2nd Joint Seminar on Control Systems

Friday October 25, 2013

SIIT Bangkadi Campus, Sirindhalai Building, BKD 3207

Sirindhorn International Institute of Technology, Thammasat University

Morning Session

Time	Program	Speaker
08.45 – 09.00	Registration	---
09.00 – 09.10	Opening Speech	Prof. Dr. Thanaruk Theeramunkong (SIIT)
09.10 – 09.30	A Voting Block Matching Technique using Unit Gradient Vectors	Assist. Prof. Dr. Toshiaki Kondo (SIIT)
09.30 – 09.50	Two Foraging Algorithms for a Limited Number of Swarm Robots	Mr. Sarun Chattunyakit (SIIT)
09.50 – 10.10	Identification for LPV control of Nonlinear Plant – Application to Arm Driven Inverted Pendulum	Dr. Sudchai Boonto (KMUTT)
10.10 – 10.30	Adaptive Focal Length Imaging System using Liquid Crystal Spatial	Mr. Kunlachat Seniwong Na-Ayutthaya (KMUTT)
10.30 – 10.40	Coffee Break	---
10.40 – 11.00	Balancing Control of Unstable Systems: Inverted Pendulum Systems, Ball Riding Robots, Bicycle Robots, and Unicycle Robots	Assoc. Prof. Dr. Manukid Parnichkun (AIT)
11.00 – 11.20	Development and Control of a Double-Links Ball-Riding Robot	Mr. Kanjanapan Sukvichai (AIT)
11.20 – 11.40	Introduction to Computer Vision Research in Electrical Engineering, Kasetsart University	Dr. Miti Ruchanurucks (KU)
11.40 – 12.00	Computer Vision for Survey, Navigation, and Modeling	Mr. Muangmol Saenpeng, Mr. Sakol Kongkaew, Ms.Panjawee Rakprayoon (KU)
12.00 – 12.10	Photo Session I	All
12.10 – 13.00	Lunch Break	---

Afternoon Session

Time	Program	Speaker
12.10 – 13.00	Lunch Break	---
13.00 – 13.20	Research Activities in Control Systems Research Lab. Chulalongkorn University	Dr. Jitkomut Songsiri (CU)
13.20 – 13.40	Design of Feedback Systems with Backlash for Inputs Restricted in Magnitude and Slope	Mr. Hai Hoang Nguyen (CU)
13.40 – 14.00	Intelligent Energy Management System (iEMS)	Dr. Rutchanee Gullayanon (KMITL)
14.00 – 14.20	Energy Harvesting from Environment	Mr. Thapanan Sudhawiyangkul (KMITL)
14.20 – 14.30	Coffee Break	---
14.30 – 14.50	Autonomous Tracking by GPS / Development of a Robot Balancing on a Ball / Control of a Self-Balancing Unicycle	Mr. Chanawat Morewang, Mr. Veerachai See-ngam, Mr. Per Kristian Remi Nordeng, Mr. Rachanon Jantavee (ABAC)
14.50 – 15.10	An Introduction to Advanced Automation System Laboratory	Dr. Rangsarit Vanijjirattikhan (NECTEC)
15.10 – 15.30	FIBO Introduction/Research	Dr. Prakankiat Youngkong (FIBO)
15.30 – 15.50	ECTI Introduction and Activity, Closing Speech	Prof. Dr. David Banjerdpongchai (CU)
15.50 – 16.00	Photo Session II	All

Presentation No. 1 – 09.10-09.30 (SIIT)	
Title	A Voting Block Matching Technique using Unit Gradient Vectors
Speaker	Assistant Professor Dr. Toshiaki Kondo
Affiliation	Sirindhorn International Institute of Technology, Thammasat University
Email	tkondo@siit.tu.ac.th
Advisor	---

Abstract

We present a novel block matching technique that is robust to both illumination changes and the occlusion problem. The technique is based on the matching of gradient orientations, in place of conventional image features such as intensities or gradients, because gradient orientations are known to be insensitive to the changes of lighting conditions. Gradient orientations can be used in the form of unit gradient vectors (or normalized gradient vectors). Moreover, the method employs a voting strategy in the process of the gradient orientation matching. The method works remarkably well even when a large part of the pattern is occluded with a foreign object because the voting strategy can effectively eliminate the foreign object from the matching process. Consequently, the method performs well under varying illuminations and is also robust to the occlusion problem.

Presentation No. 2 – 09.30-09.50 (SIIT)	
Title	Two Foraging Algorithms for a Limited Number of Swarm Robots
Speaker	Mr. Sarun Chattunyakit
Affiliation	Sirindhorn International Institute of Technology, Thammasat University
Email	mr.sarun.ch@gmail.com
Advisor	Assistant Professor Dr. Toshiaki Kondo and Dr. Itthisek Nilkhamhang

Abstract

Foraging behavior of ants can be beneficial when used in robotic applications that involve traveling between two points, such as harvesting, mining, and rescue robots. Following billions of years of evolution, ants have adapted themselves to become versatile and responsive to their environment. Their main motivation is to search for food and transport it back to the colony. Though a solitary ant may not be able to accomplish this task, a group of ants working together can allow the entire swarm to achieve the objective. Several algorithms have been developed by imitating this behavior, but most of them require a large number of robots to perform efficiently. Some researchers proposed robots that use physical markers, such as heat, alcohol, fluorescent tracks, and RFID tags, to simulate pheromone deposits. The main problem with these approaches is that they cannot perform properly in real operating conditions due to the specific types of markers used. However, recent innovations have made it possible for swarm robots to operate without markers. Since physical markers are unreliable, these new techniques assign some robots to serve as beacons, so-called communication-based navigation. These algorithms perform properly in both obstacle-free and complex maps. It is noted that the performance of these communication-based foraging methods depend on the size of the swarm, and presently there is no algorithm that can perform reliably and efficiently in practical situations using only a limited number of robots. This paper proposes two novel algorithms that can imitate swarm behaviors using a limited number of robots. Both methods are constructed as decentralized systems that can function in unfamiliar environments. Virtual pheromone field (VPF) uses a sampling-graph based method to construct virtual pheromone trails that attract other robots. Sampling-graph based foraging (SGF) employs connected graphs to mitigate the effect of random movement. These two algorithms are simulated and compared with uncooperative (UC) swarm robots. Both proposed methods increase the efficiency and robustness of the swarm, while SGF provides the best results in the benchmark.

Presentation No. 3 – 09.50-10.10 (KMUTT)	
Title	Identification for LPV control of Nonlinear Plant – Application to Arm Driven Inverted Pendulum
Speaker	Dr.-Ing. Sudchai Boonto
Affiliation	Department of Control Systems and Instrumentation Engineering, KMUTT
Email	sudchai.boo@kmutt.ac.th
Advisor	---

Abstract

This talk shows how the identification of LPV input-output models can be used in real applications. The method is applied to an under actuator unstable Arm Driven-Inverted Pendulum (ADIP). The model of the plant is identified in the quasi-LPV input-output structure with all polynomials in Left Polynomial Representation form (LPR). The model is then transformed into LPV state- space model in observable form. The objective of the identification is to use the identified LPV input-output model to design an LPV controller that can stabilize the ADIP for a wider operation range than that of the LTI controller used for identification. The closed-loop system has been test with a real ADIP system provided by Quanser, Inc. The results shows that the proposed procedure gives the best results achieved with this plant published so far.

Presentation No. 4 – 10.10-10.30 (KMUTT)	
Title	Adaptive Focal Length Imaging System using Liquid Crystal Spatial
Speaker	Mr. Kunlachat Seniwong Na-Ayutthaya
Affiliation	Department of Control Systems and Instrumentation Engineering, KMUTT
Email	acidjune@gmail.com
Advisor	Associate Professor Dr. Pakorn Kaewtrakulpong

Abstract

In this paper, we present a single-lens based imaging system that its focal length can be adjusted by using liquid crystal spatial light modulator (LC-SLM). The SLM is placed at the aperture stop of the imaging system to work as a phase mask (PM) that modifies the light wave front passing the exit pupil. By changing the pixel-based phase mask pattern that sends through the SLM, the focal length of the imaging system can be varied in the same spirit as conventional mechanical-zoom lenses. We demonstrate a proof-of-concept system for high magnification industrial inspection applications in a laboratory setup. We show the results that the focal length of the system is adjustable within the range 2:0 mm.

Presentation No. 5 – 10.40-11.00 (AIT)	
Title	Balancing Control of Unstable Systems: Inverted Pendulum Systems, Ball Riding Robots, Bicycle Robots, and Unicycle Robots
Speaker	Associate Professor Dr. Manukid Parnichkun
Affiliation	Asian Institute of Technology
Email	manukid@ait.ac.th
Advisor	---

Abstract

Several systems are unstable in their natures. In the unstable systems, one or more poles of their characteristic equations lie on the right half of the complex plane. Dynamic control of unstable systems is a challenged topic for any control engineers. Several control algorithms have been proposed in order to stabilize unstable systems. In the presentation, 4 unstable systems are introduced as platforms to test control performance. They are inverted pendulum systems, ball riding robots, bicycle robots, and unicycle robots. There are many types of the inverted pendulum systems, including moving cart, rotary, x-y planar, and double-link inverted pendulum. They are classical platforms used in control theory. Ball riding robot, or ballbot, has a robot riding on a spherical ball. Several driving mechanisms are applied to control the robot motion and balancing on horizontal plane. AIT has introduced a double-level ballbot which has a ballbot on top of another ballbot. Bicycle robot, bicyrobo, is a bicycle which balances itself using some mechanisms. Mass balancing, centrifugal force balancing, and gyroscope balancing are widely used to balance the bicycle robots. Unicycle robot balancing requires both longitudinal and lateral balancing control. The robot is highly unstable. Both longitudinal and lateral planes are coupled which make unicycle robot balancing become very difficult.

Presentation No. 6 – 11.00-11.20 (AIT)	
Title	Development and Control of a Double-Links Ball-Riding Robot
Speaker	Mr. Kanjanapan Sukvichai
Affiliation	Mechatronics, School of Engineering and Technology, Asian Institute of Technology
Email	st111444@ait.ac.th
Advisor	Associate Professor Dr. Manukid Parnichkun

Abstract

A ball-riding robot or BallBot is an interesting research topic due to the mechanic and control algorithm. Ball-riding robot is a nonlinear unstable and under actuated system. In this research, a new ball-riding robot, double-links ball-riding robot, is introduced. The mechanism is designed and developed. Inverted mouse driving mechanism is designed as a robot driving mechanism in order to balance a robot to straight up right position. The robot consists of an upper ball-riding subsystem and a lower ball-riding subsystem. The robot's dynamics model can be considered separately in two identical planes. Euler-Lagrange equation of motion is applied to a planar ball-riding robot in order to obtain the robot dynamics and it is combined with actuating motor dynamics in order to obtain more precise robot model. The model is then linearized. The robot's parameters are identified. Linear Quadratic Regulator with Integral (LQR+I) controller is proposed and applied in order to balance both levels of the robot. The complementary and orientation transformation are used to fuse sensors in order to obtain robot leaning angles. The real robot is implemented and controlled by using microcontroller-based approach. Balancing performance of the developed double-links ball-riding robot is evaluated by simulations and experiments. The results show efficient control performance of LQR+I controller.

Presentation No. 7 – 11.20-11.40 (KU)	
Title	Introduction to Computer Vision Research in Electrical Engineering, Kasetsart University
Speaker	Dr. Miti Ruchanurucks
Affiliation	Electrical Engineering Department, Kasetsart University
Email	fengmtr@ku.ac.th
Advisor	---

Abstract

I would like to introduce activities in Electrical Engineering, Kasetsart U. related to Computer Vision. Then I will go into detail about Computer Vision for Survey. The survey is for agricultural area calculation. Devices used in this research are a camera and an orientation sensor. The orientation sensor provides roll, pitch, and yaw angles for the camera to warp a perspective view image to a top view image. In the top view, we can then convert the number of (green) pixels to the area size. One notable novelty in this work is our modified homography matrix. (Homography is a conventional computer vision theory.)

Presentation No. 8 – 11.40-12.00 (KU)	
Title	Computer Vision for Survey, Navigation, and Modeling
Speaker	Mr. Muangmol Saenpeng, Mr. Sakol Kongkaew, Ms. Panjawee Rakprayoon
Affiliation	Electrical Engineering Department, Kasetsart University
Email	muangmol.s@gmail.com, sakol_kongkaew@hotmail.com, panjawee_tao@hotmail.com
Advisor	Dr. Miti Ruchanurucks

Abstract

Survey: We are working with GISTDA on a flood prevention project. The project relies on a vehicle equipped with a Ladybug camera and a SICK range sensor. We propose a new method to calibrate between the camera and the sensor.

Navigation: We are working with DTI on a UAV auto-landing project. This project relies on visual information to land the plane properly. We propose an on-ground-marked-based method for auto landing.

Modeling: We are working with Nopparat hospital on a burn surface area modeling project. This project relies on a set of RGBD cameras to calculate the area of burn vs. normal skin. We propose to enhance the accuracy of a low-cost device 'Microsoft Kinect.'

Presentation No. 9 – 13.00-13.20 (CU)	
Title	Research Activities in Control Systems Research Lab. Chulalongkorn University
Speaker	Dr. Jitkomut Songsiri
Affiliation	Department of Electrical Engineering, Chulalongkorn University
Email	Jitkomut.s@chula.ac.th
Advisor	---

Abstract

In this talk, we present on-going research activities at Control System Research Laboratory, Chulalongkorn university. These topics include applications of control design and optimization problems in power systems, stability analysis for nonlinear systems with backlash and Lur'e systems with time delays, design of feedback systems for non-rational MIMO plants, simultaneous localization and mapping (SLAM) problems and sparse optimization techniques in system identification. We give an overview of each topic and describe its applications.

Presentation No. 10 – 13.20-13.40 (CU)	
Title	Design of Feedback Systems with Backlash for Inputs Restricted in Magnitude and Slope
Speaker	Mr. Hai Hoang Nguyen
Affiliation	Department of Electrical Engineering, Chulalongkorn University
Email	haihoangnguyen13021987@yahoo.com.vn
Advisor	Assistant Professor Dr. Suchin Arunsawatwong

Abstract

This talk presents a design method for unity feedback systems comprising a backlash and linear time-invariant convolution subsystems, where the main design objective is to ensure that the error and the controller output stay within prescribed bounds for all time and for all possible inputs having bounded magnitude and bounded slope. The design formulation is based on the principle of matching, thereby explicitly considering the peak error and the peak controller output for such a possible set. The original design inequalities are replaced with the surrogate design criteria that are in keeping with the method of inequalities. Essentially, the backlash is replaced with a gain and an equivalent disturbance; thus, the nominal system used during the design process becomes linear and the associated performance measures are readily obtainable by known methods. To illustrate the usefulness of the method, a design example is given where the plant has a time-delay.

Presentation No. 11 – 13.40-14.00 (KMITL)	
Title	Intelligent Energy Management System (iEMS)
Speaker	Dr. Rutchanee Gullayanon
Affiliation	Control and Mechatronics Engineering Program, KMITL
Email	ler.gullayanon@gmail.com
Advisor	---

Abstract

A brief organization introduction to the Control & Mechatronics Engineering department at KMITL including a brief department history.

A detail presentation of my current research: Intelligent Energy Management System (iEMS). This system is designed to reduce energy consumption of a/c systems in office buildings while maintaining users thermal comfort zone.

Presentation No. 12 – 14.00-14.20 (KMITL)	
Title	Energy Harvesting from Environment
Speaker	Mr. Thapanan Sudhawiyangkul
Affiliation	Department of Instrumentation and Control Engineering, KMITL
Email	---
Advisor	Dr. Don Isarakorn

Abstract

This contribution will describe about energy harvesting technology, which received more attention in the past decades due to infinite amount of harvested energy. It can provide endless power without obligation. The presentation includes the concept of energy harvesting technology, harvesting technique and its applications for utilizing in industrial processes or agriculture. The available primary energy sources for harvesting are solar energy, thermal, kinetic and vibration, which have different advantages. Moreover, each harvesting techniques will be compared and discussed. The researches of energy harvesting at Department of Instrumentation and Control Engineering, KMITL, mainly aiming at vibration energy harvesting using piezoelectric energy harvesters will also be presented.

Presentation No. 13A – 14.30-14.50 (ABAC)	
Title	Autonomous Tracking by GPS
Speaker	Mr. Chanawat Morewang, Mr. Veerachai See-ngam
Affiliation	School of Engineering, Assumption University
Email	chanawatmorewang@gmail.com
Advisor	Dr. Narong Aphiratsakun

Abstract

The latitude and longitude is the coordinate of the surface of the earth, we will use latitude and longitude as our marking and GPS receiver for our sensor. We will use the latitude and longitude received from GPS module to set the starting point of the bicycle. After receive the starting point, by setting the destination as latitude and longitude, the microcontroller will control the bicycle to the destination point. The microcontroller will control the back wheel to drive the bicycle. Microcontroller control the position of handle to control the direction of vehicle and detect the position of handle by the encoder. As the vehicle move toward the destination point, the GPS receiver keep detect the coordinate of the bicycle and give the value to computer until the bicycle reach the destination point then stop. When the bicycle is out of track, the Microcontroller will control the handle to keep the bicycle to reach the destination. The application of this project can be used with the GPS navigator device in the car. Since the GPS navigator will give the path to the destination point, we can use that path to make the vehicle drive by itself. The benefit of this project is the knowledge of applying the coordinate of the earth to the transportation.

Presentation No. 13B – 14.30-14.50 (ABAC)	
Title	Development of a Robot Balancing on a Ball
Speaker	Mr. Per Kristian Remi Nordeng
Affiliation	Assumption University, Thailand
Email	pernordeng@gmail.com
Advisor	Dr. Narong Aphiratsakun

Abstract

Inherently unstable systems are becoming more and more common. These systems require active control to maintain their stability and will crash if the active control is disabled. A robot that balances on a ball is such an unstable system. The Assumption University Balancing Ball Bot (AUB3) is built from standard components, some custom 3D printed parts and uses an inexpensive digital MEMS accelerometer and gyroscope combination for orientation sensing. Using three omni-wheels to move the robot on the ball allows it to move in any direction without turning first. The drive system uses stepper motors as actuators. A gear reduction was implemented using a synchronous belt and pulley for increased torque due to the weight of the robot. In addition, an acceleration profile was implemented to limit the maximum change in step frequency to limit the chance of stalling the stepper motors. By using a planar control system, x and y axis is treated separately until the motor sharing algorithm calculates the speed of each of the three motors. The control system consists of a complementary filter to give a good approximation of the orientation of the robot, and a simple proportional-derivative feedback controller to perform the actual balancing. The complementary filter uses low frequency signals from the accelerometer and high frequency signals form the gyroscope to approximate the angles of tilt and minimize drift. The control loop runs at 100 times per second on a small 16 bit microcontroller. The stepper motor step generation runs on a separate 16 bit microcontroller. This was done to simplify development and maintain proper timing of each function. A radio frequency telemetry system was developed to receive real-time data from the control system and to allow real-time changes of control variables. It consists of two identical RF transceivers, one on the robot and one connected to a PC via USB and an 8 bit microcontroller. By using this very simple control system, the robot is able to balance on a soft surface. On a hard surface, the robot will start to wander in a random direction. The reason for this is the lack of any mechanism that will counter this. This control system was developed without any computer models or simulations. A much more sophisticated control system will be required to make the robot drive, turn or make any advanced moves.

Presentation No. 13C – 14.30-14.50 (ABAC)	
Title	Control of a Self-Balancing Unicycle
Speaker	Mr. Rachanon Jantavee
Affiliation	School of Engineering, Mechatronics Engineering, Assumption University.
Email	rachanonjantavee@gmail.com
Advisor	Dr. Narong Aphiratsakun

Abstract

Getting to places or transportation is one of the major needs of today's society, which requires the use of various vehicles, such as bikes, cars, etc. But these options run out of play when it comes to indoor travelling including surveillance in malls, reaching from one to the other is too time-consuming on foot and too polluting and energy wasting using conventional vehicles. So our group focuses on the idea of a compact and efficient mode of transportation, namely unicycle. It is a self-balancing auto operated mode of transportation.

The control system to be designed involves balancing a unicycle, thus making it able to balance itself in the horizontal and the vertical plane. This task is achieved by use of Gyro-sensors detects difference degrees of the platform. Moving forward or stopping is done by adjusting the acceleration and the rotational direction of a wheel which we need to set in our controller. It includes brushless DC motor and a Motor control hub to vary the speed (from acceleration control) and direction of the movement. The cycle is controlled by a Programmable disPIC4011 chip (ABAC PCB Circuit II). The speed control (or initiation of the movement) is done by applying desired force on in the direction of motion. In order to achieve the balance point, the motor is run with the speed proportional to that of the force applied and the motion is attained.

Thus, unicycle can be used as a convenient mode of indoor transportation run from a DC source, being efficient and time saving at the same time.

Presentation No. 14 – 14.50-15.10 (NECTEC)	
Title	An Introduction to Advanced Automation System Laboratory
Speaker	Dr. Rangsarit Vanijjirattikhan
Affiliation	National Electronics and Computer Technology Center (NECTEC)
Email	rangsarit.vanijjirattikhan@nectec.or.th
Advisor	---

Abstract

The Advanced Automation Control Laboratory (AAS lab), previously named as Industrial Electronics Lab and Industrial Control and Automation Lab respectively, has been founded since 1993. AAS lab is working under Advanced Automation and Electronics Research Unit, National Electronics and Computer Technology Center. The objectives of the lab is not only to conduct in-house research and development in automation area, but also to closely collaborate with and support local industries in R&D by following the vision of the center, "Being a core organization collaborating with alliances in R&D of electronics and computer technologies for strengthening the sustainability of Thai industries and the sufficiency society". The areas of expertise for AAS lab include designing and implementing the controller for automated machine, machine vision, optimization software, and special machine/robot. This presentation introduces the previous and current works of AAS lab such as Automatic Sewing Machine, Automatic Screening Machine for Angle-Closure Glaucoma Detection, Gas Turbine Spare Parts Management System, and Robot for Generator Inspection.