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

Graduation Design Project Proposal Form

Project # P10

Project Title: Control methods, design and Implementation, for Autonomous Truck and Trailer Backward Driving.

Professor(s) Name(s): 1. Dr. Yasser Bin Salamah.
2. Dr. Irfan Ahmad.

Number of Students: Two.

Students Qualifications
Courses: EE 351.
Comfortable Working with MATLAB.

Statement of Problem
Tractor-trailer path tracking in backward motion is a challenging control problem in automated vehicle development. The control challenges arise from the fact that a backward driving truck with trailer is an underactuated system with unstable internal dynamics. Additionally, there exists a relative body angle margin for saturated steering input beyond which a jackknife accident is unavoidable if backing further.

Brief Description of the Project
This project will focus on investigating, developing, and testing a path tracking control method for a tractor-trailer vehicle in reverse motion.

Objectives

- To develop and understand the model of truck and trailer vehicle.
- To design a controller that remove/reduce/assist driver's workload of driving a tractor-trailer vehicle, in general.
- To improve the time efficiency of a tractor-trailer vehicle parking process.
- A precise path tracking control is needed to track a planned path.

Technical Approach and Expected Deliverables

The project will have two main phases.

Phase 1 (1st semester):

1. Conduct a literature review and formulate the problem.
2. Develop a control model for the Truck and Trailer.
3. Choose a suitable control method.
4. Study the suitability of the proposed solution via Simulation.

Phase 2:
After completing (1-4):

1. To use a more complex (high fidelity) model.
2. Update and implement the design using industrial simulation tool (e.g. CarSim).
3. Implementation of the developed method using a robot-like model (physical prototype).
4. Test the developed algorithm for a parking scenario to park a truck with a trailer.

Project #E6

Project Title: Design, simulation and implementation of a light tracker with smooth functionality

Professor(s) Name(s): 1. Dr. Irfan Ahmad
2. Dr. Yasser Bin Salamah

Number of Students: Two

Students Qualifications

Students must have background in modeling, identification, basic control design methods, performance analysis as well as in real-time implementation. Interested students must have good programming skills with MATLAB / Simulink for simulation. They must also have strong willingness to learn about ARDUINO based real-time implementation.

Statement of Problem

Tracking, or targeting, systems are control systems that align at least some part of the plant with an object, in this case light. As this is a light tracking system, there is no mechanical or electrical link between the source object and the plant. Electric motor is an important part of such tracking systems. A smooth functionality of the prototype with good precision is the main requirement of this system. In order to achieve the desired performance of the tracking system, an appropriate control design methodology is indeed required.

Brief Description of the Project

A light tracking system can be related to real systems such as solar trackers, line following robots and vehicle navigation. Other than light detecting sensors, an important part of this system is electric motor. Electric motors are found in many pieces of domestic, industrial and transport equipment. These motors are used in many modes; mostly speed but also position and torque. One well known example in which electric motors are used is in the positioning of solar panels to place them at the most efficient angle. This project will deal with modeling, identification, control design, simulation and finally real-time implementation of a light tracking system.

Objectives Following tasks will be performed during this project:

1. To understand the working principle and accordingly highlight the required components for prototyping of a light tracker with smooth functionality
2. To perform system identification in order to achieve a mathematical model and then design a basic controller
3. To develop a simulation software in MATLAB / Simulink
4. To design an ARDUINO based complete prototype
5. To analyze simulation results as well as real-time performance of the prototype

Technical Approach and Expected Deliverables

This project will cover modeling and simulation aspects by using MATLAB/Simulink environment. The deliverables will be simulation software as well as real-time results with a prototype.

Project # E7

Project Title: Design, modeling, simulation and implementation of an ultra-precise positioning system based on piezoelectric actuator

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

Number of Students: Two

Students Qualifications

Students must have background in modeling, basic control design methods, performance analysis as well as in real-time implementation. Interested students must have good programming skills with MATLAB / Simulink for simulation. They must also have strong willingness to learn about LabVIEW based real-time implementation.

Statement of Problem

Piezoelectric actuators convert electrical energy directly into linear motion. These actuators are widely used in every modern high tech field from semiconductor test and inspection to super-resolution microscopy, nanotechnology and astronomy/aerospace industry. The positioning precision of these actuators may deteriorate due to the presence of nonlinear phenomena of hysteresis and creep. If these phenomena are not compensated, the positioning system may produce oscillatory response or even the closed loop system may become unstable. An appropriate control design methodology is indeed required.

Brief Description of the Project

Ultra-precise positioning system based on piezoelectric actuators are widely used in different industries. These actuators have ultra-high positioning precision, fine resolution, large mechanical force, compact design, less power consumption and fast response time. In order to take maximum benefits from these actuators, the inherent nonlinear phenomena of hysteresis and creep must be well compensated. In this project, the students will first perform the system identification in order to have a mathematical model from the real-time experimental data of the positioning system available in Control Lab of EE department. Then, an appropriate control design methodology will be adopted in order to achieve desired performance in terms of positioning precision.

Objectives Following tasks will be performed during this project:

1. To understand the working principle of the positioning system based on piezoelectric actuator
2. To perform mathematical modeling and system identification
3. To highlight control problem and the desired performance of the system
4. To design an appropriate control methodology
5. To develop a simulation software in MATLAB / Simulink
6. To analyze the real-time performance of the positioning system, available in control lab of EE department, in LabVIEW

Technical Approach and Expected Deliverables

This project will cover modeling and simulation aspects by using MATLAB/Simulink environment. The real-time implementation will be performed in LabVIEW.

Project # C15

Project Title: Real-world applications of Communication Network Design

Professor(s) Name(s): 1. Dr. Yahya Alharthi
2.

Number of Students: Two to three

Students Qualifications

Students should have good understanding of the OSI model, wireless networks, queuing theory, probability models, and protocols. Students need to develop their ability to research specialized topics. Students must be able to model assumptions, analyze results, and write technical papers.

Statement of Problem

Recent and future technologies are relying more and more on wireless networks, which will be deployed/distributed in a massive scale. Therefore, any communication cost/power savings, etc. however small, will produce large benefits overall. Students must pick a sub-topic related to communication networks, such as wireless sensor networks, IoT, etc. They must then decide on a metric (or metrics) that they will improve or a problem to solve. Examples can be signal to noise ratio, average packet-delay, information freshness, co-operation amongst nodes, or robustness against malicious nodes/attacks on the network. Additional suggestions are protocol design and cross-layer optimization.

Brief Description of the Project

It is a must that students provide a problem statement/question to solve. Projects without simulated results will be considered incomplete. Any simulation tool can be used (MATLAB, Octave, Opnet, etc.) as long as the student clearly sets up the model and shows how his novel idea/design contributed to the field of Communication Networks. Student will need to review related literature and show how his results have compared to what researchers on the field are working on.

Objectives

- Understand the current topics and trends in Communication Networks, learn how to conduct research and make meaningful contributions to the field.
- Be able to analytically characterize the performance of a model and investigate how changes can improve metrics of performance. Be able to compare one's own work to other attempts.
- Learn integrity and design/experimentation. All simulation must be made open to scrutiny.

The objectives of the project will be for students to learn how to make positive contributions to their field. This will be needed whether the students will pursue a route in industry or academia. Engineers are responsible for the reliability and performance of systems that they will be either overseeing, actively designing, or both. It is critically important that students develop a passion for their field and learn/appreciate the methodology of research and critical thinking. It is also important for them to learn unique key terms that define performance metrics, and understand how to make systems better, with tangible results. Finally, ethics in research and experimentation will be considered, as students will be expected to provide their references, and make their simulations available.

Technical Approach and Expected Deliverables

- Must show a solid understanding of certain subsets of Communication Networks and the current trends. Technical writing must be easy to understand.

- Solid grasp of pre-requisite knowledge, such as probability, must be without flaws, since these flaws can seriously compromise the validity of results.
- Report must be written in a research paper style, along with a presentation. There are no specific length requirements. Score will be based on novelty of the idea, and contribution made.
- Absolutely no copying of existing work, idea must be original.