduino in order to record videos for targets, which controlled by the radar simulator to monitor the border. It displayed a pan and tilt of target in a computer screen with the same as radar's position. As the result design an electronic surveillances system to the borders, important buildings and oil pipelines.

5.2 Recommendations

In this, research designed control system to monitor the boarder's by using border's station. To used wireless or optical fiber to monitor the borders remotely.

The PTZ camera can be used in surveillance system's applications to give high quality images.

The PTZ camera can be connected to satellite instead radar.

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Appendixes

Appendix A: Data Sheet of Ground Surveillance Radar (GR40)

HOMELAND SECURITY

bats
Belgian Advanced Technology Systems

Ground Surveillance Radar

GR40

Incorporating BATS vast experience in surveillance radars and utilizing modern radar technologies, the GR40 is easily deployed, user-friendly, reliable and cost-effective. The radar operates 24 hours a day, even under poor weather and low visibility conditions. By utilizing the radar information you maximize the efficiency of your military and law enforcement units, because BATS Advanced Ground Surveillance Radar puts you in control.

The radar is also capable of supporting artillery fire correction by detection of the impact location of shells. The GR40 automatically detects moving targets, such as walking persons, vehicles and flying objects (low flying aircraft, hovering helicopters and gliders) at ranges of up to 60 km.

BATS GR40 is a coherent Pulse Compression, ground-based radar for military and paramilitary applications.

This radar belongs to BATS family of tactical radars that detect and monitor movements inside areas of interest.

Higher ranges are available by addition of power amplifier and by increasing antenna size.

Features

- Real-time, accurate detection and acquisition of moving targets up to 60 km and 360°
- Detection of ground target, maritime, helicopters and shells impacts
- High resolution, colored, north oriented, clear radar picture on ruggedized portable colors PC display
- Target display on digital map
- Mode of operation: search, sector, zoom artillery and enhanced track-while-scan & automatic tracking
- Standard interface to other sensors such as electro optic, plotter, printer, GPS and C4I center
- Extensive BIT - down to each function
- ECCM - Low probability of interception and pulse compression technique

Applications

- Border surveillance and protection
- Critical infrastructure protection
- Harbor surveillance
- Field artillery fire correction

Specifications

Frequency band :	X-Band
Antenna :	120cm x 45cm, 34dB gain
Transmitted peak power (Tx) :	25w
Processing :	FFT, CFAR, TWS
Weight :	65kg (approx.)
Power consumption :	110w (at 18 – 30VDC)

Detection range	Surveillance Mode	Artillery Mode
Pedestrian	15km	-
Helicopter	25km	-
Heavy vehicle	60km	-
Artillery Shell impact	-	>15km
Range accuracy	50m	25m
Azimuth accuracy	7mils	3mils
Sector search	>360°	2° - 6°
Tracked targets	>100	-

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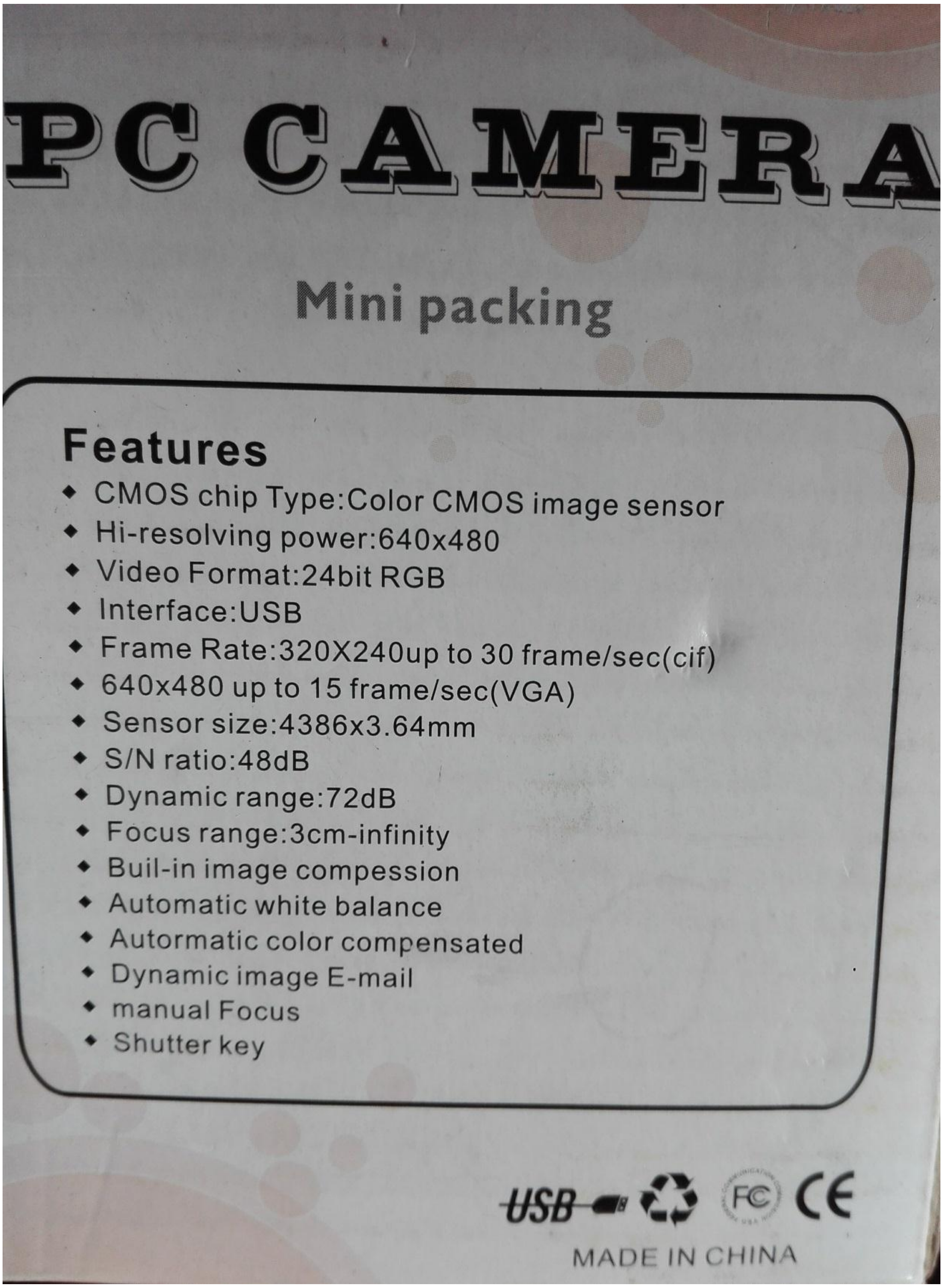
Appendix B: Features of Webcam



Appendix C: Code of Control System Program

```
//code control system for tow servo motor moved by output of
//radar simulator with serial port
#include <Servo.h>       // Library of servo
Servo servopan;     // Create servo object to control a servo
Servo servotilt;   // Create servo object to control a servo
int val, i, valnew, valold=0;  //variable define
long lastPulse = 0; //The last pulse was calculated in //millisecond
int refreshTime = 20;  // Time allocated between each frequency
int minPulse = 500;   // minimum pulse width
int maxPulse = 2400; // maximum pulse width
int pulseWidth1, pulseWidth2 = 0;  // Amount to pulse the servo
//  The setup begins here
void setup ()
{
  Serial.begin(9600); //set the frequency of serial
  servopan.attach(3);  // Attaches the servo on pin 3 to the servo
//object
   servotilt.attach(5);   // Attaches the servo on pin 5 to the servo
//object
  pulseWidth1 = minPulse; // Initialize the variable
  Serial.println("Servo control program ready"); //Show the
//words “Servo control program ready” on the serial monitor
//later on
 servopan.write(0);   //Servopan position in begin zero
 servotilt.write(0);  //Servotilt position in begin zero
 void loop()   // The main part of the program begins here
```

```
}
While (Serial.available() > 0 ) //loop of serial input
}
  val = Serial.read(); //put serial read equal val
 Serial.print("Moving servopan to position "); //Show the words
//“Moving servopan to position:” on the serial monitor later on
 Serial.print("val="); //Show the words “ val:” on the serial
//monitor later on
Serial.println(val); //show the read out
pulseWidth1 = (val * 10.56) + minPulse; // convert pan angle to
//microseconds
Serial.print( "pulseWidth1="); //Show the words “pulseWidth1:”
//on the serial monitor later on
Serial.println( pulseWidth1); //show the read out
servopan.write(val);   // update pulsewidth2 delay servopan
//position
delay (pulseWidth1); // waits  for the servo to reach the position
valnew = abs(val - valold); //the angle value moved second //servo
motor
valold = val;  // save the time of the last pulse
Serial.print("Moving servotilt to position ");  //Show the words //
“Moving servotilt to position:” on the serial monitor later on
Serial.print("valnew="); //Show the words “valnew:” on the
//serial monitor later on
Serial.println(valnew); //show the read out
 pulseWidth2 = (valnew * 10.56) + minPulse; // convert tilt //angle
to microsecond
```

```
Serial.print( "pulseWidth2="); //Show the words "pulseWidth2:"
//on the serial monitor later on
Serial.println( pulseWidth2); //show the read out
servotilt.write(valnew); //update servotilt position
 delay (pulseWidth2);  // waits pulsewidth2 delay for the servo //to
reach the position
{
Serial.flush();  //clear data in serail port
}
```

Appendix D: Data Sheet of TowerPro SG90 Servo

TowerPro SG90 Servo

Basic Information

Modulation:	Analog
Torque:	**4.8V:** 25.0 oz-in (1.80 kg-cm)
Speed:	**4.8V:** 0.12 sec/60°
Weight:	0.32 oz (9.0 g)
Dimensions:	Length: 0.91 in (23.0 mm) Width: 0.48 in (12.2 mm) Height: 1.14 in (29.0 mm)
Motor Type:	3-pole
Gear Type:	Plastic
Rotation/Support:	Bushing

Additional Specifications

Rotational Range:	? (add)
Pulse Cycle:	? (add)
Pulse Width:	500-2400 µs
Connector Type:	JR