Internship topics

India – Bulgaria

2019

1. Faculty of telecommunications

The Faculty of Telecommunications is the leading educational institution in the field of communication technologies in Bulgaria. It offers advanced Bachelor, Master and PhD Degrees training in "Telecommunications". Telecommunications is one of the most modern and dynamic areas of engineering and technology nowadays. Area, where a huge investment is allocated and many leading companies in the world are working, with the lowest unemployment and a constant need for qualified specialists.

Proposed Topics:

Automatic Discrimination of Speech and Music in Radio Broadcasts

Supervisor: Assoc. Prof. Dr. Ivo Draganov, E-mail: idraganov@tu-sofia.bg

The discrimination of speech from music is based on the ability to identify any portion of pre-recorded or live audio as containing either type of content. It may find lots of applications, such as recording only of musical content (songs), preserving news podcasts, extraction of advertisement segments and much more for archival, re-broadcasting, or market analysis purposes. Due to the continuous nature of broadcasts and extremely large number of radio stations worldwide it is obligatory the process to be automated without the need of operator intervention. Various methods exist for audio content classification based on feature selection and analysis – zero-crossing rate, average energy of the frame, MEL coefficient analysis and others. Implementing successful application for discrimination of music from speech whether for mobile devices (smartphones, tablets, etc.), desktop computers or dedicated media servers relies on proper combination of extracted features and metrics for measuring the similarity between them. The aim of this project is to test, analyze and select the most efficient similarity measures and the metrics associated with them for automated classification of radio content. Based on the results obtained a sample application should be implemented which demonstrates the operability of the approach. It is recommended, although not obligatory, the prior knowledge of at least one programming language, some experience in signal (image) processing and good knowledge in math (undergraduate level, engineering oriented). The programming environment for testing is Matlab.

Detection and Tracking of Moving Objects in Video

Supervisor: Assoc. Prof. Dr. Ivo Draganov, E-mail: idraganov@tu-sofia.bg

Detection and tracking of moving objects in pre-recorded or live video streams are important stages in numerous applications for both professional and personal use. They could be used for public roads traffic analysis and detection of critical events (e.g. car crashes), security surveillance of restricted areas (spotting intruders), large number of military applications (detecting, tracking and aiming at various targets), personal use in games based on 3D virtual reality and many more. In order to detect a particular object in a visual scene (captured by a video camera) proper descriptors need to be estimated from separate frames. They include intensity levels change, finding edges and corners with shifted positions from frame to frame,

high-order statistical moments (e.g. forming Gaussian Mixture Models, etc.) and others. Once selected for a given application these features need to be combined so the phase of detecting the object of interest could take place. The same or additional features may be used afterwards in order to track the object in time. Its trajectory within the frame or specific isolated locations (e.g. passing through restricted areas, etc.) may be registered and further actions undertaken (e.g. raising an alarm, blocking certain exits, etc.). The aim of the project is to investigate some of the most popular features for object detection and tracking from video by testing them over various video samples. The efficiency of analyzed descriptors in terms of precision and needed processing time should be estimated and then proposition of the most efficient for highway traffic analysis need to be incorporated in demo application. It is recommended, although not obligatory, the prior knowledge of at least one programming language, some experience in signal (image) processing and good knowledge in math (undergraduate level, engineering oriented). The working environment for testing is Matlab.

Object Shape Evaluation and Dimensions Estimation from Images

Supervisor: Assoc. Prof. Dr. Ivo Draganov, E-mail: idraganov@tu-sofia.bg

Industrial applications relating to manufacturing of large number of details rely on precise estimation of their dimensions and overall shape evaluation in order to comply with common standards and to ensure high reliability of the final products. Non-automated measuring of dimensions is proved to be slow and expensive. Digital imaging offers a way with the use of data processing algorithms to automate the whole process at low price rendering it extremely efficient. In this project various operators applied over digital images of different objects in size and shape will be investigated, e.g. edge and corner detectors, morphology operators, segmentation functions and others. Sequence of processing steps need to be selected for a given type of objects captured at different positions over non-stationary background in order to complete the measurements. Based on them, final decision should be made about the compliance of the manufactured object. Testing with different real-world images will provide wider capabilities for the students to use freely and in a flexible manner the most popular techniques in the field. It is recommended, although not obligatory, the prior knowledge of at least one programming language, some experience in signal (image) processing and good knowledge in math (undergraduate level, engineering oriented). The working environment for testing is Matlab.

Methods and algorithms for automatic 3D object model construction from multiple views

Supervisor: Assoc. Prof. Dr. Agata Manolova, E-mail: amanolova@tu-sofia.bg

Objects which occupy space in the virtual environment can be entities that the user can observe and/or manipulate. So creating consistent and useful models of objects and background of the constrained space is essential. This task explains how to apply mathematical transforms that translate them in the virtual world. This involves two components: Translation (changing position) and rotation (changing orientation). The main goal of this task is to find the best ways to express and manipulate 3D rotations, which are the

most complicated part of moving models. Accurate models of already existing complex shaped objects are required for synthesizing arbitrary views and also for recognizing them. Automatic construction of geometric models of 3D objects involves three major steps: (i) data acquisition, (ii) registration of different views, and (iii) integration. Data acquisition involves obtaining either intensity or depth data of an object from multiple viewpoints. Accurate 3D spatial relations between different views may not be easily and directly obtained in many cases. Therefore, integration of data from multiple views is not only dependent on the representation chosen for the model description, but also requires a knowledge of the transformations relating the data obtained from multiple views. The goal of registration, is to find the transformations that relate multiple views, thus bringing the object regions that are shared between them into alignment. Integration merges data from multiple views using the computed view transformations, to create a single surface representation in a unique coordinate frame.

Methods and algorithms for skeleton generation and tracking of skeleton joints for human activity recognition

Supervisor: Assoc. Prof. Dr. Agata Manolova, E-mail: amanolova@tu-sofia.bg

The 3D avatar generates large amount of data points, which have to be sent through the network in real-time. To create the skeleton, a human body is described by a number of joints representing key body parts such as head, neck, shoulders, elbows, wrist, torso, hip, knee and ankles. Each joint is represented by its 3D coordinates. The tracking involves determining all coordinates of these joints in real time to allow fluent interactivity. Multiple sensors are necessary to avoid self-occlusion, which is a common problem among most vision-based sensing systems. However combining the measurements from the different sensors creates a new issue known as the data fusion problem. Based on the captured skeletal data an avatar can be animated. The created 3D model needs to be rigged with the captured skeleton hierarchy and appropriate texture maps. A skeleton based animation strategy must is employed for robustly and accurately fitting the avatar to the skeleton and then large scale deformations and movements can are applied in real-time.

Real-time facial identification, facial features detection and tracking in multi-view environment

Supervisor: Assoc. Prof. Dr. Agata Manolova, E-mail: amanolova@tu-sofia.bg

We will develop and implement methods and algorithms to efficiently identify human faces, including: improved method with increased accuracy for face segmentation; method and algorithm for extracting facial features, after transformation into subspaces for dimensionality reduction and a classifier based on a deep learning neural networks. The method for face segmentation of individuals will be based on sequential combination of the known method of Viola-Jones and convolutional neural network CNN. The developed algorithm will serve to recognize expressions based on facial characteristics. Software development and simulation algorithm to extract facial features will be based on reducing the dimensionality of data by face segmentation in the wavelet space and principal component analysis (PCA). The

classification will be made by classifiers such as convolutional neural networks or other types of deep learning neural networks suitable for this application.

Real-time photorealistic animation of the avatar's body and head movement

Supervisor: Assoc. Prof. Dr. Agata Manolova, E-mail: amanolova@tu-sofia.bg

The main idea of the project is to combine geometry and texture based techniques to animate a personalized avatar. The user's performance is captured by an RGB-D camera and transferred to the avatar in real-time. We rely on a skeleton based animation to transfer large scale deformations of the body, e.g. walking, jumping or moving the arms. Each joint of the skeleton is represented by its 3D coordinates. The tracking involves determining all coordinates of these joints in real time to allow fluent interactivity. Multiple sensors are necessary to avoid self-occlusion, which is a common problem among most vision-based sensing systems. However combining the measurements from the different sensors creates a new issue known as the data fusion problem so the sensors can work together to correct any inaccurately captured joint data. Based on the captured skeletal data an avatar can be animated. The created 3D model needs to be rigged with the captured skeleton hierarchy and appropriate texture maps. A skeleton based animation strategy will be employed for robustly and accurately fitting the avatar to the skeleton and then large scale deformations and movements will applied in real-time.

Designing and simulating realistic clothing

Supervisor: Assoc. Prof. Dr. Agata Manolova, E-mail: amanolova@tu-sofia.bg

Dressing virtual avatars and animating them with high quality, visually plausible, results is a challenging task. Highly realistic physical simulation of clothing on human bodies in motion is complex: clothing models are laborious to construct, patterns must be graded so that they can be sized to different characters, and the physical parameters of the cloth must be known. Current methods for 3D garment capture are not sufficiently accurate or detailed to compete with physical simulation. Existing capture methods suffer from low resolution, static shapes, simple body motions, capture only one clothing piece, or do not segment the clothing from the body. The main goal of this task is to develop a data-driven clothing capture approach; to capture dynamic clothing on humans from multi-view scans and transform it to more easily dress the virtual avatars. The first step will be capturing the garment geometry in motion on a body, estimate the body shape and pose under clothing, and segment and extract the clothing pieces. Then the captured clothing can be transferred to new body shapes and poses.

Create a 3d model of real object

Supervisor: Assist. Prof. Dr. Nicole Christoff, E-mail: nicole.christoff@tu-sofia.bg

The aim of this project is to create a parametric modeling of objects and to create a photorealistic avatar. To achieve this, a 3D scanner and / or RGB-D sensors will be used to acquire the necessary data to be processed (point cloud). Before the object size can be calculated, the point cloud must be filtered to segment the object from the surrounding

environment. This should be done using an automatic segmentation techniques. After the correct segmentation of the object, an algorithm has to be developed and applied to animate this object.
The deliverable is a report including:
 state-of-the-art on various approaches for modelling of an object;
 improved algorithm for object modelling and selection in 3D space;
 created a database of deformable object models;
 results from simulation experiments related to the developed algorithms.
Programming language: C ++ / Java / Matlab
Tools at disposition: 3D scanner Sense and test field table

Scan and avatar yourself

Supervisor: Assist. Prof. Dr. Nicole Christoff, E-mail: nicole.christoff@tu-sofia.bg

The objective of building human representations is to extract compact, features to encode and characterize a human's attributes from human shape, pose, and motion, when developing human-centered reasoning systems. Skeleton-based human representations are attractive, due to their robustness to variations of viewpoint, human body scale and motion speed as well as the real-time, online performance. 3D skeleton-based representations are able to model the relationship of human joints and encode the whole body configuration. They are also robust to scale and illumination changes, and can be invariant to camera view as well as human body rotation and motion speed. In addition, many skeleton-based representations can be computed at a high frame rate, which can significantly facilitate online, real-time applications.
The deliverable is a report including:
 state-of-the-art on various approaches for modelling of human body;
 improved algorithms for human body modelling with real-time application in 3D space taking into account changes in the multi-view environment;
 created a database of deformable human body models;
 results from simulation experiments related to the developed algorithms.
Programming language: C ++ / Java / Matlab
Tool at disposition: 3D scanner or Kinect

Android based speech recognition applications

Supervisor: Prof. Dr. Snejana Pleshkova, E-mail: snegpl@tu-sofia.bg

User can control a variety of applications on an android based platform, which include native applications as well as user installed applications with voice commands. These include - calling, texting, switching on and off sensors (Wi-Fi, GPS, Bluetooth),setting alarms. The application provides online as well as offline services. The application also applies machine learning concepts to identify usage patterns and create an environment which anticipates user requirements. The tasks being performed repetitively are automated. Services of activity recognition, recognizing nearby friends using Bluetooth are performed. The importance of the

project is that it provides visually challenged people as well as the general population an alternate and a very easy way to control applications on android smart phones.

Wireless and Mobile Audio Streaming Technologies

In this project the students will learn the principles and structures of wireless and mobile audio streaming technologies, the architecture and block diagrams of wireless and mobile audio systems. They will design the basic algorithms for audio streaming via wireless and mobile audio professional or home networks developing real working applications for audio information streaming and also applications of remote control of wireless and mobile audio system using smart phones or tablets.
PREREQUISITES: Audio Systems, Wireless and Mobile Networks, Audio Streaming, Matlab, Simulink, Android Studio, Eclipse IDE, Web Design

Microphones, Microphone Arrays Based on MEMS Technology and Applications in Audio Visual Mobile Robots Motion Control

In this project the students will learn the MEMS microphones technology. Using the fundamental theory of microphone arrays they will develop practical applications of different structures of microphone arrays, testing them and analysing their ability to determine the direction of sound of arrival from speakers or other audio sources and using the results in real time audio visual mobile roots motion control.
PREREQUISITES: Audio Systems, Microphones, Microphone Arrays, MEMS Microphone Technology, Microcontrollers Hardware and Software, Microsoft Mobile Robots Studio

Room Acoustic Analysis. Simulations an Real Implementations

In this project the students will acquire basic knowledge and skills about principles of acoustic, specific and principles of room acoustic for audio studios, concert halls, offices, home rooms, etc. These knowledge's will be applied from the students in simulations and practical implementations of real room acoustic analysis, taken the results and conclusions for choosing and using appropriates building materials and building constructions to greatly improve the acoustic characteristics of the room under test.
PREREQUISITES: Audio Systems, Acoustic, Room Acoustic, Audio Signal Processing, Neural Networks, Matlab, Simulink, Microsoft Visual Studio, Java, Sound Insulation Materials and Constructions

Audio Systems for Creation, Editing and Mastering of Songs and Musical Productions

In this project the students will learn the principles, the architectures and basic functions of audio systems for creation, editing, processing and mastering of songs or other musical production. Then students will work with the professional audio editing system PreSonus Studio to develop real practical applications producing the new songs, applying all necessary steps for creation of audio and instrumental tracks, adding the special audio effects, editing and processing all created tracks to form the final release of the created song.
PREREQUISITES: Audio Systems, Editing Audio Systems, Audio Signal Processing, Special Audio Effects, Audio Mastering.

2. Faculty of Mechanical Engineering

Supervisor: Assist. Prof. Dr. Kalin Chuchuganov, E-mail: chuchuganov@gmail.com

- **Condition monitoring and analysis of ball bearings, using vibration monitoring software –** The condition of ball bearings is analyzed using specially developed diagnostic stand and by taking vibration spectra, which are analyzed in vibration monitoring software in Labview environment.
- **Dynamic balance analysis and methods for balancing of rotating machinery –** vibration spectra of rotating machinery is examined in order to assess their balance condition using vibration analysis hardware and software in Labview environment. Consequently methods for balancing are used and a secondary assessment of the balance condition is performed to evaluate the balancing process. The test object used for research is a computer fan.
- **Analysis of the quality of color printing of laser and LED color printers, used for prepress hard-proofing and digital offset –** the conformance to printing standards for offset printing and hard-proofing of digital color printers is assessed qualitatively and quantitatively using spectrophotometers, calibration and profiling and software packages for printer quality evaluation and color management. The research is made in a specially developed color management and research laboratory.
- **Analysis of color reproduction abilities of color LCD displays, used in prepress and digital color laser printing –** color LCD displays are evaluated with the use of color management software, profiling and calibration procedures with spectrophotometer. The conformity of the displays with the standards for digital color printing and prepress is assessed. The research is made in a specially developed color management and research laboratory.
- **Quality evaluation of illumination lighting systems, used in premises for prepress and finished print production examination –** the spectra and other parameters of the light, emitted from lighting systems, used in the printing industry are assessed for conformity with the specifications of the standards in the field. The research is made in a specially developed color management and research laboratory.

3. Faculty of Electronic Engineering and Technologies

Faculty of Electronic Engineering and Technologies (FEET) is recognized as a leader in education and research in the field of electronics at national level (accreditation by Institution of Electrical Engineering, London, UK). Training in FEET is consistent with the latest advances in electronics, as well as with educational and research programs of leading European universities in England, Germany, France, The Netherlands, Italy, etc.

Supervisor: Assoc. Prof. Dr. Petar Yakimov, E-mail: pij@tu-sofia.bg

Subjects: Students will have the opportunity to learn about the principles of operation and to explore various transformer devices used as mains power supplies. Research is conducted on real-power models (rectifiers, stabilizers, UPS, photovoltaic systems, rechargeable batteries, etc.). Measuring points are shown on the test devices to illustrate the principles of operation and the basic electrical ratios in these circuits. An opportunity for computer simulation of individual schemes has been created. Through simulation studies with specialized software, it is possible to compare the results with real devices.