Year-5 _ CVDI IP Report

The following tables list the Intellectual Property (IP) items developed for each Year 5 project that are available for licensing, along with a description of key features.

Project reports containing detailed information about the associated research results are available.

The ID numbers that appear in the tables are identified by the following patterns: IP Item: Project-[Project #]-[Item #]

CVDI Project 16.01 - Platform Invariant Low-Level Image Processing, Prof. Moncef Gabbouj and Dr. Serkan Kiranyaz (Tampere University of Technology)

IP Item Description
P - 16.01 - 1: A software prototype: Two Convolutional Neural Network based methods performing the state-of-the-art in well-known color constancy datasets; equipped with a linear color conversion approach, camera invariance was achieved (under consideration, work not yet complete)
Key Concept 1: The proposed Convolutional Neural Network based method performed the state-of-the-art in well-known color constancy datasets
Key Concept 2: Another CNN-based method and our method was evaluated with the above-mentioned evaluation strategies. It was observed that our method outperforms the baseline CNN method in scene invariance thanks to its deeper structure, multi-resolution population strategies and two-stage training procedure. However, both methods as is could not achieve camera invariance.
Key Concept 3: The linear color conversion approach was applied for each CNN-based method and it was observed that camera invariance could be achieved for both methods.

CVDI Project 16.02 - Patient Specific Framework for Biomedical Signal Management,
Prof. Moncef Gabbouj and Dr. Serkan Kiranyaz (Tampere University of Technology)

IP Item Description
P - 16.02 - 1: A software prototype: A novel feature extraction method is proposed based on the nullcline analysis of ECG signals (under consideration, work not yet complete)
Key Concept 1: The proposed method reveals information about the nullcline of the system over the reconstructed phase space. These features reflect information about the underlying system only based on a measurement.
Key Concept 2: The achieved results for Dataset I yields the highest average sensitivity and specificity rate in contrast to the state-of-the-art methods.
Key Concept 3: Moreover, the classification performance obtained using only three features, which shows the potential application of the proposed approach for online processing. A related work was developed by the team outside of CVDI and led to a novel advanced warning of heat arrhythmia in otherwise healthy persons. An article about this was published in Scientific Reports – Nature, Aug 2017 (http://rdcu.be/vfYE).

CVDI Project 16.03 - An Evolutionary Face Recognition and Verification System, Prof. Moncef Gabbouj and Dr. Alexandros Iosifidis (Tampere University of Technology)

IP Item Description
P - 16.03- 1: A software prototype: and a demo system that combines face detection, face recognition and spoofing attacks detection (under consideration, work not yet complete)
Key Concept 1: Our system is a complete system that includes face image registration, query image recognition, spoofing data collection and training.
Key Concept 2: We showed that combining spoofing detection into a face recognition system does not degrade the system performance.
Key Concept 3: Our system achieves 10 fps in face recognition, which is enough for a real-time system. The developed system was demoed at a high-level Nokia Event in August 2017 and received high attention from the attendees.

CVDI Project 16.04 - Project 16.04- Automating Operational Response Planning and Execution Based on Business Situational Awareness on Social (and Other) Media, Prof. Petri Myllymäki (University of Helsinki)

IP Item Description
P - 16.04 - 1: A software prototype: Combining different modalities of social and other media data in order to produce social graph like structures for analyzing and planning actions given the state of the graph. (under consideration, work not yet complete)
Key Concept 1: Sentence level vectorization of textual documents based on combination of syntactical and morphological features, dependency structures, feature hashing and random projections.
Key Concept 2: Graph segmentation viewed as an instance of correlation clustering and examining its efficient estimation using SAT solver motivated methods.

CVDI Project 16.05 - High Dimensional Data Reduction, Sampling and Visualization for Big Data Applications, Dr. Xiaohua Tony Hu (Drexel University)

IP Item Description
P - 16.05 - 1: A software prototype: Multivariate Hawkes Process framework to simulate topic evolution process, to deal with topic detection and tracking from social media. Languages/technologies: Java, Stanford NPL, LDA, Dragon ToolKits
Key Concept 1: A new method for handle topic detection from short messages efficiently;
Key Concept 2: Algorithm can track topics from continuous message stream without time granularity definition requirement
Key Concept 3: Can reveal the underlying mechanisms that drive a topic's generation and evolution

CVDI Project 16.06 - Developing an Incremental and Active Learning Framework for Evolving High-Volume Data Streams, Dr. Gail Rosen (Drexel University)

Please note: IP Item [P – 16.06-1] was previously sent as an interim report.

IP Item Description
P - 16.06 - 2 : A software prototype that performances clustering based Expectation Maximization algorithm (CBEM) on input data (semi-supervised learning algorithm).
Key Concept 1: A new incremental learning algorithm based on existing techniques that can update the model based on new samples without reprocess the existing data
Key Concept 2: Combined supervised learning with clustering algorithm to help the classifier understand the hard-to-classify samples

IP Item Description
P - 16.06 - 3: A software prototype that performances incremental author disambiguation on input digital citation records (pseudo-semi-supervised learning algorithm). *(described in a paper being published in IEEE International Conference - DSAA 2017)*
Key Concept 1: A new incremental learning algorithm based on Naïve Bayes Classifier and High Precision Clustering that can update the disambiguated digital authorship model based on new citation records without reprocess the existing dataset
Key Concept 2: Implemented a novel adjustable criterion to determine whether the sample belongs to a new author or an existing author
Key Concept 3: Allow user to adjust threshold according to their goal (desire a conservative result or not)

CVDI Project 16.07 - An N-Point Statistics Framework for Predicting Tissue Traits Spatial in Biomedical Images, Drs. David Breen and Mark Zarella (Drexel University)

IP Item Description
P - 16.07 - 1: A software prototype capable of defining an alternate color representation for the analysis of Hematoxylin and Eosin (H&E) images (a type of immunohistochemistry-stained (IHC) image), a capability which supports color normalization and effectively reduces inter-slide variability during downstream analysis.
Key Concept 1: A general framework for combining shape analysis with color for the purposes of color representation.
Key Concept 2: Exploited the correlation between the spatial distribution of pixels and their colors in order to establish a color invariant representation of H&E images.
Key Concept 3: An analytical process that explicitly relates colors to histologic structures.

IP Item Description
P - 16.07 - 2: A software prototype capable of estimating fine-scale histologic features at low magnification which allows for the analysis of IHC images at lower pixel resolutions; thus providing computational speed-ups that facilitate high-throughput analysis of whole-slide IHC images.
Key Concept 1: Ability to assess the impact of resolution reduction on the histological attributes of H&E images.
Key Concept 2: Development of a predictive model to estimate the histological composition of tissue in a manner that exceeds the resolution of the image.

IP Item Description
P - 16.07 - 3: A software prototype capable of characterizing spatial structures in biomedical images based on N-point statistics analysis.
Key Concept 1: Modeling histologic structures based on simulations of the formation of elementary shapes using a gravity model.
Key Concept 2: Normalization of N-point statistics histograms in order to remove the influence of point density.
Key Concept 3: Definition of a shape feature space via application of Principal Component Analysis to N-point statistics k-NN (k nearest neighbors) curves.

CVDI Project 16.08 – Online Mining for Association Rules and Collective Anomalies in Data Streams, Drs. Jian Chen and Jennifer Lavergne (UL Lafayette)

IP Item Description
P - 16.08 - 1: CSM (Contrast Set Mining). A variation of Contrast set Mining which, instead of discovering Jumping Emerging Patterns, we modified to discover patterns associated with certain specified sets of items.
Key Concept 1: Utilizes contrast items/patterns for rule discovery, thereby limiting results to these sets.
Key Concept 2: Discovers relationships between contrasting items and their patterns in a dataset
Key Concept 3: Implemented on the Spark Platform for the distribution of the itemset tree structure.

IP Item Description
P - 16.08 - 2: Online Action Rule Mining System. This system combines Action Association Rule Mining and Online Anomaly Detection to detect the rules of specific range of streaming data.
Key Concept 1: Implemented on Spark Streaming for analysis on specific time frames.
Key Concept 2: Detects anomalous sequences and utilizes them to discover action association rules.

IP Item Description
P - 16.08 - 3: Bayesian Classifier Combination of Prediction. Utilizes Independent Bayesian Classifier Combination (IBCC) to select suitable prediction results for specific data points.
Key Concept 1: Enables easy swapping of classifier models.
Key Concept 2: Applies IBCC on our online predication system.
Key Concept 3: Supplies prediction results based upon anomalies.
Key Concept 4: Extrapolates prediction points from historical data to one year in the future utilizing TenserFlow.

IP Item Description
P - 16.08 - 4: Machine Learning + MapReduce. A MapReduce enabled system which utilizes online prediction with machine learning algorithms.
Key Concept 1: Allows more robust predictions.
Key Concept 2: Discovers anomalies and association rules.

CVDI Project 16.09 – Comparative Knowledge Discovery: Analyzing, Understanding and Visualizing Rankings, Dr. Raju Gottumukkala (UL Lafayette) jointly with Prof. Moncef Gabbouj and Dr. Alexandros Iosifidis (Tampere University of Technology)

IP Item Description
P - 16.09 - 1: Data-driven methods that learn to rank multi-dimensional objects. The learning to rank method automates the construction of ranking model using the training data instead of manual ranking by expert. This method allows user to select the objects and attributes that are of interest to the user. TUT's part resulted in a software prototype (refer P – 16.09 – 3) implementing the ideas described above (under consideration, work not yet complete)
Key Concept 1: An unsupervised method for rank aggregation that is specified as an optimization problem to learn a linear combination of ranking functions with maximum agreement.
Key Concept 2: A hybrid method with linear time complexity (O(n)) with respect to the number of samples that takes advantage of both hierarchical partial ordering and unsupervised method to rank.

IP Item Description
P - 16.09 - 2: A partial-order based system and method for ranking of multi-dimensional objects. A scalable partial-ordering method, and a web-based interactive dashboard that enables decision makers to compare multi-dimensional objects much more effectively than existing ranking systems.
Key Concept 1: Partial-ordering method to compare or sort multi-dimensional objects. This method for ordering expressed as a Hasse diagram (a form of direct acyclic graph) provides rich information about how objects compare with each other unlike existing ranking methods that hides conflicts and missing information.
Key Concept 2: Unsupervised learning method for rank aggregation based on dynamically selected attributes at multiple levels of hierarchy.
Key Concept 3: A hierarchical directed graph based visualization comparison of objects using the scalable partial-ordering method.

IP Item Description
P - 16.09 - 3: Data-driven methods that learn to rank multi-dimensional objects. TUT's part resulted in a software prototype implementing the ideas described under P-16.09 - 1 (under consideration, work not yet complete)
Key Concept 1: A multiview approach is adopted to combine multiple modalities and optimize a fitness function defined on a common feature space.

CVDI Project 16.10 – Interactive Visual Exploration of Large Graphs with Enhanced Sampling and Summarization, Drs. Borst and Tozal (UL Lafayette).

IP Item Description
P - 16.10 - 1: Weighted Jaccard similarity measure for graph summarization. We have designed and implemented a new similarity metric for use in graph summarization, allowing large graphs to be rendered more easily. A weighted version of the Jaccard similarity measure was developed during our project to remove observed graph summarization biases.
Key Concept 1: The summarization priorities are distributed uniformly among both low degree and high degree nodes.
Key Concept 2: By avoiding the bias toward low degree nodes, we allow more important nodes to merge at earlier stages of the process.
Key Concept 3: When visualizing the resultant hierarchy, the most important nodes are at the top and, other nodes will cluster around these in later summarization levels.

IP Item Description
P-16.10 – 2: Detail level control for graph collapse/expand, with touch-release mechanic, associated preview highlighting, and merge tree view. A graph summarization front-end implemented in JavaScript provides dynamic visualizations across multiple device types, such as desktops, laptops, and smart-phones.
Key Concept 1: Users are able to adjust the level of summarization via a slider. A touch-release mechanic controls summarization level selection, and a preview ribbon updates continuously, indicating which nodes will be merged in the next summary levels
Key Concept 2: A merge history view of the summaries contained within a supernode is shown as a binary tree, and the centrality metric distributions are given for the same supernode.

IP Item Description
P-16.10 – 3: Client/server communication protocol and architecture for managing the visualization/interface on any device. A web server hosts the summarization front-end and calculates all summarization steps up to and including the desired level.
Key Concept 1: The previous two items reside in a Python-based web server implementation as dynamic (Jaccard-based summarization) and static (JavaScript front-end) html pages.
Key Concept 2: We programmatically generate the dynamic web pages based on the input graph and summarization state (e.g., summarized topology and numerical level results as requested by touch gestures).