King Saud University
College of Engineering
Electrical Engineering Department **Semester: 411**

Graduation Design Project Proposal Form

Project # C1

Project Title: Smart Electronic Liquid Level Controller System

Professor(s) Name(s): 1. Dr. Ahmad Fauzi Abas
2. Dr. Mohammed Alresheedi

Number of Students: Two

Students Qualifications

Knowledge and skills in electronics circuit development and microcontroller programming.

Statement of Problem

In our everyday life, we involve in many applications where the level of liquid, for example water, oil, acid, alkaline and others need to be detected, measured and controlled. This needs exist in many industrial sectors including agriculture, oil and gas, home appliances, security and safety, food, and many more. Existing solutions tend to be bulky and costly. Therefore, it is an interest of this project to develop a miniature Smart Liquid Level Controller System that is low cost so that can be affordable to the mass consumer.

Brief Description of the Project

In this project the students need to:

1. Design the concept of the system
2. Develop the printed circuit board (PCB) of the controller circuit
3. Use microcontroller as the brain of the system

Many design parameters can be studied such as the reading accuracy, control response time, the best location to install the control circuit, its size and the shape, and its smart aspect.

Objectives

(1) To design the detection and control system concept
(2) To develop a system PCB
(3) To use microcontroller as the system decision maker

Technical Approach and Expected Deliverables

To achieve above objectives, the students need to first analyze all possible system designs. Once the final design is selected, the student need to start designing the required electrical circuit, test and verify its performance. At the same time, the students need to work with the microcontroller, which can provide the 'smart' features to the board. The student will know that this project has reached it complete state once they manage to build a working system of liquid level controller system, that can accurately measure and control the level of the specified liquid. This is the expected deliverable from this project.

Project # C2

Project Title: Sensitive Microwave Sensors for Material Characterization

Professor(s) Name(s): 1. Ali Albishi 2. Abdullah Alsuwailem

Number of Students: Two to three students

Students Qualifications

1- Highly motivated, adaptable, quick, and eager learner of new materials and subject matters.
2- Microwave circuit design (reading Pozar's book can help to catch up)
3- Knowledge of simulation tools such as Matlab and Numerical simulation (HFSS, CST, etc.)
4- Having skills in report writing and presentation.

Statement of Problem

Although microwave planar resonators based sensors have been utilized in many sensing techniques, the utilization of such resonators is still in preliminary stage since most of the resonators have shown limited sensitivity due to the electromagnetic field concentration inside dielectric substrates. This is where the project will address the limitation by utilizing novel parasitic elements to disturb the field distribution. Thus, we predict higher sensitivity.

Brief Description of the Project

Planar microwave near-field sensors can provide many advantages such as high penetration, resolution, and sensitivity. The latter can be achieved by adopting the concept of electrically-small resonators where their largest length is relatively small compared to the excitation wavelength. The excitation mechanism is based on the use of the microstrip line technology where the sensing mechanism is based on observing the shifts in the resonance frequency due to the interaction with the materials under test (MUTs). Thus, after developing sensitive sensors, the sensors will be used to characterize the MUTs. The sensors will be fabricated using relatively cheap technology (printed circuit board). All the measurements will be conducted using vector network analyzers (VNAs).

Objectives

1. Conducting a comprehensive literature review of microwave resonators based sensors for sensing and particularly for material cauterization
2. Choosing a well-cited paper and duplicate the results to build confidence with the simulation tools.
3. Trying to come up with new ideas to increase the sensitivity
4. Fabricating the sensor using PCB technology and sample preparation and testing, and data collection
5. Modeling and data processing utilizing fitting function techniques

Technical Approach and Expected Deliverables

1-Conducting a comprehensive literature review on the topic using the university electronic library and international engineering journals such as IEEE. 2- Modeling using simulations tools such as HFSS and analyzing the result using MATLAB 3- Building the model using fitting function techniques.

Expected Deliverables

A sensitive microwave sensor that is able to characterize dielectric materials. The experiments will be in the second parts of the graduation project (EE497).

Project # C3

Project Title: Near-Field Microwave Probes for Dielectric Imaging

Professor(s) Name(s): 1. Ali Albishi 2. Abdullah Alsuwailem

Number of Students: Two to three students

Students Qualifications

5- Highly motivated, adaptable, quick, and eager learner of new materials and subject matters.
6- Microwave circuit design (reading Pozar's book can help to catch up)
7- Knowledge of simulation tools such as Matlab and Numerical simulation (HFSS, CST, etc.)
8- Having skills in report writing and presentation.

Statement of Problem

Composite dielectric materials have been utilized in many applications such as flat lenses, highly directional antennas, cloaks, etc. There is a need for non-destructive testing techniques where 2D surface near-field scanning microscopy can be conducted. Microwave imaging based on planar electrically-small resonators can be utilized. Planar microwave probes can provide many advantages such as high penetration and sensitivity, yet the resolution of the probes to be widely used as a near-field has to be investigated. This project will address such challenges.

Brief Description of the Project

Utilizing planar microwave probes based on electrically-small resonators, where their largest length is relatively small compared to the excitation wavelength, can provide the advantageous of penetration and sensitivity. The excitation mechanism is based on the use of the microstrip line technology where the sensing mechanism is based on observing the shifts in the resonance frequency due to the interaction with the 2D surface of materials under test (MUTs). Thus, after developing relatively high-resolution probes, the probes will be used as near-field microscopy probes. The sensors will be fabricated using relatively cheap technology (printed circuit board). All the measurements will be conducted using vector network analyzers (VNAs).

Objectives

6. Conducting a comprehensive literature review of microwave resonators based sensors for sensing and particularly for material cauterization
7. Choosing a well-cited paper and duplicate the results to build confidence with the simulation tools.
8. Trying to come up with new ideas to spatial resolution
9. Fabricating the sensor using PCB technology and sample preparation and testing, and data collection
10. Constructing the 2D imaging using MATLAB or similar programs.

Technical Approach and Expected Deliverables

1- Conducting a comprehensive literature review on the topic using the university electronic library and international engineering journals such as IEEE. 2- Modeling using simulations tools such as HFSS and analyzing the result using MatLab 3- Constructing the 2D image using MATLAB

Expected Deliverables

A high resultion microwave probe that is able to image 2D surafce of dielectric materials. The experiments will be in the second parts of the graduation project (EE497).

Project #C4

Project Title: DESIGNING AND OPTIMIZING AN OPTICAL RECIRCULATION LOOP FOR HIGH-SPEED MULTI-FORMAT OPTICAL NETWORKS

Professor(s) Name(s):
1. AMR MOHAMED RAGHEB 2. SALEH ABDULLAH ALSHEBEILI

Number of Students: Two

Students Qualifications

1- Knowledge of communication systems.
2- Aware of programing software tools.
3- Commitment to attend weekly meetings.

Statement of Problem

Optical recirculation loop (ORL) is a key device in advanced optical communication laboratories. It simulates the long-haul transmission by rotating the optical signals a certain number of times in a pre-designed loop. This has the effect of saving the overall cost of the transmission system by reducing the number of expensive devices needed for thousands of kilometers transmission.

Brief Description of the Project

This project aims to design, optimize, and prototype an ORL device that simulates the long-haul (i.e. hundreds of kilometers) transmission of optical signals. The ORL will include fiber spools, optical amplifiers, and a controller circuit. Besides, the signals under test will comprise standard non-return- to-zero (NRZ) On-Off keying (OOK) and advanced multiformat (i.e. M-ary quadrature amplitude modulation (M-QAM)) optical signals. The ORL optimization will be achieved by conducting different simulation and experimental trials to achieve the optimum communication metrics under the achieved distance. The ORL performance will be evaluated using optical signal-to-noise ratio (OSNR), bit error rate (BER), Q-factor, and error vector magnitude (EVM) metrics.

Objectives

(1) Conducting literature review about ORL and optical data transmission,
(2) Assessing the performance of the proposed ORL using simulation tools (i.e.VPItransmissionmaker),
(3) Learning the laboratory safety procedures and how to read equipment's manuals,
(4) Optimizing the demonstrated ORL using different experimental test and trials,
(5) Evaluating the developed ORL using communication metrics (i.e. BER, EVM, eye diagram, Constellation…etc.).

Technical Approach and Expected Deliverables

Literature review and model programming will be conducted using KSU electronic library and *VPITransmissionmaker* software, respectively. Hardware implementation will be achieved using devices, equipment, and software available at RFTONICS CNL-lab.

Expected Deliverables

1- A test-bed optical recirculation loop (ORL).
2- Technical recommendation report for MS and PhD researchers.

Project #C5

Project Title: **Development of Cloud-Based Radio Access Network for Millimeter-Wave 5G Systems**

Professor(s) Name(s): **Ibrahim Elshafiey & Abdulhameed Al-Sanie**

Number of Students: **Two**

Students Qualifications:
Basic knowledge of Communication Engineering

Statement of Problem

Millimeter-wave MMW systems are needed to solve the deficit of microwave spectrum. The propagation nature of in MMW band requires the use of compact size cells, and thus necessitates the deployment of very large number of cells. To reduce the cost and complexity, the cells should be equipped with simple and low functionality radio heads. Complex and intelligent functionality are to be carried into a central office and the obtained signal is carried through an efficient backhaul network to remote cells. This approach is recognized as cloud-based radio access network (C-RAN).

Brief Description of the Project

The project aims at desinining C-RAN system that optimizes cost, energy efficincy and spectral efficiency. The backhaul network of this system is realized through RF-over-Fiber, in which MMW signal is carried over optical fiber to remote head units.

Objectives
The objective of this project

(1) Investigate the requirements of 5G communication systems
(2) Get acquainted with simulation tools of wireless and optical communication systems.
(3) Design MMW RF-over-Fiber system.
(4) Simulate performance for C-RAN systems
(5) Conduct experimental validation tests.

Technical Approach and Expected Deliverables

The steps to achieve these objectives:

- Phase I: Students will investigate 5G communication systems using simulation.
- Phase II: Students will conduct simulation of RF over fiber system.
- Phase III: Students will test the performance of C-RAN system.
- Phase IV: Students will conduct experimental validation experiments.

Project #C6

Project Title: **Development of Linearization Tool of Power Amplifiers in Communication Systems**

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

Number of Students: **Two**

Students Qualifications:
Basic knowledge of Communication Systems

Statement of Problem

Power amplifier PA modules are important elements for all communication systems. An essential impairment of PA is nonlinearity, which causes degradation in performance. Conventional techniques to reduce nonlinearity of PA have high cost, and novel solutions are required to mitigate nonlinearity with high efficiency.

Brief Description of the Project

The focus of this project is to design a system for predistortion linearization of PA. The first step incorporates identification of an accurate model of the amplifier that takes into account memory effects. Linearization model is then developed based on precoding of digital input data. This approach provides an adaptive and efficient system for reducing the impairment of PA nonliearity

Objectives
The objective of this project

(6) Recognize nonlinear models of PA.
(7) Get acquainted with computational analysis tools.
(8) Experience working with ADC and DAC tools.
(9) Measure amplifier characteristics and develop appropriate model.
(10) Design linearization model and optimize the design.
(11) Test performance.

Technical Approach and Expected Deliverables

The steps to achieve these objectives:

- Phase I: Students will investigate power amplifier models.
- Phase II: Students will test PA characteristics.
- Phase III: Students will practice developing PA nonlinear models.
- Phase IV: Students will design linearization tools.
- Phase V: Students will investigate the performance of the developed system.

Project #C7

Project Title: Design of Nantennas (optical antenna) for next generation Energy harvesting

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

Number of Students: Two

Students Qualifications

Knowledge of electromagnetic theory, optical communication and basic knowledge of antennas

Statement of Problem

One of the pillars of future sustainable development in any country, is the development of renewable energy technologies and solutions. With the exponential emergence of wireless communications networks, and massive deployment of sensing technologies and electronic instrumentation, our environment is progressively becoming a large reservoir of electromagnetic energy. This can be explored and then reused achieving a double benefits. In effect, this minimizes the use of traditional polluted energy sources and reduces energy radiation that may affect the health of population. The main purpose of this project is to develop a technology for energy collection and harvesting of the electromagnetic (EM) wave radiation existing in our environment. This aims to design optical nantenna (Solar antennas) based EM harvesting at solar optical frequencies ranging from 200 THz up-to 700 THz (or alternatively 400 nm-1600 nm wavelength). i.e the goal is to design optical nantenna (or nano-antenna) based solar panels.. The efficiency in these kind of solar panels is more than 70% compared to conventional solar panels (40%) which will be a milestone in the history of energy harvesting technologies.

Brief Description of the Project

The principle objective of this proposal is to design a portfolio of electromagnetic energy harvesting panels starting from existing radio frequencies and reaching the optical frequencies radiating from the sun earth in the visible and infrared bands. The work under this project consists of a continuous mix of theoretical analysis, numerical simulation of optical antennas. In principle, harvesting technology of optical frequencies included in the sun light during the day, and radiating out from the earth surface during the night(infrared rays), is in its early stage. However this promises outstanding performance of more than 70% efficiency and a dramatic decrease of cost compared to traditional low efficient (40%) semiconductor based photovoltaic technology. The aim of this phase is to build in-house knowledge and expertise in this emerging technology that is strategic for the country and the region with ultimate goal of developing and prototyping an optical rectenna based panel targeting optical visible and infrared frequencies. This nantenna technology is in principle able to work 24 hours collecting the visible and invisible light coming from the sun during the day and the same frequencies radiating from the earth during night.

Objectives

1) Study the nano antenna technology
2) Finding the best technology to design antenna at optical frequency, because low frequency technology is not applicable at high frequencies.

Technical Approach and Expected Deliverables

Phase I: Students will study optical frequency spectrum
Phase II: Study the Potential Applications of nano antenna technology
Phase III: Study the different antenna designing technologies by literature review
Phase IV: Design optical antenna using CST Microwave studio simulation software.

Project #C8

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

Professor(s) Name(s): Dr. HamsakuttyVettikalladi and prof. 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 #C9

Project Title: ***Multiple Sensor Design for Distance and Direction Measurements***
Professor Name : Professor Majeed Alkanhal and Dr. Hamsakutty Vettikalladi
Number of Students: Two
Students Qualifications:
Statement of Problem: To invistigate, compare, and design different arrangements of simple sensors for the purpose of distance and direction measurments for security applications. Sensor arrangements and geometries will be analyzed and modeled and, hence, selected for different applications.
Brief Description of the Project: In this project, students will analyse, model, and engineer distance and direction sensors with different types and arrangements. The purpose is to invistigate and design different sensor arrangement types and shapes for different purposes of security applications.
Objectives: <u>Phase 1 (EE496):</u> Problem formulation, Sofware/Hrdware Practice, Circuit and system models, simulations and results verification. <u>Phase 2 (EE497):</u> Design and selection of different alternative sensor distribution, structures and circuits according to the proposed specifications, conclusions and documentation**.**
Technical Approach and Expected Deliverables: Technical Review acoustic sensor Basics, Specifications and alternatives, Analysis and simulation, Evaluation and adjustments to meet Specifications, Possible measurments and demonstration of simple sensor types and geometries.

Project #C10

Project Title: ***Microwave/Millimeter-wave Energy Harvesting Antennas: Analysis and Design***
Professor Name : Professor Majeed Alkanhal and Dr. Hamsakutty Vettikalladi
Number of Students: Two
Students Qualifications:
Statement of Problem: To invistigate, compare, and design different "possible' material and shape antennas for the purpose of energy harvesting (EH) applications. Antenna structures and geometries will be analyzed and modeled and, hence, selected for different energy harvesting enviroments.
Brief Description of the Project: In this project, students will analyse, model, and engineer EH-antennas with different materials and shapes. The purpose is to invistigate and design different antenna "possible' materials and shapes for different purposes of EH applications.
Objectives: <u>Phase 1 (EE496):</u> Problem formulation, Sofware Package Practice, Antenna/circuit simulation model, simulations and results verification. <u>Phase 2 (EE497):</u> Design and selection of different alternative materials, structures and circuits according to the proposed specifications (using the simulation models), conclusions and documentation**.**
Technical Approach and Expected Deliverables: Technical Review of EH antenna Basics, Design Specifications and alternatives, Analysis and simulation, Evaluation and adjustments to meet Specifications, Possible measurments of simple EH antenna at microwave frequencies.

Project # C11

Project Title: Optimum Digital Beamforming Algorithms for Multi-Antenna Passive Radar

Professor(s) Name(s): 1. Dr. Mubashir Alam
2. Dr. Irfan Ahmed

Number of Students: Two to three

Students Qualifications: Students should be from the radar, signal processing, communication area, strong willingness to learn, and then model, simulate and test algorithms for digital beamforming.

Statement of Problem

To design, implement and test different optimum digital beamforming algorithms for multi-channel passive radar. The optimum algorithm will be the one, which has the optimal control on main beam width and level of side-lobes. Different optimum algorithms will be investigated to obtain the best beamforming weights.

Brief Description of the Project

As compared to active, passive radars uses the signal, which are already in the environment. These signals include FM, TV, DTV-B, GSM, UMTS, WiMAX , WLAN/WiFi.). Classical passive radar usually uses two antennas to collect the signal of interests. However, these suffer from poor range and Doppler resolution. The more modern approach is to use the passive radar with multi- antennas to collect the signals. With multi antennas, it become must to use digital beamforming algorithms to extract signal of interests. In order to null strong interference (main transmitter signal), it is must to that the beam former used should have the low side-lobe levels. The classical beamforming algorithm does not provide the full control on side-lobe levels. Hence, there is a need to develop beamforming algorithms with optimal weights to obtain best rejection. This project will try to develop, simulate and test these optimal beamforming algorithms.

Objectives

(1) Design and Modeling of the setup for Multi-channel Passive Radar
(2) Design the signal processing algorithm chain for multi-channel passive radar.
(3) Design and simulate different classical beamforming algorithms
(4) Design and simulate different optimum beamforming algorithms to exhibit the control on main lobe width and side-lobe levels.
(5) Test the beamforming algorithms for multi-channel passive radar and if possible use real-data.

Technical Approach and Expected Deliverables

This project will cover Data modeling and implementation of algorithms in Matlab/LabView or any other environment suitable for Radar simulation. The deliverables will be efficient implementations of all these algorithms mentioned in objectives especially with respect to real-time implementation.

Project #C12

Project Title: Design of Efficient 5G Hybrid Beamforming System

Professor(s) Name(s): 1. Dr. Abdel Fattah Sheta
2. Dr. Ibrahim Elshafiey

Number of Students: Two Students

Students Qualifications:

Statement of Problem

Beamforming becomes an essential technology for future high data rates comminication systems in particular 5G. Recently, various architectures including analog and digital beamforming have been investigated for advanced communication systems. Digital beamforming (DBF) offers flexibility and performance. With increase in the number of the antenna elements, the complexity and power consumption of beamforming network make the system non-practical. Hybrid analog-and-digital beamforming are suggested as a cost effective approach to overcome these drawbacks. In hybrid structure, a small number of RF chains are connected to a large number of antennas through a network of phase shifters. The challenge in this configuration is to optimize the design of hybrid beamforming system.

Brief Description of the Project

This project focus is to design efficient hybrid beamforming system for 5G communication system. Simulation is conducted under Matlab. Phase shifting network is developed to demonstrate analog phase shift and software defined radio systems are used to obtain digital phase shift.

Objectives

At the end of the project, the students should be able to:

1) Understand basic concepts of hybrid beamforming
2) Be familiar with simulation tools for 5G communication systems
3) Design hybrid beamforming phase shift network
4) Evaluate the performance of the developed system

Technical Approach

1) Students will build a simulation model for hybrid beamforming system
2) Students will design phase shift network
3) Students will demonstrate the performance of the developed system

Expected Deliverables

- Simulation tool of hybrid beamforming system
- Demonstration setup of phase shifting network

Project # C13

Project Title: Design of RFID Tags for Internet of Things

Professor(s) Name(s): Abdel Fattah Sheta

Number of Students: Two

Students Qualifications:
Basic knowledge of Communication Systems

Statement of Problem
The recent progress on identification, tracking, and sensing applications for the Internet of Things (IoT) has pushed the RFID technology to gain much attention due to its remarkable advantages compared to conventional ways of identification. Chipless RFID tags technology has recently proposed as a promising way to dramatically reduce the tags cost by eliminating the need of Ics or any active devices of the conventional RFID.

Brief Description of the Project
This projects aims at the design of small size low cost chipless RFID. To do this, various compact resonators will be studied and compared. The best resonator will be selected to design high density RFID tag.

Objectives
The objective of this project

(12) Understand basic concepts of chipless RFID
(13) Be familiar with simulation tools to design RFID resonators
(14) Design compact high data tags
(15) Theoretical and experimental characterization

Technical Approach and Expected Deliverables

The steps to achieve these objectives:

- Students will investigate the various types of Chipless RFID resonators.
- Students will perform comparative study to select the most appropriate resonator
- Students will design chipless tag based on the selected resonator
- Students will evaluate the performance of the designed tag

Expected Deliverables

Chipless RFID prototype

Project #C14

Project Title: Efficient and Privacy-Preserving Video Descriptor for Fire Detection using IoT Devices

Professor(s) Name(s): 1. Dr. Tariq Alshawi
2. Dr. Saleh Alshebeili

Number of Students: Two Students

Students Qualifications

Two students from Communications Group or Electronics Group. It is preferable that the students (or some of them) have studied signal processing related course(s)

Statement of Problem

In recent years, Internet of Things (IoT) devices have exploded in numbers, thanks to their advanced functionalities and affordable prices. In homes and private properites, IoT-based surveillance cameras offer many attractive features to their owners, which led to their wide spread use. In addition to surveillance, these cameras can be used for many applications such as intrusion detection, operation monitoring, and fire detection. However, due to the limited computational power of these devices, cloud-based analysis is used to provide such advanced applications. While these cameras are built with security measures to protect against unauthorized access to the video feed, users would prefer to use some privacy-preserving means to protect their private life.

Brief Description of the Project

In the literature, fire detection using video cameras have gained traction recently. Many proposed algorithms utilize state-of-the-art deep learning architectures to detect fire, in many cases with high accuracy results. However, executing such compuationally-heavy algorithms on IoT devices might not be feasable. The work in this project includes the following:

1. Test multiple state-of-the-art algorithms for fire detection on publically available data sets,
2. Develop a privacy-preserving video descriptor that encodes the video stream to include only features relevant to fire detection,
3. Show by simulation the performance of the proposed video decriptor, and finally,
4. Build an IoT device prototype to capture and process video and its cloud-based counterpart for fire detection as a demonstration.

Objectives

At the end of the project, the students should be able to:

5) Understand basic concepts in video processing and machine learning,
6) Test the performance of video processing algorithms using simulation,
7) Implement IoT prototype with video processing capabilities,
8) Build cloud-based backend service to execute deep neural network models,

9) Integrate the subsystems implemented in (3) and (4), and demonstrate the proposed functionality of the IoT device.

Technical Approach

4) Students will first make a comprehensive review about the topic,
5) Students will study and implement multiple state-of-the-art algorithms for fire detection, and test their performance on publicly available data sets,
6) Students will design a video descriptor according to the desired properties,
7) Students will study the performance of the proposed algorithm using simulation,
8) Students will demonstrate the proposed algorithm using an IoT device prototype and a cloud-based fire detection service.

Expected Deliverables

1) Computationally efficient privacy-preserving video descriptor,
2) Cloud-based fire detection service,
3) Prototype of an IoT device and the cloud-based backend.