King Saud University
College of Engineering
Electrical Engineering Department **Semester: 391**

Senior Design Project Proposal Form

Project # C1

Project Title: Water Leakage Warning System in Residential Buildings

Professor(s) Name(s): Prof. Saleh A. Alshebeili and Dr. Tariq Alshawi

Number of Students: Two

Students Qualifications

1) Knowledge of embedded hardware design and wireless communication systems,
2) Excellent skills in mobile apps programming

Statement of Problem

Water leakage in residential buildings wastes water and might lead to problems in the structure of the building or damage to the insulation and wiring. Detecting water leakage remains a challenge because it requires costly periodic examination and sometimes requires removing parts of the home installations such as floors or bathroom accessories. Therefore, automating water leakage detection would be desirable to home owners both for water saving and to avoid future problems associated with water leakage. One way to efficiently detect water leakages is to monitor water consumption. If abnormal water consumption is detected this might indicate the presence of water leakage.

Objectives

The main objectives of this project are as follows:

1) Conducting literature review on automated water leakage warning systems
2) Program an embedded hardware platform that monitors the operation of the water pump and wirelessly communicate the data via the internet
3) Program a mobile application that receives the data from the moitoring gadget and alerts the user (home owner) to possible leakages or abnormal behavior in the water pump.

Technical Approach

Literature review will be conducted using KSU electronic library and the embedded hardware and the mobile application will be programed using open source software suite.

Expected Deliverables

A complete monitoring system for water pump operation and well-designed mobile application to display the data and alert the user. The design and implementation is expected to be oriented towards commercializing the end product.

Project #C2

Project Title: Design of Microwave and Millimeter Wave Amplifiers

Professor(s) Name(s): Abdel Fattah Sheta & Ibrahim Elshafiey

Number of Students: Two

Students Qualifications:

Basic knowledge of Communication and Electronics Engineering

Statement of Problem

Power amplifier circuits are essential for all communication systems. Typical design requirements involve enhance efficiency reduce size and cost of amplifier circuit. Next generation communication systems (such as 5G) move toward mm-waves. High level of integration at this frequency ranges is essential. The concept of system-on-chip has thus immerged.

Brief Description of the Project

The focus of this project is to understand the role and requirements of power amplifier modules in communication systems. Design is conducted through the development of PCB for microwave range power amplifer that inveloves high power transistors. On the other hand, design of amplifier on IC level is sought for mm-wave range.

Objectives

The objective of this project

(1) Investigate requirements of power amplifier
(2) Get acquainted with ADS and Cadence design tools.
(3) Design of basic power amplifier circuits using simulation tools.
(4) Optimize the design.
(5) Conduct tests on the developed modules.

Project #C3

Project Title: Design and Placement of UAV Antennas

Professor Name : Professor Majeed Alkanhal and Dr. Hamsakutty Vettikalladi

Number of Students: Two

Students Qualifications:

Statement of Problem:

To invistigate, compare, and design different antenna "possible' structures for specific purposes for communication and electronic warefare (EW) applications. Antennas with different shapes and performances will be analyzed , modeled and selected for different communication and EW enviroments.

Brief Description of the Project:

Unmanned Air Vehicle (UAV) system typically has several wireless links. These links include a remotely operated control system in addition to wireless communication (usually UHF) links to transmit information to the control base-station. These wireless links need high quality designed antennas that can operate with minimized destructive interaction among them and between them and the airplane body. This is the root of the problem of design and placement of UAV antennas to ensure best performance for the control and communication links between the UAV and the ground-based station.

Objectives:

Phase 1 (EE496):

Problem formulation, Antenna Sofware Package Practice, the UAV simulation model, simulations and results verification.

Phase 2 (EE497):

Design and selection of different band UHF antenna structures and their placement on the UAV according to the proposed specifications (using the simulation model), conclusions and documentation**.**

Technical Approach and Expected Deliverables:

Technical Review of antenna Basics, Design Specifications and alternatives, Analysis and simulation, Evaluation and adjustments to meet Specifications, possible measurments of simple antenna on UAV model at microwave frequencies.

Project #C4

Project Title: ***Target Radar Cross-Section Analysis, Design, and Measurments***

Professor Name : Professor Majeed Alkanhal and Dr. Hamsakutty Vettikalladi

Number of Students: Two

Students Qualifications:

Statement of Problem:

To invistigate, compare, and design different target "possible' materials and shapes for specific purposes for radars and electronic warefare (EW) applications. Stealth targets and/or high RCS targets will be analyzed and modeled and selected for different radar/EW enviroments.

Brief Description of the Project:

The radr-cross section (RCS) of targets paly the major rule in target detection in radar and electronic warefare (EW) systems. The target RCS is a function of many variables related to its shape, material, and the electromagnetic enviroment of the radar and target. In this project, the students will analyse, model, and engineer the RCS for radra targets with different materials and shapes. The purpose is to invistigate and design different target "possible' materials and shapes for different purposes for radars and EW applications such as stealth targets.

Objectives:

Phase 1 (EE496):

Problem formulation, Sofware Package Practice, Radar target simulation model, simulations and results verification.

Phase 2 (EE497):

Design and selection of different alternative target materials and structures according to the proposed specifications (using the simulation models), conclusions and documentation**.**

Technical Approach and Expected Deliverables:

Technical Review of RCS Basics, Design Specifications and alternatives, Analysis and simulation, Evaluation and adjustments to meet Specifications, possible measurments of simple radar targets at microwave frequencies.

Project # C5

Project Title: **Development of Passive Radar System**

Professor(s) Name(s): **Ibrahim Elshafiey, Abdel Fattah Sheta and Khaled Jamil**

Number of Students: **Two to Three**

Students Qualifications:

Basic knowledge of communication engineering.

Statement of Problem

Passive radar depends on detecting the presence and identifying the properties of an object by collecting and analyzing signals reflected from that object. Contrary to active radars, passive radars depend on non-cooperative sources such as broadcast or communication systems. Passive radar simplifies the design of hardware components of and reduces the system cost, size and enhances. It is flexible and immune to jamming. Signal analysis tools however should be capable of adapting to type and features of signals available in place of deployment. This project aims at designing and implementing a passive radar system.

Brief Description of the Project

The focus of this proposal is directed to developign a software-defined receiver that can identify the location and speed of targets.

Objectives

The objective of this project

(6) Investigate characteristics of passive radar system.
(7) Design a software defined receiver module.
(8) Design signal analysis tool.
(9) Improve the efficiency of the system.
(10) Conduct tests on the developed system.
(11) Identify applications in the Kingdom of the developed system.

Technical Approach and Expected Deliverables

The steps to achieve these objectives:

- Phase I: Students will investigate and study the subject of software defined receiver.
- Phase II: Students will design system modules.
- Phase III: Students will validate and optimize the design using simulation.
- Phase IV: Students will manufacture the modules.
- Phase V: Students will investigate the applications the can be based on the developed system.

Project #C6

Project Title: Design of Sub-THz antennas for 5G communication

Professor(s) Name(s): Dr. HamsakuttyVettikalladi and Majeed Alkanhal

Number of Students: Two

Students Qualifications

Knowledge of electromagnetic theory and basic knowledge of antennas

Statement of Problem

Over the last few years, wireless data traffic has drastically increased due to a change in the way today's society creates shares and consumes information. This change has been accompanied by an increasing demand of much higher speed wireless communication anywhere, anytime. In particular, wireless data rates have doubled every eighteen months over the last three decades. Following this trend, wireless Terabit-per-second (Tbps) links are expected to become a reality within the next five to ten years. In this context, Terahertz Band communication is envisioned as a key wireless technology to satisfy this demand, by alleviating the spectrum scarcity and capacity limitations of current wireless systems, and enabling a plethora of long-awaited applications in diverse fields. The THz Band is the spectral band that spans the frequencies between 0.1 THz and 10 THz. The very large bandwidth provided by the THz Band opens the door to a variety of applications in 5G Cellular Network links,WLAN,WPAN etc, which demand ultra-high data rates and allows the development of a plethora of novel applications in classical networking scenarios as well as in new nanoscale communication prototypes. Some of these applications can already be foreseen and others will undoubtedly emerge as technology progresses. Antenna is the fundemental element in all these communication system. Low profile, wideband, high gain and low cost antennas are needed for this purpose.

Brief Description of the Project

In the most recent years, wireless communication networks have been facing a rapidly increasing demand for mobile traffic along with the evolvement of applications that require data rates of several 10s of Gbit/s. In order to enable the transmission of such high data rates requires ultra-high bandwidths beyond 20 GHz. Such an amount of unregulated spectrum can be identified only in the sub-THz to THz frequency range of >~ 0.1THz-10THz in general (Sub THz range is 0.1 THz to 1THz). Systems operated at those frequencies are referred to as THz communication systems. The very large bandwidth provided by the THz Band opens the door to a variety of applications which demand ultra-high data rates. Some of the potential applications are in 5G cellular networks, ultra high speed Wireless Local Area Networks (LAN), ultra high speed Wireless Personal Area Network and secure wireless terabit communication. The technology enabling small integrated transceivers with highly directive, steerable antennas becomes the key challenges at THz frequencies in face of the very high path losses. This proreject plans to study the technology and design compact antennas suitable for Sub-THz frequency operation. Because of the atmospheric losses and oxygen absorption phenomena around 300GHz band, it is ideally suitable for the next generation extra high speed (24Gb/s) short range wireless communication after 2020. The speed is expected to be more than 10 times faster than 60GHz indoor communication systems which are available in the market soon.

Objectives

1) Study the THz waves and technology

2) Finding the best technology to design antenna around 300 GHz, because low frequency technology is not applicable at high frequencies.

Technical Approach and Expected Deliverables

Phase I: Students will study sub-THz waves and its frequency spectrum

Phase II: Study the Potential Applications of sub-THz technology

Phase III: Study the different antenna designing technologies by literature review

Phase IV: Design sub-THz antenna using CST Microwave studio simulation software.

Project # C7

Project Title: Design of Substrate Integrated Waveguides Antennas for millimeter wave Applications

Professor(s) Name(s): Dr. HamsakuttyVettikalladi and Majeed Alkanhal

Number of Students: Two

Students Qualifications

Knowledge of electromagnetic theory and basic knowledge of antennas

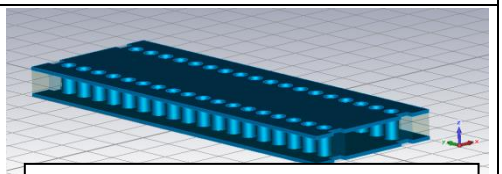
Statement of Problem

Rectangular waveguides are widely used in microwave and millimeter wave engineering, due to their advantages of low losses, high power handling, and high isolation. But due to the bulkiness and difficulty in integration with RF circuits especially at millimeter wave frequencies, it is less used at high frequencies. Recently, the substrate integrated waveguide (SIW) technique, a substitute to normal waveguide, has been proposed which maintains the advantages of rectangular waveguides as well as additional merits e.g., ease of integration, low cost, and reduced size. This proposal first design the substrate integrated waveguides and hence the design of SIW antennas at millimeter wave frequencies.

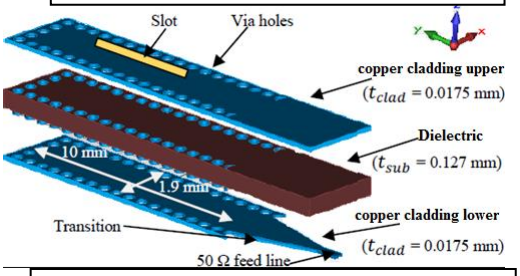
Brief Description of the Project

In this project the students will design a substrate integrated wave (SIW), a substitute to normal rigid waveguides at high frequencies, using the design equations. SIW uses the top and bottom metallization of the substrate and metallized via holes to create an artificial waveguide, which act as a metallic side walls of the waveguide.

Later stage the students will design the SIW antenna using the substrtae integrated technology for millimeter wave applications. The main advantage of these kind of technology is, easy to integrate with other RF circuits at high frequencies. These SIW antennas find application in high speed millimeter wave WLAN/WPAN Communication.



Substrate Integrated wavuguide



Substrate Integrated wavuguide Antenna

Objectives

1) Study and the design of Substrate integrated waveguides (SIW) at millimeter wave frequencies using CST Microwave Studio.
2) Design the SIW antenna suitable for millimeter wave applications; optimize the antenna for an operational frequency of 28/38/60 GHz.

Technical Approach and Expected Deliverables

Phase I: Students will study the substrate integrated waveguide technology by literature review

Phase II: Design a Substrate integrated waveguide using CST Microwave studio simulation software.

Phase III: Design the SIW antenna using the substrate integrated technology and later optimize it to the operational frequency of interest .

Later the design will be manufactured in our laboratory if possible.

Project # C8

Project Title: Implement Real-Time Spectrum Sensing Using SDR Platoforms

Professor(s) Name(s): Dr. Majid Altamimi and Dr. Mohammed Alresheedi

Number of Students: Two

Students Qualifications

- Good understanding of wireless communications and signal processing.
- Good programming skills in MATLAB and Python.
- Basic knowledge in communication spectrum.

Statement of Problem

In the era of the dramatic growth of wireless technologies, the RF spectrum becomes fully occupied and cannot accommodate the demand for the RF bands by new wireless technologies. Therefore, the dynamic spectrum access is invented to overcome this problem by allowing more than one wireless network to share the RF bands. However, sharing the bands introduces a new problem, which is how to enable the sharing with minimum interference and transmission collision.

Brief Description of the Project

This project is designed to give the students an overview on the cutting edge technologies in the wireless communications. The students need to understand the current regulation for the RF spectrum and the anticipated future regulation. In addition, they are expected to design and implement dynamic spectrum sensing then develop spectrum access protocols based on the result from the implemented spectrum sensing.

Objectives

This project is intended to:

1) design and implement dynamic spectrum algorithms, and
2) examine the performance of these algorithms.

Technical Approach and Expected Deliverables

The project is expected to deliver the above objectives by conducting an academic research and write a short survey on the proposed algorithms for dynamic spectrum sensing. Then, the students have to design their experiment using their programming skills to examine some attractive sensing from the literature. Finally, the students will be encouraged to deploy their full real-time system to sense and access the spectrum.

Project # C9

Project Title: Decorative Room Temperature Display using Ferrofluids

Professor(s) Name(s): Dr. Tariq Alshawi and Prof. Saleh A. Alshebeili

Number of Students: Two

Students Qualifications

3) Knowledge of embedded hardware design,
4) Excellent skills in programming

Statement of Problem

Design and décor in electronic gadgets and displays play an important role in the purchase decisions by consumers. Therefore, building beautiful and engaging products is an important factor in engineering designs. Ferrofluid-based displays that magnetically manipulate liquids made of nanoscale ferromagnetic particles to create engaging patterns present an interesting engineering challenge. Such displays can be designed to work as a canvas to display predefined letters, numbers, and shapes, thus, providing a unique look and design. Therefore, we seek to design and build a ferrofluid-based temperature information display that can be placed in living rooms and offices that is both informative and decorative.

Objectives

The main objectives of this project are as follows:

4) Conducting literature review on control of ferrofluids control and ferrofluids-based displays
5) Design and build a ferrofluid chamber with appropriate size and shape to work as temperature display
6) Design and assemble magnetic control mechanism of ferrofluids
7) Program an embedded hardware platform to operate the ferrofluids control system and display temperature data

Technical Approach

Literature review will be conducted using KSU electronic library and the embedded hardware will be programed using open source software suite.

Expected Deliverables

A fine-tuned ferrofluid-based temperature display that is both informative and decorative. The design and implementation is expected to be oriented towards commercializing the end product.

Project # C10

Project Title: Low-Cost Smart Home-Monitoring System

Professor(s) Name(s): Dr. Tariq Alshawi and Prof. Abdullah Alsuwailem

Number of Students: Two

Students Qualifications

5) Knowledge of embedded hardware design and wireless communication systems,
6) Excellent skills in mobile apps programming

Statement of Problem

Remote home monitoring remains to be a challenge for home owners even with the availability of commercial products. Besides high cost, currently available home monitoring solutions are primitive in their functionality such as motion detection since any kind of movement can trigger the system to send warning to the home owner even as small as movement of tree branches. In this project, we seek to develop a smart home-monitoring system that operates in two modes. First, the user can control the camera remotely and control its operation schedule. Second, when the camera senses motion it executes a human detection algorithm that classifies the motion source as human vs n0n-human and notifies the home owner only if the source is human.

Objectives

The main objectives of this project are as follows:

8) Conducting literature review on remote home-monitoring systems
9) Program an embedded hardware platform that captures camera feed and wirelessly communicate the data via the internet
10) Implement human motion detection in the monitoring system
11) Program a mobile application that controls the monitoring system remotely and can receive data from the moitoring system as well as alerting the user (home owner) when the camera detects human motion

Technical Approach

Literature review will be conducted using KSU electronic library and the embedded hardware and the mobile application will be programed using open source software suite.

Expected Deliverables

A complete home-monitoring system and well-designed mobile application to display the video stream and alert the user in the case of human motion detection. The design and implementation is expected to be oriented towards commercializing the end product.