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CONTENTS

From Editor

Engineering Faculty of Istanbul Aydın University has started to publish an international journal on Electronics, Mechanical and Mechatronics Engineering, denoted as ''International Journal of Electronics, Mechanical and Mechatronics Engineering (IJEMME)''. We have especially selected the scientific areas which will cover future prospective engineering titles such as Robotics, Mechanics, Electronics, Telecommunications, Control Systems, System Engineering, Biomedical, and Renewable Energy Sources.

We have selected only a few of the manuscripts to be published after a peer review process of many submitted studies. Editorial members aim to establish an international journal IJEMME, which will be welcomed by Engineering Index (EI) and Science Citation Index (SCI) in short period of time.

Prof. Dr. Zafer UTLU
Editor

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Antenna Design with Band Notched Characteristic for UWB Applications

Hashmatullah Ahmadzai[1], Saeid Karamzadeh[2]

Abstract - In this paper, a small, low cost and light weight monopole antenna is presented with notched characteristic for Ultra Wideband application. The patch of the antenna consists of sides that are cut a half circle and a rectangle. A narrow rectangular slot has been made to notch the undesired frequency band. The ground plane of the proposed antenna has a rectangular cut which is useful for Impendence matching. The antenna is fed with 50 Ω micro-strip feedline. It has been printed on FR4 substrate which has the relative permittivity of ε_r =4.4 and the thickness of 1mm. The total size of the antenna is (26 ×20×1) mm^3. The proposed antenna is working at a larger frequency band from 2.9 GHz to 10.8 GHz and has notch band characteristic at 5 GHz to 5.9 GHz. C band notch can be achieved with a band width from 4GHz to 8GHz by increasing the slot size. Some of the simulation results and the characteristics of the proposed antenna are explained in this paper.

Keywords - *Monopole antenna, ultra wideband, notch band, rectangle slotted*

1. Introduction

The Ultra wide band technology got more attention from the time when the Federal Communication Commission (FCC) approved that the band Width 3.1GHz - 10.6GHz said to be Ultra Wideband UWB [1]. In the recent years, a significant development was achieved in Ultra Wideband technology and it has been widely used in some radars, wireless communication systems, medical and military applications. The main part of the Ultra wideband technology is the antenna; the printed monopole antenna is a better choice for Ultra wideband applications due to its simple structure, wide frequency range, omni-directional properties and low cost.

There are many different shapes and structures of monopole antennas and ultra-wide band was achieved [2-5], however the main problem in UWB antennas is that there are some standard narrow bands allocated in FCC frequency range such as Wireless Local Area Network (WLAN) which has the band Width of 5.1 GHz-5.8 GHz according to IEEE802.11a or C Band which has band width of 4GHz to 8GHz that may cause potential interference. For avoiding interference, filters can be used with Ultra Wideband antenna but it means more complexity and extra cost [6] so another option to avoid or minimize the interference is using Rejection techniques. There are commonly two main techniques used in antenna design to notch band of frequencies [7]. The first technique is very simple. In this technique, undesired band of frequencies can be notched or filtered by cutting different shapes of slots in radiator or ground plan or both [8-9] whereas in the second technique, notch band frequencies can be obtained by using different shapes of parasitic elements which are electromagnetically coupled with radiating patch and placed near the ground plane [10-11].

In this paper, we have discussed compact size, low profile, simple structure and omni-directional properties of the Ultra-Wide band antennas that have a band width from 2.9 GHz to 10.8 GHz which covers FCC's Ultra-wide band frequency range. This antenna has avoided the frequency range from 5 GHz to 5.9 GHz which is WLAN frequency range according to IEEE802.11a by simple narrow rectangle slot. or C band 4GHz to 8 GHz can be notched by making

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the slot wider. The Ansoft's (HFSS) software was used for designing the structure and analyzing the properties of the proposed antenna [12]. This paper was arranged as follows:

In Section II, the geometry of proposed antenna was explained; in Section III, C band notched antenna was explained; in Section IV, various results were shown and discussed and in Section V, we sum up with a brief conclusion.

2. Antenna Design

Figure 1 shows the design of the proposed antenna. The antenna is fabricated on FR4 substrate, the relative permittivity of FR4 substrate is $\varepsilon_r = 4.4$ with loss tangent of $\delta = 0.02$. The overall size of the proposed antenna is $20 \times 26 \times 1$ mm^3, which shows the width W_s of antenna is 20mm, the length L_s of antenna is 26 mm and the thickness h of substrate is 1 mm. The radiating patch which is one of the important parts of the antenna, consists of sides cut a half circle with radius R and a rectangle with Width $W_2 \times$ Length L_2. The ground plane has the length L_g and width W_s. Rectangular cut was made for good impendence matching and for getting wide range of frequency band; that is why the rectangle cut in ground plane produces capacitive load which minimizes or cancels out the inductive nature of radiating patch to produce almost resistive input impendence [13]. The radiating patch is fed with 50Ω micro-strip feed line with width W_f.

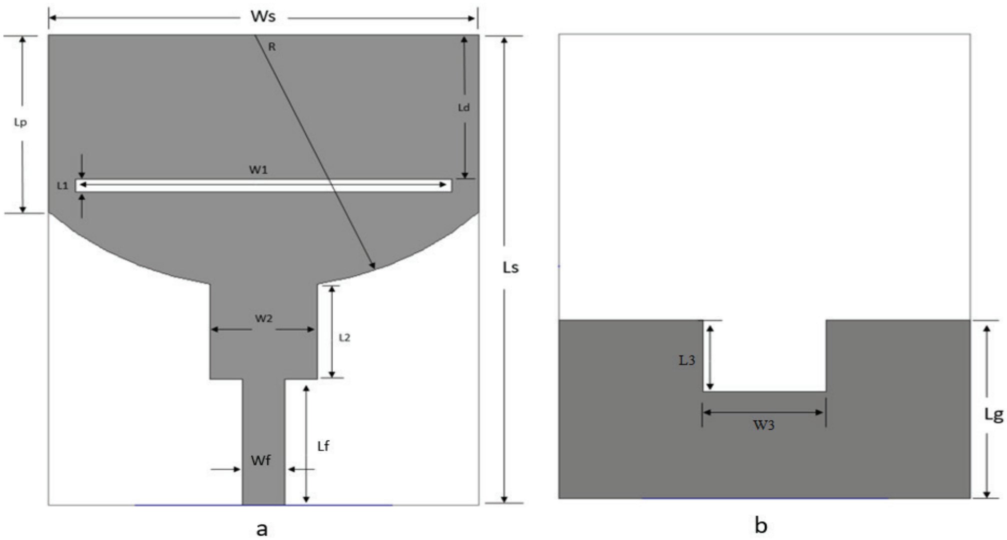


Figure 1. (a) Shows the front view of proposed antenna, (b) Shows the back view of proposed antenna

All the parameters which are shown in Figure 1 are listed in Table 1 and each of the parameters is measured in millimeters (mm).

Table 1. Parameters of Proposed Antenna

Parameters	Values (mm)	Parameters	Values (mm)
W_s	20	W2	5
L_s	26	L2	5
h	1	W_f	2
R	14	L_f	7
L_p	10	L_g	10
L_d	8.6	W_3	6
W_1	17.5	L_3	4
L_1	0.4		

Note: In order to notch the C Band, just increase the size of slot, change the value of L_1 from 0.4mm to 4.5mm and W_1 from 17.5mm to 19mm and change the position of slot L_d from 8.6mm to 3.4mm.

In Figure 2, all the phases were shown to get the proposed antenna. Simple antenna was shown in first phase (I) without any changes in its patch and ground plan. In the second phase (II), a rectangular cut was made in ground plane and no changes were made in radiating patch whereas in the third phase (III) we only added a rectangle shape to the radiating patch and Ultra wideband has been achieved in this phase. In the fourth phase (IV), a narrow rectangle slot was cut in radiating patch which helps us to notch undesired frequency band.

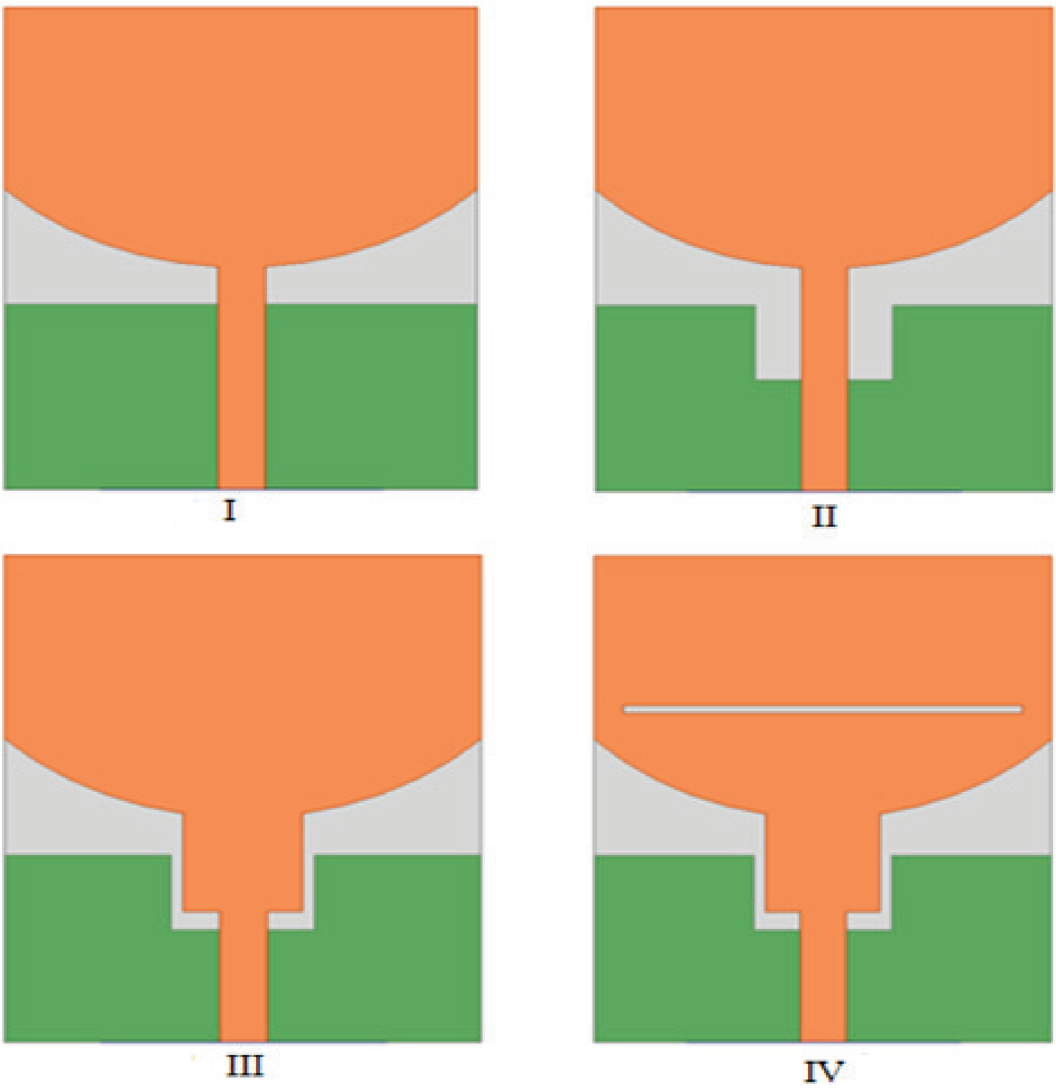


Figure 2. (I) Sample antenna, (II) Rectangle Cut in ground plan,(III) adding Rectangle to radiating Patch, (IV) Slot in Patch

The return losses or the S11 of all the phases (I to IV) were shown in Figure 3. The figure shows the variation that has occurred in each phase, and in phase (III) we have achived the Ultra wideband and in phase (IV) an undesired frequency band was notched.

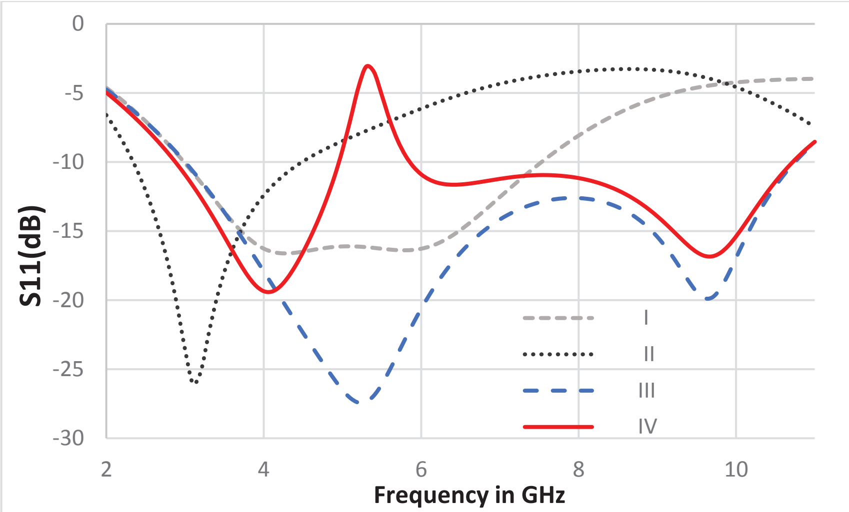


Figure 3. The variation that has occurred in S11 due to the changes made in the design antenna from (I),(II),(III) and (IV)

In Table 2, we compared our design with some other designs which are in References. We have compared the designs in terms of dimensions, gain, notched band, and bandwidth.

Table 2. Comparison of some Reference designs with proposed antenna in terms of Dimensions, Gain, Frequency Range and Notched Band

Reference No	dimensions (mm^3)	Frequency Range (GHz)	Gain	No0tched band (GHz)
[8]	26×35×1.6	2.8 ~ 11.4	6.7 dB	5.1 - 5.825
[14]	30×40×1.6	2.3 - 11.4	5.5 dB	4.9 – 6
[15]	26×32×1.6	2.8 – 11	2.7 dB	3.3 - 3.6
[16]	35×35×1.6	2.21 – 12.83	6.7dB	3.3 - 3.8, 5.15 - 5.8 & 7.9 - 8.4
[17]	48×48×0.8	2.5 – 12	6.7dB	5.1-6
[18]	50×45×0.787	2.7 - 10.9	4dB	5.1-5.9
[19]	32×38×1.6	2.8 - 14.9	6.5 dB	3.1-4.8 & 9.6-11.2
The proposed antenna	20×26×1	2.9-10.8	4.7 dB	5 - 5.9

3. C Band Notched Antenna

According to IEEE, C band has a bandwidth ranging from 4GHz to 8GHz, which is also allocated in FCC's Ultra wideband range and may cause potential interference. Therefore, rejection techniques that we have discussed can be used for avoiding the interference. In this paper, we have designed a C band notched antenna by making some changes in the slot of our proposed antenna. We have changed the width W_1 of the slot which was 17.5mm to 19mm, the length

L_l of the slot which was 0.4mm to 4.5mm and we have also changed the position of the slot L_d from 8.6mm to 3.4mm. Figure 4 shows the design of C band notched Antenna.

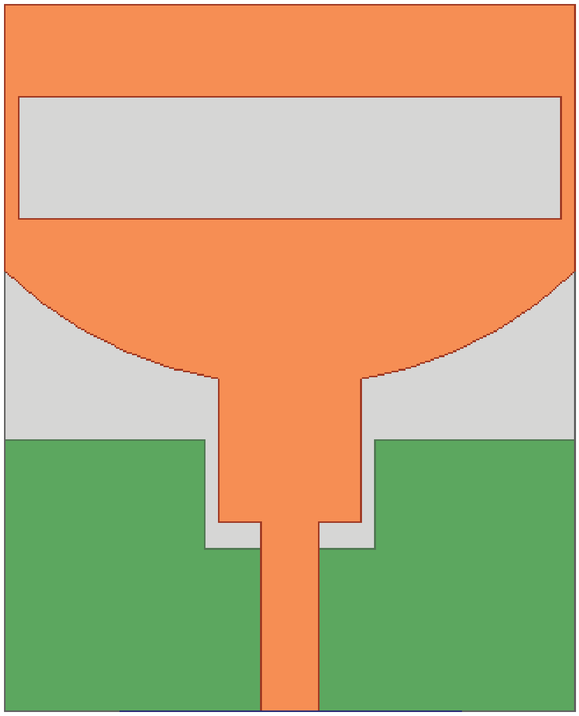


Figure 4. C Band Notched Antenna Design

The return loss or the S11 of the antenna is shown in Figure 5. The figure shows that the antenna is working from 2.9GHz to 10.7GHz with the notch band at 4GHz to 8GHz.

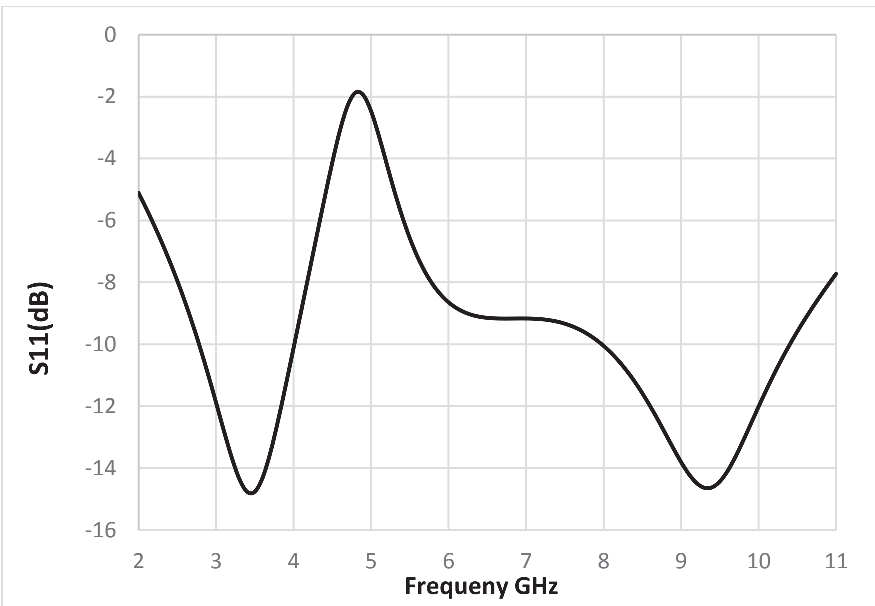


Figure 5. The Return loss S11 of C Band Notched antenna

4. Results and Discussions

The simulated results have been measured and analyzed in the Ansoft's High Frequency Structure Simulator (HFSS) software [12]. The proposed antenna has a bandwidth of 7.9GHz and it is working in the frequency range of 2.9GHz to 10.8GHz that covers the frequency range of Ultra-Wide band. The proposed antenna is notching the WLAN Band.

S11 or Return loss is one of the important parameters of the antenna, which is also called the refection coefficient. It shows how much power is reflected from the antenna. The S11 of proposed antenna is shown in Figure 6 which shows that the antenna is working from 2.9 GHz to 10.8 GHz with the notched band at 5 GHz to 5.9 GHz. Figure 7, shows that by changing the size of the slot, the performance of the notched band also changes. As we can see in Figure 7 (a), by keeping the Width of the slot W_1=17.5 and changing the Length L_1 of the slot, the performance of a notched band does not vary that much whereas in Figure 7 (b), some variation is observed in the performance of the notched band by keeping the Length of the slot L_1=0.4 and by changing the Width W_1 of the slot and at W_1 =17.5mm notch band can be observed to rise from 5GHz to 5.9GHz.

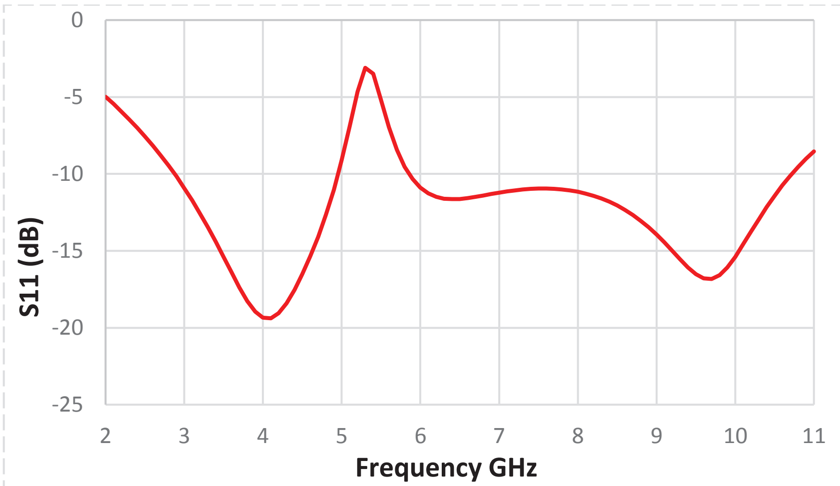
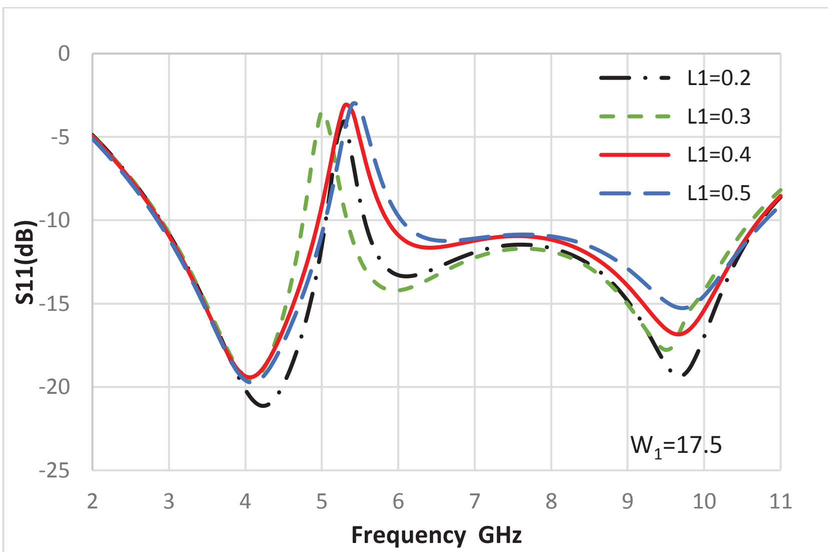


Figure 6. S11 of the Proposed Antenna



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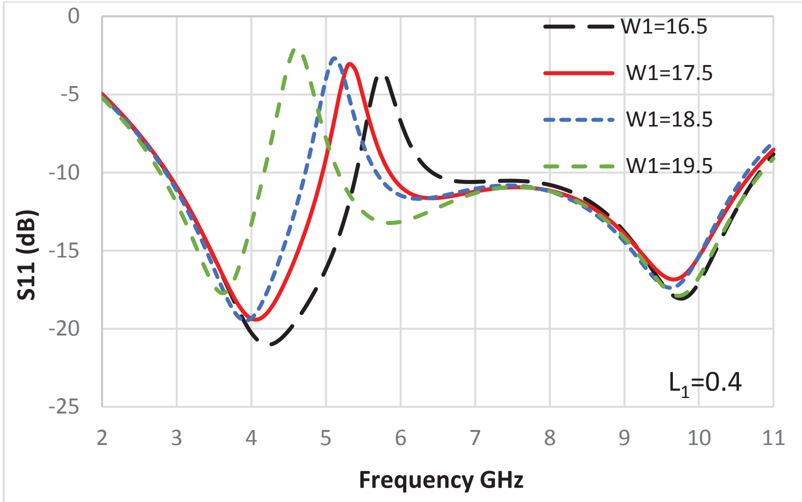
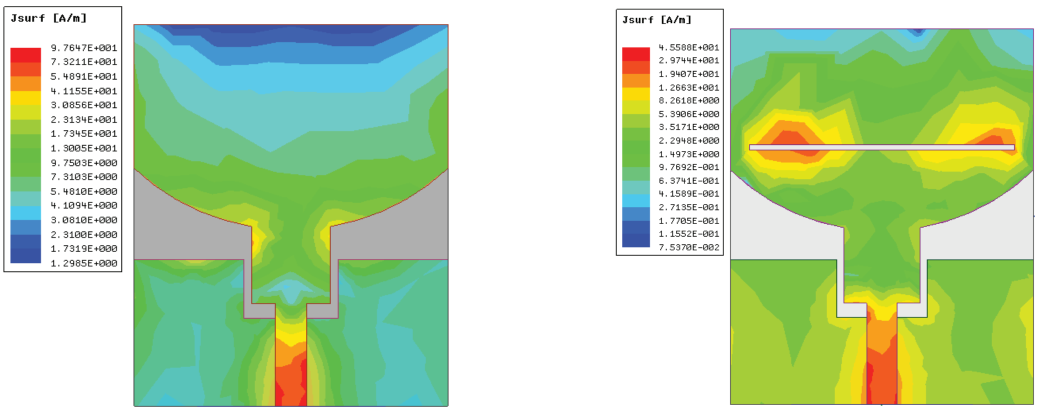


b

Figure 7. (a) shows the return Losses of the proposed antenna with different Length L_1 slot that is 0.2,0.3,0.4 and 0.5 with W_1 =17.5 and L_d =8.6 where all units are given in mm. While (b) shows the return losses of the proposed antenna with different Width W_1 of slot that is 16.5,17.5,18.5 and 19.5 with L_1 =0.4 and L_d =8.6 where all units are given in mm.



a b

Figure 8. Simulated Surface Current Distribution at Notched band 5.4GHz (a) without and b) with a slot

Figure 8 shows the simulated surface current distribution and compares at notched frequency 5.4GHz, the comparison was done on the basis of the slot. In Figure 8 (a), it is shown that the maximum current distribution is around the edges of the rectangular part of the patch when we have no slot in the antenna whereas in Figure 8 (b) we can see that maximum current distribution is around the slot. Figure 9 shows The Voltage Standing Wave Ratio (VSWR); VSWR describes the power reflected from the antenna. The value of VSWR should be less than 2 (VSWR<2). In Figure 9, we can see that the value of VSWR is less than 2 in the frequency range from 2.9GHz to 10.8GHz while in the notched frequency band from 5GHz to 5.9GHz, the value of VSWR is greater than 2 (VSWR>2). In Figure 10, the radiation pattern of the proposed antenna was measured and compared at notched frequency of 5.4GHz when there was no slot and when there is a slot. The gain of the proposed antenna is shown in Figure 11, which is another good measurement to describe the performance of the antenna. The gain of proposed antenna is sharply decreases at 5.41 GHz then it increases back and almost reaches to 4.7 dB.

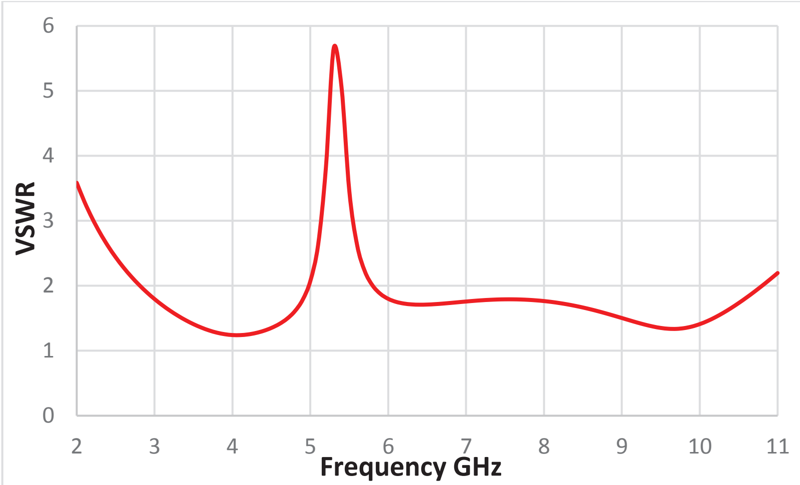


Figure 9. The VSWR of the proposed antenna

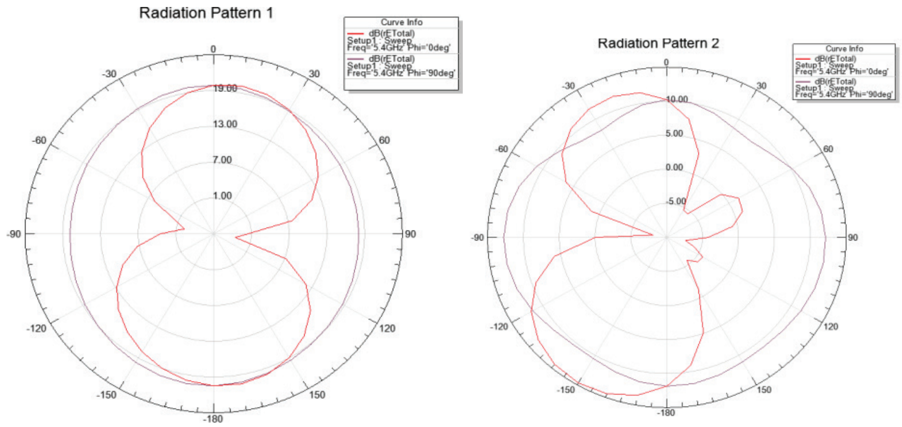


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Figure 10. The Radiation pattern of Proposed antenna at notched frequency 5.4GHz (a)without a slot and (b) with a slot

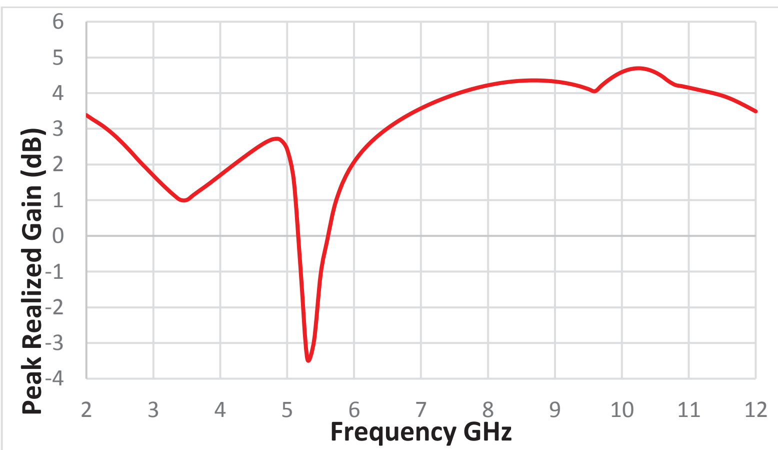

Figure 11. The Peak Realized Gain of Proposed antenna

5. Conclusion

A new micro strip fed monopole Ultra Wideband antenna was discussed in this paper. The proposed antenna has a frequency band width range from 2.9GHz to 10.8GHz and band rejected characteristic at 5GHz to 5. 9GHz.The band reject characteristic can be obtained by cutting a rectangular slot in its radiating patch. The rectangular cut in the ground plane is made for obtaining good impendence matching. The above mentioned results and discussions show that the proposed antenna is an appropriate choice for Ultra wideband applications.

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Computer Aided Wind Turbine Design and 1 kW Prototype Manufacturing

Zafer UTLU[1], Arthur CEBULA[2], Oğuzhan TOSUN[3]

Abstract - Wind energy is one of the alternative energy sources with a great potential in world energy production. The design, simulation and manufacturing stages of the wind turbine are explained throughout this study. After creating the design, the blade and airflow behaviors of the turbine are examined in the simulation environment. Then, the components required for turbine production are manufactured and supplied according to the technical drawing. Finally, the turbine is manufactured and the alternator performance is observed according to the blade rotation speed.

Keywords: *Wind turbine, turbine design, prototype manufacturing, simulation, wind energy*

1. Introduction

The world is increasingly shifting into using renewable energy sources. Especially in recent years, increasing investments in the energy field shows the importance of renewable energy. Wind energy is a type of renewable energy that has become very popular in recent times [1]. Wind, leaving fuel oil behind, was the 5th largest form of power generation capacity in 2007. Moreover, wind left behind nuclear energy as the 4th largest form of power generation capacity in 2013. In 2015, wind surpassed hydro as the 3rd largest form of power generation capacity. Finally, wind surpassed coal as the 2nd largest form of power generation capacity in 2016. Germany was the largest market in new wind power capacity installations with 44% of the total EU installations in 2016. This was followed by Spain, England and France. Turkey (1.4 GW) also broke its record for annual new installations. Wind turbines are the systems which mechanically capture the kinetic energy of the wind in a rotor connected to an electric generator which consist of two or more blades and convert the energy of wind; first into mechanical energy and then into electrical energy [3-4]. Today, the most common wind turbine design is horizontal-axis wind turbines. The rotational axes of such turbines are parallel to the ground. The rotors of these turbines are usually classified according to the direction of the rotor (the wind is from front or the wind is from behind), the blade hub design, the number of blades (usually two or three), the rotor control (pitch or stall), alignment with the wind (free yaw or active yaw) and the gear design [5]. These design-related differences affect the amount of energy the turbine produces. That's why, the amount of investment related to the wind turbine increases every year. The first capital investment in wind energy is used for machinery and supporting infrastructure. Factors that increase the energy such as turbine design, installation and operation of the plant are expensive making wind power an alternative energy source. Mathematical modeling of a wind turbine is necessary to

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understand the behavior of the wind turbine on the process area. The reason for this is that it allows the development of comprehensive control algorithms that will help the wind turbine operate at optimum values. The modeling ensures that the values of the wind turbine performance are controlled [6].

In this article, wind energy systems were studied and computer aided design and prototype construction of a 1 kW wind turbine system were emphasized. Firstly, the turbine design was carried out in a computer environment then a prototype of the wind turbine was fabricated.

2. Computer Aided 1 kW Wind Turbine Design

1 kW wind turbine design was modelled in a single system with two 500 watt alternators, shafts, bearings, gear system and fasteners. In the simulation environment, it is assumed that the wind speed has a constant value (20 m/s). Three-bladed wind turbine design with 2.1-meter rotor diameter and simulation calculations were made. Each turbine component that was designed and simulated by calculations were specially manufactured according to the technical drawings. A double braking system is used for protecting the turbine system from excessive wind speed. The first of these braking systems is the bicycle hydraulic brake disc system. Turbine-mounted braking system allows the turbine to be slowed or stopped at any time when being desired. The second brake system is the charge control device, in which the charge control system automatically brakes the 24-volt alternator when it reaches 29-volt power. The magnetic alternators that provide alternating current output were used for electricity generation. The router that caught the wind was made to constantly turn the turbine in the direction of the wind and a slip ring was added to prevent the circulating of the alternator cables. Finally, the turbine was mounted on the aluminum pipe and the manufacturing phase was completed.

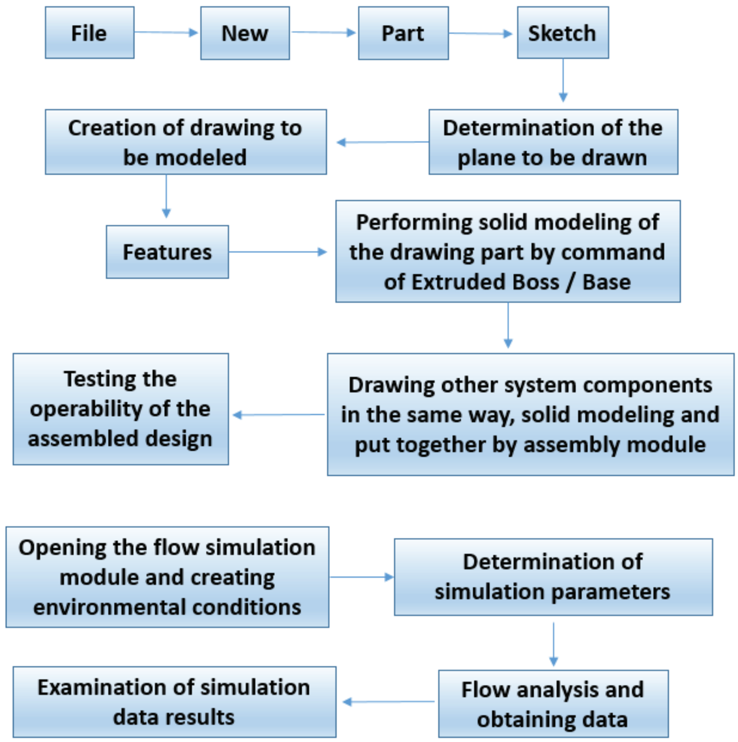
2.1. Using cad program for wind turbine modelling

Computer aided design of a product is the first step taken during product engineering and production, and it is the modeling process of that piece in software. The designed product model can be visualized in a desired perspective. Interaction and compatibility between the parts themselves can be visually examined, thanks to the advantages providing convenience in the production of parts, such as sectional view. The drawing of the turbine components was conducted using the SolidWorks program as a part of the design of the wind turbine. The AH79-100C blade profile was designed according to the UIUC (Department of Aerospace Engineering) for evaluating the design of the airflow-based system [7]. Aerodynamic behaviors of the system were determined by the flow analysis and as a result of this analysis the blade performance evaluation was conducted.

The reasons for using the drawing program to create the model are as follows;

a) Vector-based and measured-3D drawings can be created with this program.
b) Thanks to coordinated work with other programs, the designs can be transferred to other programs, the programs can be examined and the technical data can be obtained on the created models.
c) Separately drawn parts can be combined and assembled with the assembly module, detailed data on many tests such as flow or static and the impact on the drawing can be obtained and motion analysis can be added to the system with animation plug-in [8].

The flow diagram that was used for creating the design is as follows;



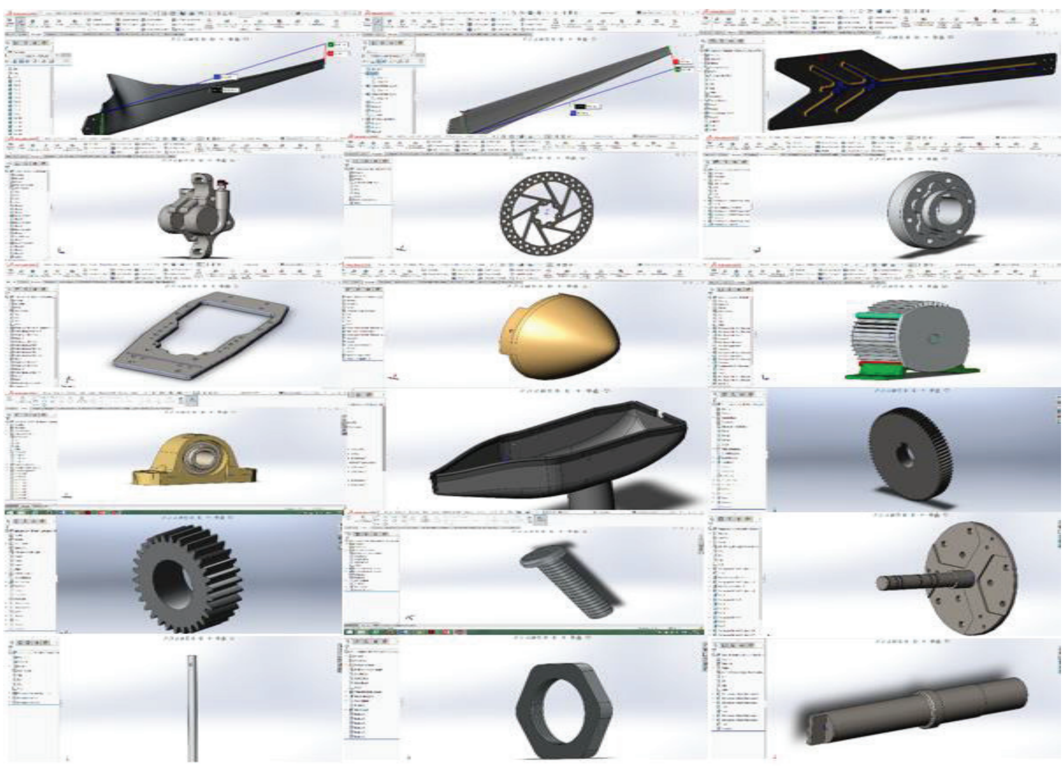


Figure 1. Solid models of wind turbine components

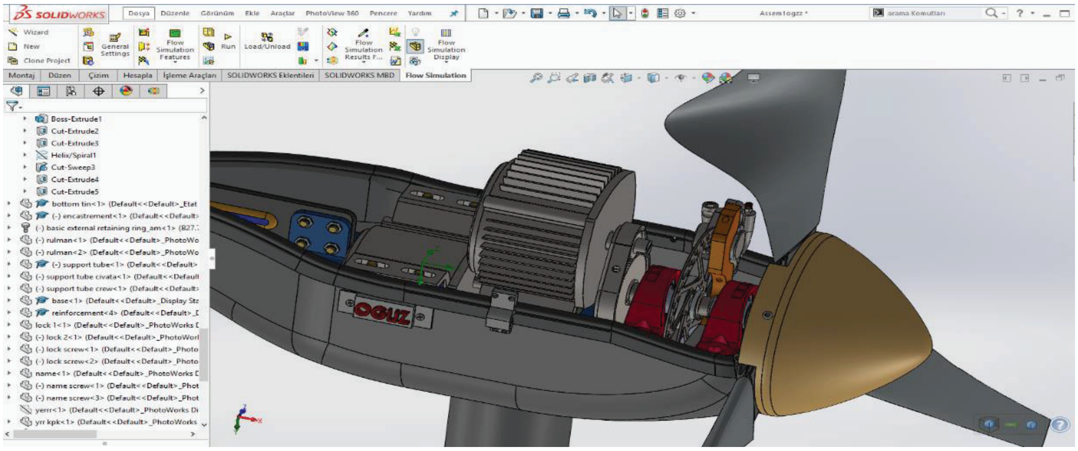


Figure 2. View of the wind turbine after assembly

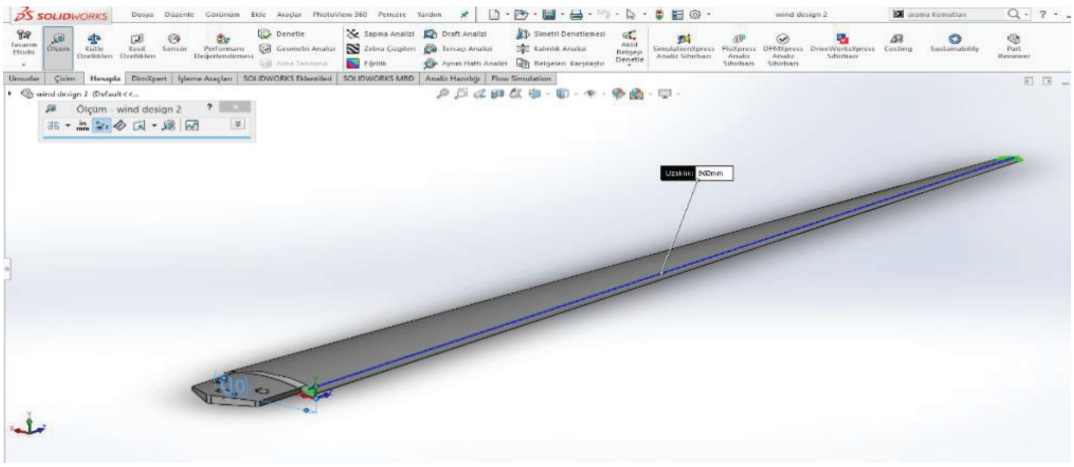
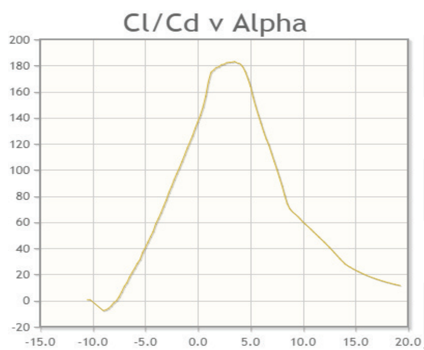


Figure 3. AH79-100C blade profile

The two important criteria to be considered while designing the blade are the aerodynamics and the strength. Aerodynamically, it is important to pay attention to the value of C_L / C_D (lift / drag coefficients) and the value of a^0 (attack angle). For best blade efficiency, the minimum value of the angle of a^0 should be selected, in addition to the maximum value of l/d. The value of C_L/C_D appears to be at the maximum value at $3{,}5^0$ attack angle in the data of AH 79-100C blade profile [7]. The variation of C_L and C_D values according to attack angle and Reynold numbers are given in the figure.



Airfoil	Reynolds #	Ncrit	Max Cl/Cd
ah79100c-il	50,000	9	32.2 at α=11°
ah79100c-il	50,000	5	31.5 at α=10°
ah79100c-il	100,000	9	61.7 at α=8.5°
ah79100c-il	100,000	5	61.5 at α=7°
ah79100c-il	200,000	9	97.6 at α=6.25°
ah79100c-il	200,000	5	97 at α=4.75°
ah79100c-il	500,000	9	147.6 at α=4.5°
ah79100c-il	500,000	5	137.7 at α=3°
ah79100c-il	1,000,000	9	183 at α=3.5°
ah79100c-il	1,000,000	5	161.4 at α=2.75°

Figure 4. Change of C_l/C_d ratio versus attack angle and Reynold numbers

The lift and drag coefficients and the Reynold number are calculated by the following equations;

$$C_L = \frac{L}{\frac{1}{2}\rho V^2 A} \tag{1}$$

$$C_D = \frac{D}{\frac{1}{2}\rho V^2 A} \tag{2}$$

$$Re = \frac{UL}{\upsilon} = \frac{\rho UL}{\mu} = \frac{Inertial\ force}{Viscous\ force} \tag{3}$$

v= velocity of the fluid

l= the characteristics length, the chord width of an airfoil.

ρ= the density of the fluid

μ= the dynamic viscosity of the fluid

υ= the kinematic viscosity of the fluid [9].

2.2 Parameters and Simulation Data Results

1. The volume to be used for the air flow simulation was generated.

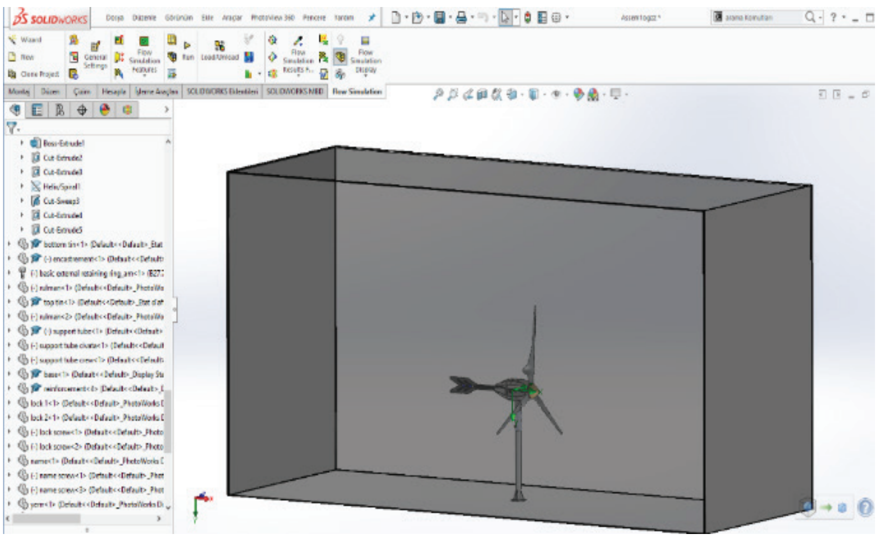


Figure 5. Air volume modeling

2. A new flow simulation project is defined by clicking the project for the flow simulation and then clicking on the wizard. The (current) box is preferred in the configuration box. Each flow simulation project is associated with a SolidWorks configuration.

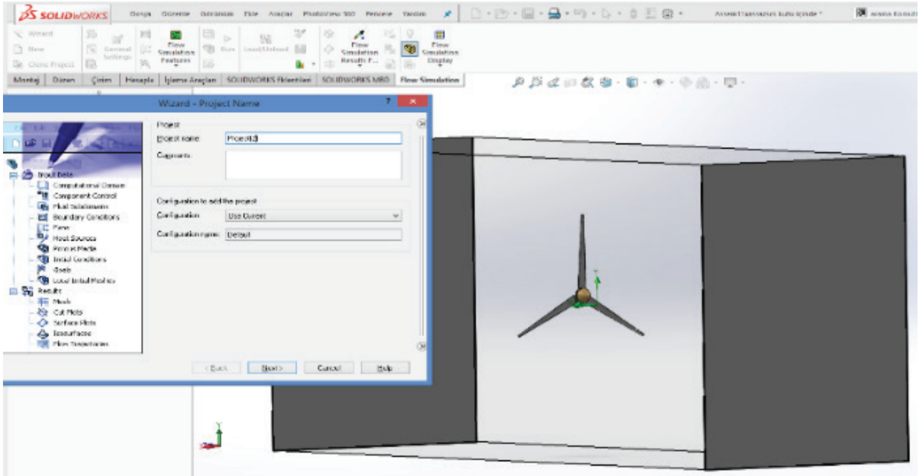


Figure 6. Project description

3. In the unit system box, we can select the desired unit system for both input and output. The International System (SI) was used by default for this project.

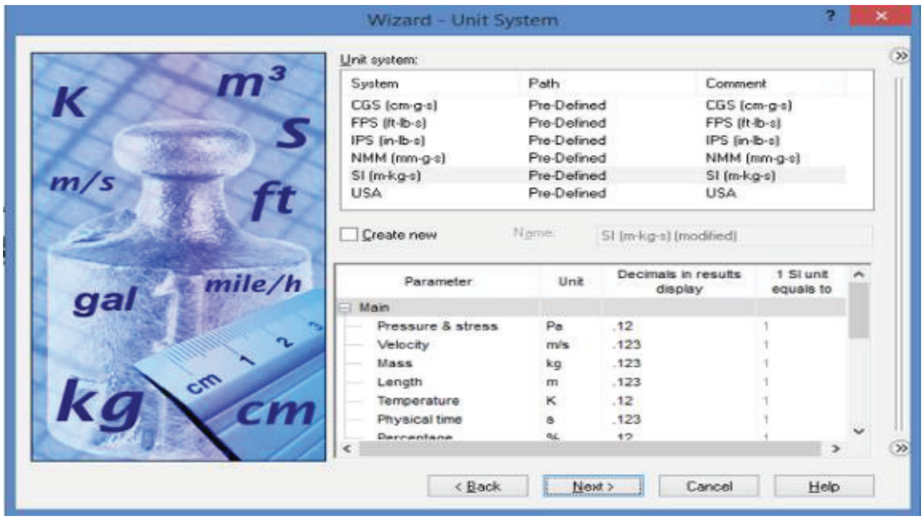


Figure 7. Unit System Identification

4. In the analysis type box, depending on the type of the flow analysis (internal) or (external) can be selected. In this study, the internal type was preferred due to the flow analysis occurıng in a closed volume air. The option to exclude cavities without flow conditions was chosen to ignore the internal gaps that are not included in the internal analysis. The x, y or z reference axis of the general coordinate system is used for determining the data in the form of a table or formula in a cylindrical coordinate system based on this axis. Another important point, that should be taken into account in the analysis, is the type box which is to be specified for the improved physical properties (heat conduction in solids, gravitational effects, time dependent problems, surface radiation from the surface and rotation). It is stated that the rotation command will rotate the turbine blades.

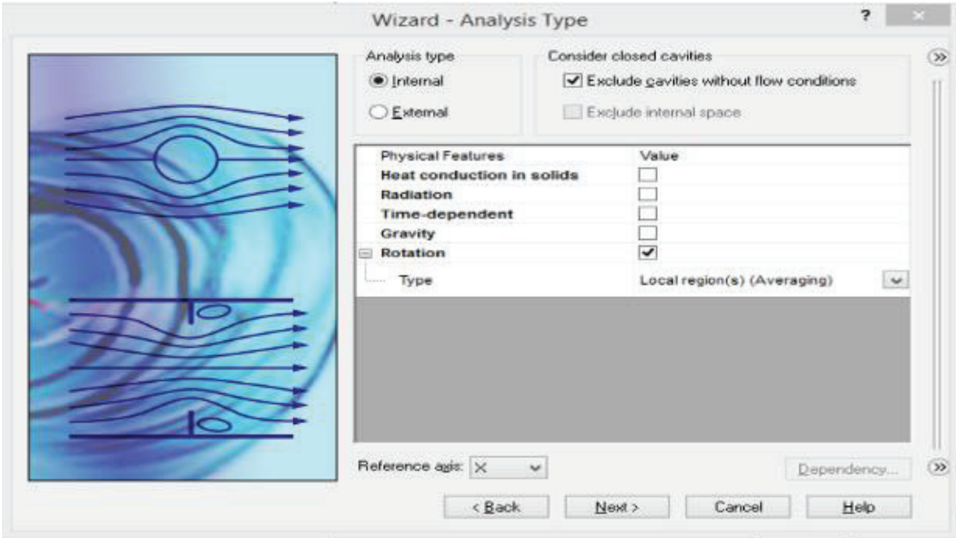


Figure 8. Determination of the type and the shape of the analysis

5. The SolidWorks engineering database contains numerical physical information on a wide variety of gases, liquids, solid materials and radiation surfaces. Air flow was used as a fluid flow in simulation. Laminar and turbulent flow were selected as the flow types in the simulation.

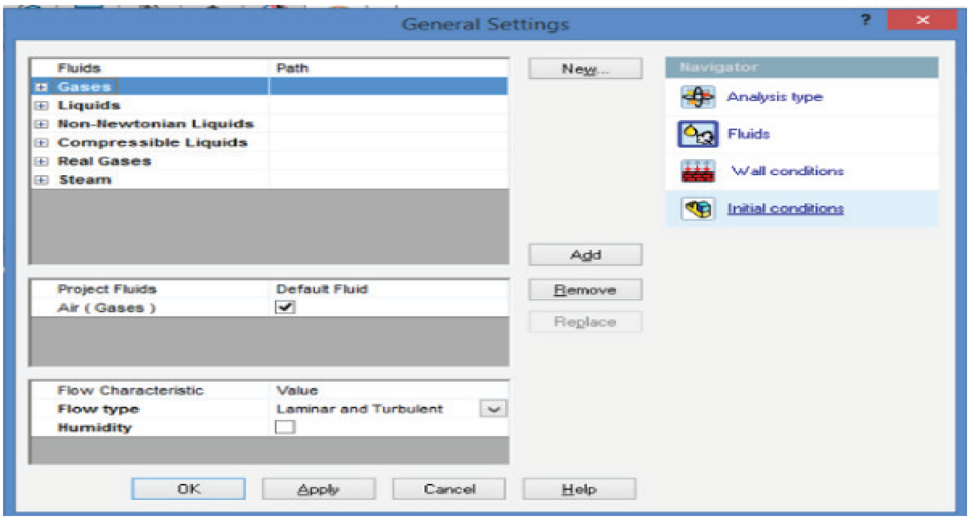


Figure 9. Determination of fluid flow and type

6. The formed air volume walls were chosen as adiabatic walls for examining the interaction on the wind turbine blade of the air flow. The initial condition parameters specify the conditions under the conditions of the starting point of flow. As the initial condition of the thermodynamic parameters, the temperature at 293.2 Kelvin, atmosphere pressure 101325 Pa and air density 1 kg / m^3 are used. The simulation wizard part is completed with the finish button. The next step is to determine the boundary conditions. The boundary conditions are used in internal flow analysis to define fluid properties in model inputs and outputs or model surfaces in external flow analysis. These data specify the computational domain settings, the boundary conditions, and the goals for which we want to calculate values such as pressure, temperature, velocity, and density.

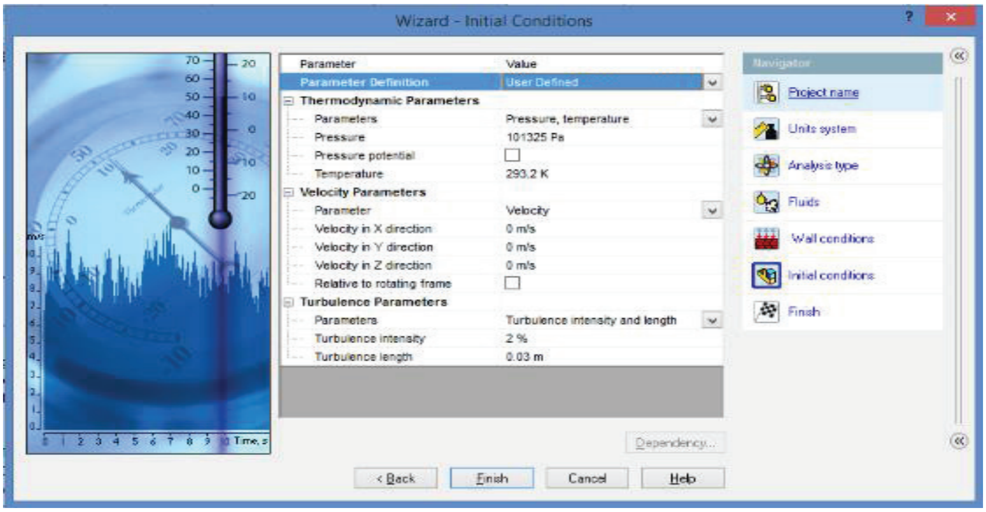


Figure 10. Selection of the atmospheric conditions

7. Firstly, computational domain boundaries determined and the domain shows the area in which analysis calculation is to be performed.

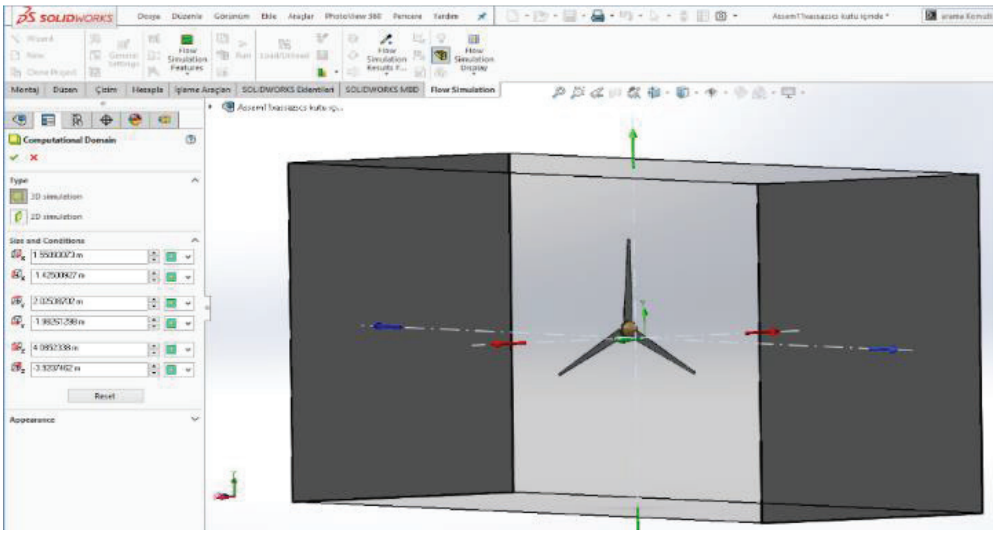


Figure 11. Determination of the calculation area

The next step is to determine the boundary conditions. The boundary conditions are used for defining the fluid properties of the model inputs and outputs in the internal flow analysis or in the model surfaces in the external flow analysis. For the computational domain, it is used for defining 20 m / s air velocity and for the external, the atmospheric pressure was defined. The rotation speed of the rotor 50 rad / s is given from the rotational regions part. In this way, the air flow movements around the rotor region and around the blade design were examined.

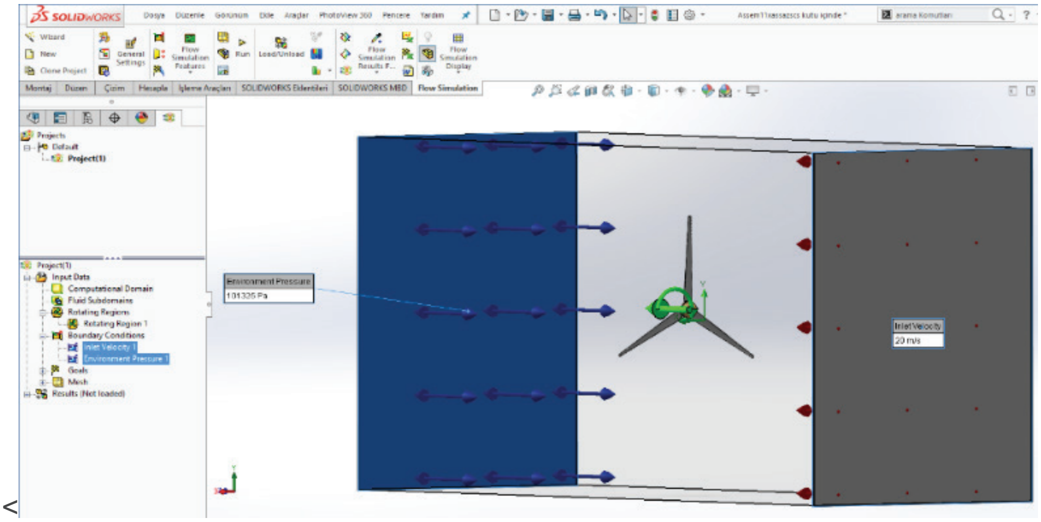


Figure 12. Boundary conditions input

The target parameters calculate the physical parameters within the computational domains. The target parameter to be calculated is determined as an examination of the distribution of the airflow over the blade profile and rotor area.

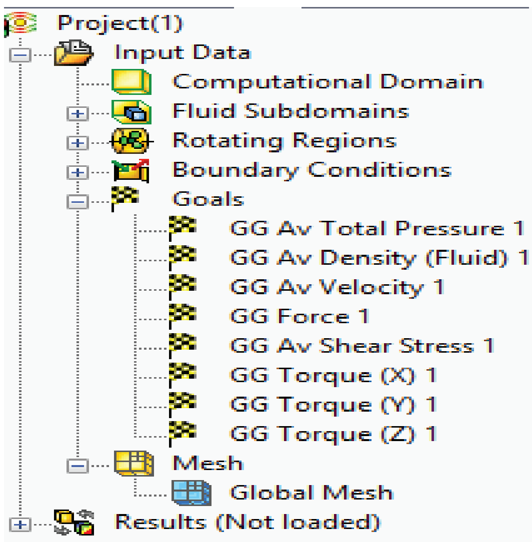


Figure 13. The input data

After entering the project data, the calculation section is started. In addition to initiating the analysis in the solution and result box, the mesh settings can be arranged. However, what is important here is the sufficiency of computer power supplies (CPU time and memory). The control is started and the analysis is started by run command. Analysis was initiated with run command after controlling the power supplies.

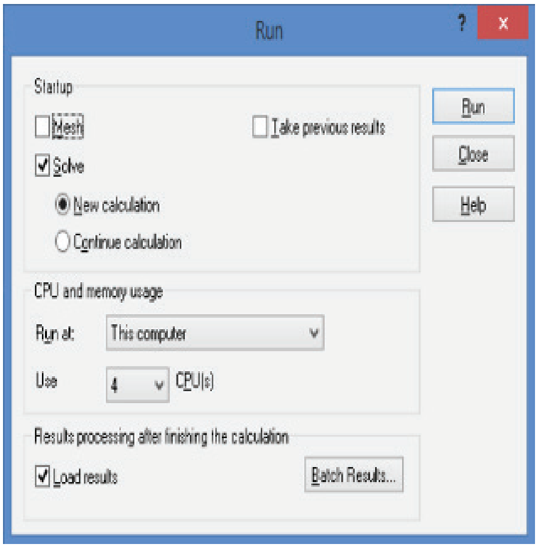


Figure 14. Obtaining solution and result

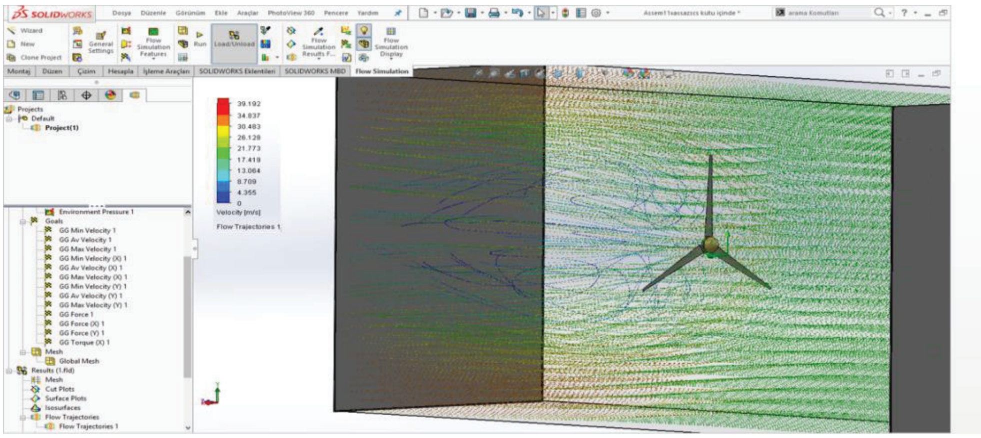


Figure 15. Simulation display

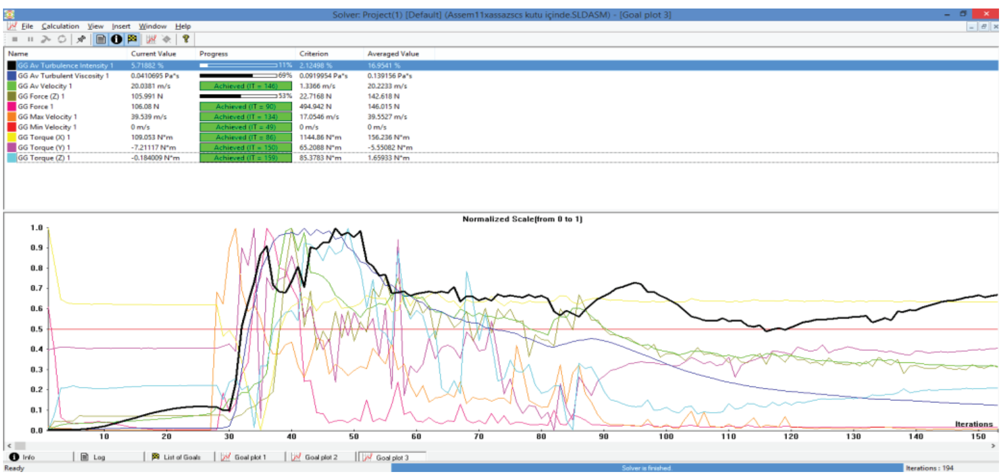


Figure 16. Calculation results for the blade model

3. The Manufacture and the Assembly of the Wind Turbine Components

During the construction phase of the wind turbine which was designed in SolidWorks, it was noted that each part was manufactured at values close to the measurement. Firstly, the parts to be manufactured in the design direction were determined and technical drawings were taken out. During the production phase of the parts, turning and milling machines were used in the production of spindle, support elements, gear and pole. The router was produced with laser cutting machine; the turbine support structure was produced through welding and sawing machines. The blades, bearings, blade connection disc, nose, alternator, charge controller, bicycle hydraulic brake disc system and fittings were provided in private. Following the manufacturing and supplying of the parts, the process progresses to the assembly phase.

3.1. Spur gear design and manufacturing

Gears are an important connecting element in the design, which allow the generator to increase the number of turns per minute and produce more energy at lower revs. The use of gears has negative aspects, such as gaining motion at greater wind speeds due to friction on the system in addition to its positive advantages, such as generating more energy at lower speeds. It has been determined that the alternator has sufficient power output at the rotor inlet revolution of 50 rpm and at the range of 2000-3000 rpm. A 2-stage spur gear design was prepared for achieving a speed range of 2000-3000 rpm and the rotor was provided with sufficient power output at 650-1000 rpm rotation speeds. The following figure shows the gear design in the CAD program and its manufactured state.

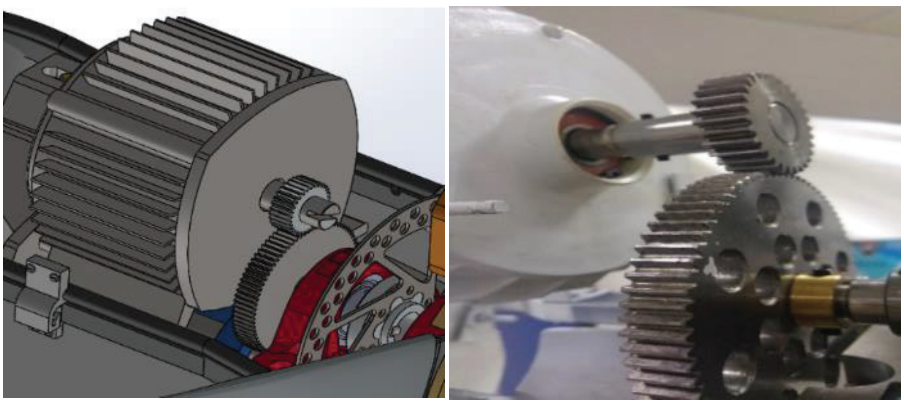


Figure 17. Designed and manufactured spur gear

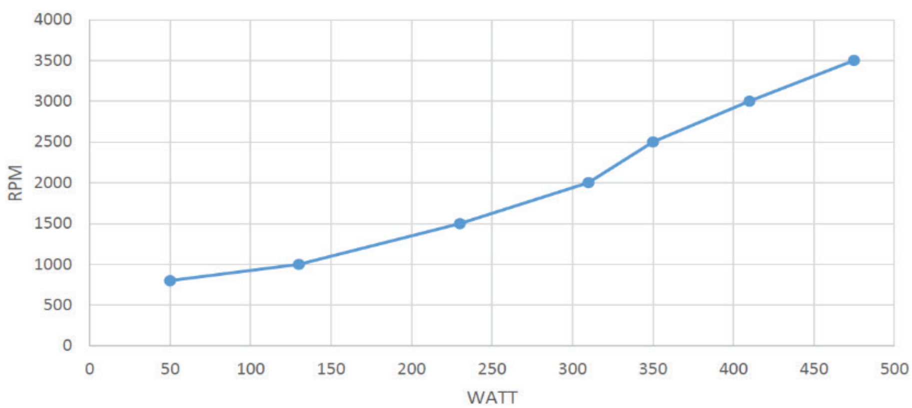


Figure 18. Alternator power output according to the rotation speed

3.2. Router design and manufacturing

The turbine rotor must always be in a perpendicular position to the wind in order to benefit from the power of the wind that drifts in different directions. This routing movement is provided either by an electronic controller which determines the direction of the wind or by a system called router that can turn around 360^0 by bearings routed in the direction. The following figure shows the router in the CAD program and its manufactured state.

Figure 19. Designed and manufactured router

3.3. Support plate and manufacturing

It is the structure that carries the alternator, rotor, connecting elements, gear box, shaft, bearing and brake disk system of the turbine. It is made of 15 mm thick aluminum material. The support plate and its construction are shown below.

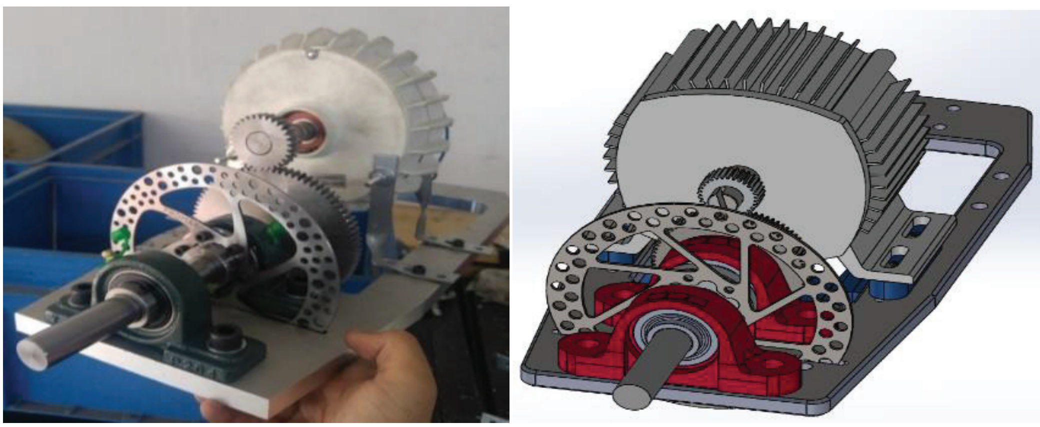


Figure 20. Designed and manufactured plate support element

3.4. Brake control system

<The turbine is controlled at high speeds and kept constant at certain speeds to protect the blades and system components. Double braking system is used in the design. The system can be manually slowed down at any time with the brake disc system on the turbine. The other braking system is the control charger. Alternators will automatically slow the system down when it reaches 29 volts. The following figure shows the brake disc mechanism and control charger.

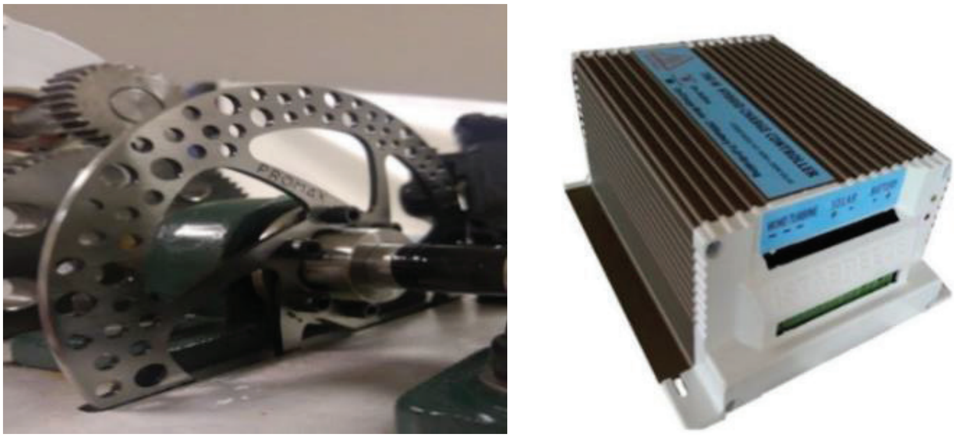


Figure 21. Brake control systems

3.5. The blade and rotor system selection

The components of the wind turbine blades catch the kinetic energy of the wind. In a wind turbine, the material from which the blades are produced must be light, robust with a high corrosion resistance and strength. In this study, composite performance blades that are 103 cm in length and 650 g in weight containing 30% fiber and 70% polypropylene fiber and glass fiber were used. The following figure shows initial appearance of the rotor design and turbine.

Figure 22. Designed and manufactured rotor turbine

3.6. Assembly phase of the turbine design

The assembly of the wind turbine is the most important part in the design process. The manufactured and supplied parts must be combined with great care and calculation. First, the assembly was commenced on the support plate with alternators, bearing, brake disc and the assembly of the shafts, then continued with the assembly of the router. The center of gravity is calculated after the parts on the plate support have been assembled. Following the finding of the center of gravity, the bearing fixture that enables the rotation of the turbine for 360^0 is fixed to the support plate first. Finally, the connection to the turbine pole is provided. A slip ring system was added to prevent the alternator cables from tangling during rotating motion. The final assembly of the turbine is shown below.

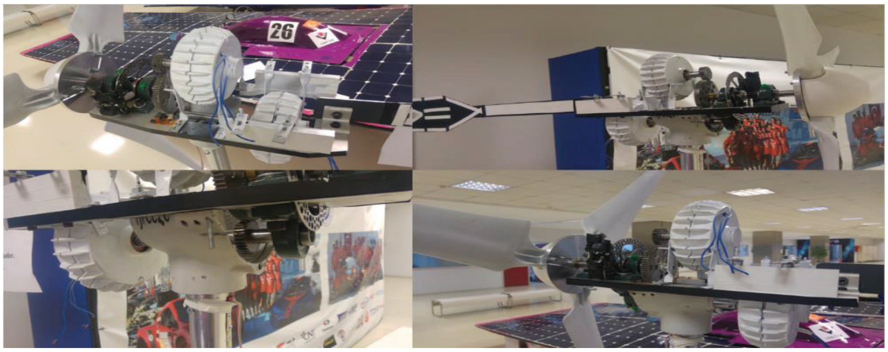


Figure 23. Final assembly of the wind turbine

4. Conclusion

In this study, a wind turbine was both designed and manufactured in 1 kW power. During the design phase, the necessary calculations were conducted, and it has been noted that all the connecting elements are dimensionally compatible with each other. Each part was individually designed and then put in the computer-based assembly phase. AH79-100C was selected as the blade profile according to the UIUC data for evaluating turbine blade performance flow analysis. The blade performance analysis was performed to observe the distribution of the air around the blade as well as the torque and power on the turbine. As a result of the flow analysis, it was observed that the pressure change increased as it got to the front of the rotor and it fell as it passed to the back of the rotor. The velocity of the air rises at high speeds on the blade tips and around the rotor, but it appears to have decreased for it is captured by the rotor, the kinetic energy of the air behind the rotor. A wind turbine prototype was manufactured with the same dimensions following the design and simulation studies. The technical drawings of the parts to be manufactured during the production phase were created and parts were manufactured using turning, milling, laser cutting, spiral cutting, sawing processes. The other materials were supplied in accordance with the system. Bearing was made to prevent the vibration of the shafts that receive the rotor movement during the assembly phase. The grub screws connection element was used for fixating the gears to the shafts. The turbine's operability was observed and tested following the completion of the assembly process. The stages of design, calculations and production are provided above step by step.

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Double Band Fractal Bow Tie Antenna Design for GPR Application

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Abstract - In this work, antenna is studied as an important part of Ground Penetration Radar (GPR). For obtaining information about materials in two different depths, a novel double band bow tie antenna is proposed. Fractal method is used for improving the antenna performance. The results of the antenna development is presented step by step. The low cost and light profile designed antenna has been fabricated and tested in microwave laboratory. The fabricated antenna results agree well with the simulation analysis.

Keywords - *Bow tie antenna, GPR*

1. Introduction

GPR application area can be classified in two main groups. In military field, GPR is used for underground warehouses, unexploded bombs, secret rooms and also bomb shelters. Besides, in civilian life, it is used for finding buried pipes, undetected blanks and the people who are left under collapsed buildings [1-4]. Antenna is needed for transmitting the signal and gathering the reflected wave as well as collecting information about the properties and the distance of the buried object. Size, weight and the price of an antenna are the chief challenges for designing. Additionally, impedance bandwidth for increasing the data resolution is important. Also, operating frequency is the key factor of signal penetration [5 and 6]. In literature, circularly polarized antenna was proposed for reaching a deeper distance and passing more layers [7 and 8]. As shown in Figure 1, the fractal objects have a combination of similar structures at different scales that are identical with themselves [9 and 10]. The first shape of recurring structure is called the generator. Repeating the initial shape with different scales, directions and positions are parts of the fractal method. In this work, Bow tie antenna is preferred for designing because of lower weight and smaller size in comparison with Horn and Vivaldi antenna. The operation frequency of the designed antenna is quite decreased for more penetration. Fractal method is chosen for increasing the impedance bandwidth and obtaining double band frequency. Ansoft HFSS program is used for simulation analyses.

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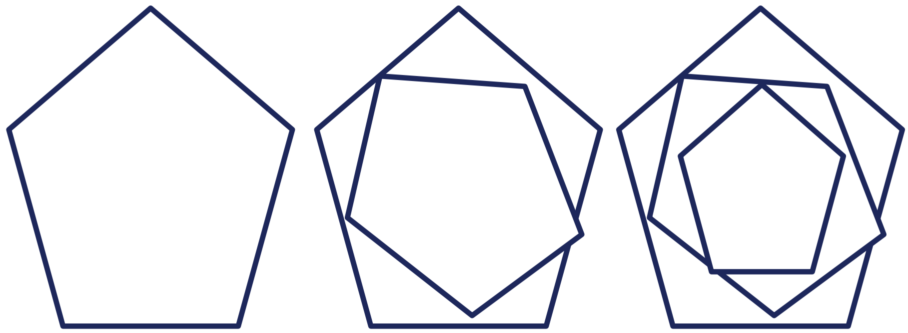
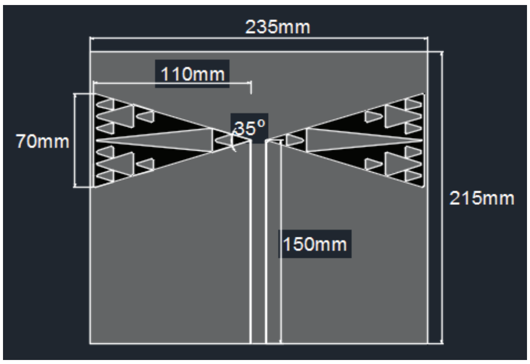


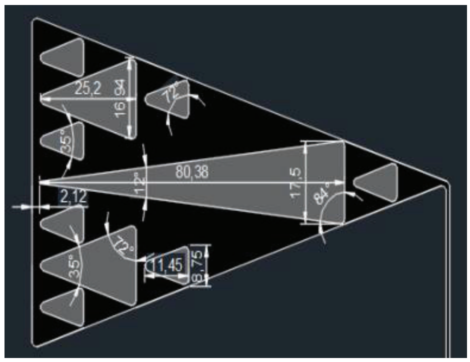
Figure 1. Fractal structure is repetitive of its own structure

2. Design of Antenna

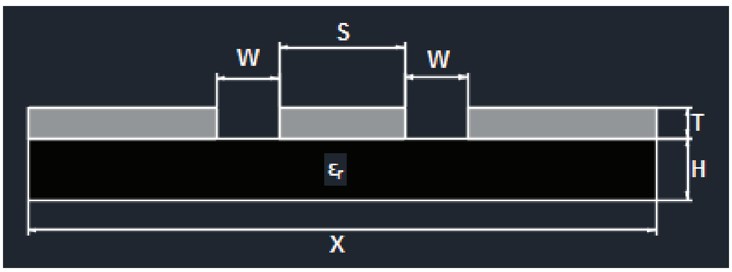
Proposed antenna structure is shown in Figure 2. Epoxy material εr=4.4 which is called FR4 with H=0.8 mm. thickness, is used as the substrate of the designed antenna.



(a)



(b)



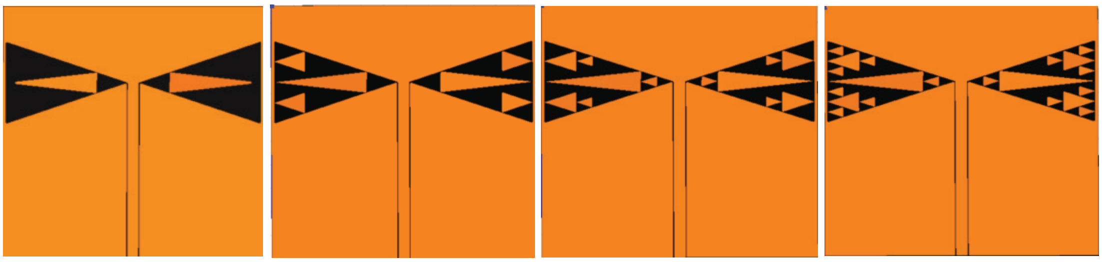
(c)

Figure 2. The geometric structure of the proposed antenna (a) Top view and angle representation of the antenna (b) One side triangle and its interior (c) Side view

The dimensions of the antenna are 215×235×0.8 mm. The feed path length of the antenna is h=150 mm; feed length width is W=0.8 mm and the gap between two ways is S=10 mm. These diameters have been found after so many simulation processes and the best result was chosen. Feed line is designed for connecting the 50 Ω SMA connector.

3. Result and Discussion

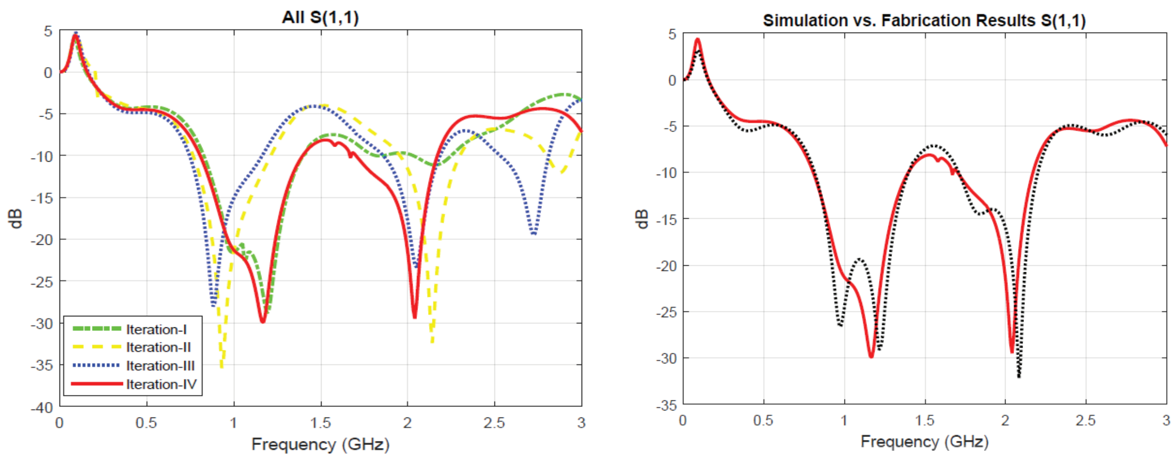
Figure 3 shows the steps of the fractal antenna design. According to the results of these steps, high resolution data regarding the buried object can be obtained by increasing the frequency bandwidth. Furthermore, more depth of penetration was successfully obtained by decreasing the operation frequency. The steps of improvement were continued as follows:



(a) (b) (c) (d)

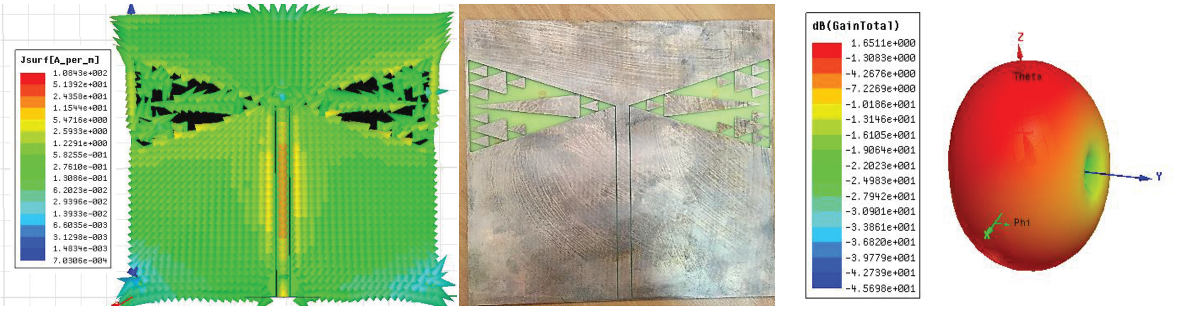
Figure 3. The improving steps of the proposed Double Band Fractal Bow-Tie Antenna (a) Iteration I (b) Iteration II (c) Iteration III (d) Iteration IV

In figure 4(a), the -10dB s11 shows that the improvement observed in the results has occurred stepwise. In the last iteration (of the proposed antenna), the starting frequency is sufficiently low for good penetration (0.8 GHz) and the two bandwidths are good enough for resolution (0.8 – 1.4 and 1.5 - 2.2 GHz). Figure 4(b) shows that the fabricated and the simulation results of the proposed antenna are significantly close. According to Figure 5(a), the current distribution is uniform at every point of the antenna, which helps with the improvement of radiation pattern and gain. The fabricated double band fractal bow-tie antenna is demonstrated in Figure 5(b). Also, Figure 5(c) shows the 3D graphic of the antenna pattern. Figure 6 shows the radiation patterns of the last version of the double band fractal bow-tie antenna in different θ and φ angles at operating frequency.



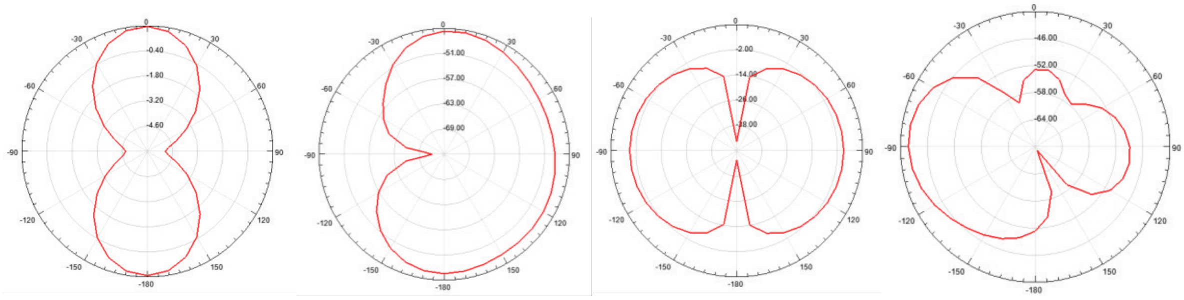
(a) (b)

Figure 4. (a) s11 graph of all iterations (b) Experimental (red line) and Simulation (black-dashed line) results for proposed antenna



(a) (b) (c)

Figure 5. (a) Current distribution of antenna at operation frequency. (b) A photograph of fabricated double band fractal Bow-tie Antenna (c) 3D antenna gain plot



(a) (b) (c) (d)

Figure 6. The radiation pattern of Double Band Fractal Antenna at operation frequency (a) φ=0°, (b) φ=90°, (c) θ =0°and (d) θ =90°

4. Conclusion

In this article, double band Fractal Bow Tie antenna has been designed and fabricated. Using the fractal method, the antenna bandwidth is increased. The bandwidth of designed antenna was analyzed by being initiated from 0.8 GHz and 1.4 GHz for the first band and from 1.6 GHz and 2.2 GHz for the second band. Thanks to the results accumulated from the proposed antenna, obtaining more details and reliable information regarding the buried objects will be possible.

5. Acknowledgment

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Title should be in 16 pt. bold, italic, small letters with Times New Roman font in Microsoft Word format. Authors' names, affiliations, e-mail addresses should follow the title after double line spacing with authors' names and surnames in lower case except first letters in 14 pt, the rest is 10 pt. italic.

Abstract should not exceed 200 words with the word "Abstract" in 10 pt. bold, abstract text in 9 pt. all in Times New Roman font in Microsoft Word format.

Key Words not exceeding 5 should be in italic.

Document Character: Subtitles should be in 10 pt. bold, small letters and text body 10 pt. both with Times New Roman font in Microsoft Word format. The first letter of the chapter titles should be capital letter and others with lower case and bold. The manuscripts should be written on a single column with single line spacing between paragraphs. Tab should be taken as 0.42 cm. A line must be left blank after the chapter heading. The problem should be clearly stated in the introduction section. The introduction should follow the method, results, discussion/comment and conclusion sections respectively. It is shown in [1] that there is a need to indicate the source in various places of the text. The rules for how to write the sources are listed at the end of the template where it should be reported.

Each image used must numbered and be named as "Figure". Formulas must be numbered sequentially.

$$Y = a + bX + \varepsilon \quad (1)$$

FRP Area (ft^2) (2)

Conclusion section should have a title written in 10 pt. bold, small letters and the text in 10 pt. all in Times New Roman font in Microsoft Word format.

Reference numbers should be given in brackets as illustrated below and Tab should be taken as 0.42 cm.

Referencing books:

[1]. Ozsu M., T, Valduriez, P., *Principles of Distributed Database Systems*, Prentice Hall, New Jersey, 128-136, 1991.

Referencing papers:

[2]. G. Altay, O. N., Ucan, "Heuristic Construction of High-Rate Linear Block Codes," *International Journal of Electronics and Communications (AEU),* vol. 60, pp.663-666, 2006.

Page number is to be placed at the top left corner of each page with pencil.
Length of the Manuscript should not exceed 20 pages excluding Figures and Tables.

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Conclusion section should have a title written in 10 pt. bold, capital letters and the text in 10 pt. all in Times New Roman font in Microsoft Word format. Conclusion should not be a version of the Abstract.

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Referencing books

[1] Özsu M., T, Valduriez, P., *Principles of Distributed Database Systems*, Prentice Hall, New Jersey, 128-136,1991

[2] G. Altay, O. N., Ucan, "Heuristic Construction of High-Rate Linear Block Codes," *International Journal of Electronics and Communications (AEU),* vol. 60, pp.663-666, 2006.

Short Biography of the authors should follow references after a single line space, names in 9 pt. surnames in 9 pt. and the text in 9 pt. The text should not exceed 100 words.

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