Abstracts

PhD Scientific Seminar

Faculty Eletronics and Automation

Technical University Sofia, branch Plovdiv

17 March 2023

Contents

Editors: Mitko Shopov & Nikolay Kakanakov

Stefan Stoyanov is 2nd year PhD student at the Technical University Sofia branch Plovdiv, Department of Computer Systems and Technologies. He has MSc degree in Computer Systems and Technology from Technical University of Sofia and BSc degree in Computer Systems and Technology from Plovdiv branch of Technical University of Sofia. His PhD research interests and activities are in Computer Architectures, Computer Security, RISC-V processors and Machine Learning

Secure Heterogeneous Architecture

Stefan Stoyanov

Computer Systems and Technologies Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
s.stoyanov@std.tu-plovdiv.bg

Embedded processors are the core of smart and IoT devices. For the last two decades, they were primarily ARM instruction set based but since the RISC-V instruction set was introduced 13 years ago, things came to a state where RISC-V challenges ARM supremacy. Due to the open nature of this instruction set, it became popular for both industry and academic studies, as it enables freedom of design, implementation and scalability.

Along with the benefits, RISC-V becoming mainstream technology leads to an increased risk of cyber attacks, necessity for data protection and execution security. Many solutions to these challenges are ported from other platforms, new approaches were introduced and advanced researches are being conducted to handle the ever-existing security threads.

The latest technology and future development direction of RICS-V security research is still to be defined.

A common tendency in computer security especially implementing Root-of-Trust is isolation in terms of hardware resources and access to these resources. Best results can be achieved if there is a complete isolation, even between the execution flows of user programs, kernel and security targeted code, which naturally leads to the use of multi-processor systems. Based

on the security level of each processor it might or might not have access to the other processor resources thus defining one of the processors as a security core. These processors perform different computations and algorithms. To optimize the device means that these processor cores should not be identical but have the minimum functionality to perform their tasks. As RISC-V base instruction set includes just 47 instruction it means that we can have very small cores perform different tasks which minimizes chip size and power consumption.

Cyber-security faces constant attempts to exploit previously undiscovered security holes. While software can easily be patched and misbehavior detected by the user, hardware security issues can only be partially fixed by software resulting in performance degradation and can also go unnoticed by the user. Hardware implemented mechanisms can spot unauthorized code on very low level. Having a separate RISC-V RoT core which is able to identify security threads can significantly improve the reliability of a RISC-V base heterogeneous computer system.

Emilia Pardo is 2nd year PhD student at the Technical University Sofia branch Plovdiv, Department of Computer Systems and Technologies. She has a MSc and BSc degree in Computer Technologies from Plovdiv University “Paisii Hilendarksi”. Her PhD research interests and activities are in

PARALLELIZING THE NEEEDLEMAN-WUNCH ALGORITHM USING GRAPHIC ACCELERATORS

EMILIA PARDO

Computer Systems and Technologies Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
epardo@tu-plovdiv.bg

Bioinformatics is used to analyze whole-genome sequencing data. It is interdisciplinary field that developes and improves methods for storing, retrieving, organizing and analyzing biological data. Bioinformatics has become an important part of many areas of biology. In the field of genetics and genomics, it aids in sequencing and annotating genomes and their observed mutations. In structural biology, it aids in the simulation and modeling of DNA, RNA and protein structures as well as molecular interactions. This involves algorithm, pipeline and software development and analysis, transfer and database/storage development of genomics data. Genomics applies recombinant DNA, DNA sequencing methods and bioinformatics to sequence, assemble and analyze the function and structure of the gehomes. A typical whole-genome sequencing workflow contains quality control and data grooming, genome assembly and post-assembly analysis. This volume of data is produced from next-generation sequencing platforms is massive.

The Needleman–Wunsch algorithm is an algorithm used in bioinformatics to align protein or nucleotide sequences. The algorithm was developed by Saul B. Needleman and Christian D. Wunsch and published in 1970.The algorithm essentially divides a large problem (e.g. the full sequence) into a series of smaller problems, than optimizes the results. The algorithm is

widely used for optimal global alignment, especially when the quality of the global alignment is of the utmost importance. The algorithm assigns a score to every possible alignment and his purpose is to find all possible alignments having highest score.

The DNA sequences are available in FASTA format, which are stored in NCBI (The National Center for Biotechnology Information). The structure of one FASTA file is presented by a thousand rows – a nucleotid sequences. A large computing resource is required for comparing and searching for matches. The graphical accelerators are suitable for this problem. GPUs (Graphical Processing Units) have thousands of cores,which can be used for parallel comparison. In 2006 appears the CUDA (Compute Unified Device Architecture) architecture, which can be used for parallel programming, using languages like FORTRAN/C, ACC, C++.

Stela Stoykova is a 1st year PhD student at the Technical University Sofia, Branch Plovdiv, Department of Control Systems. She has a MEng in Automation, Information and Control Engineering and BEng degree in Industrial Engineering from the Plovdiv Branch of Technical University of Sofia. Her PhD research interests and activities are in the field of

Application of AI in Management Information Systems and Business Analytics

Stela Stoykova

Control Systems Department
Technical University of Sofia, Branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
stoykova@tu-plovdiv.bg

Management information systems (MIS) are information systems used for decision-making, and coordination, control, analysis, and visualization of information regarding the processes, people and technology employed within an organizational setting. MIS is a term unifying various organization level software solutions such as: Decision support systems (DSS), Executive information systems (EIS), Office automation systems (OAS), Enterprise resource planning systems (ERP), etc. The field of MIS relies on the implementation and integration of business analytics (BA) tools to transform aggregated organizational and business data into insights for improving business decisions as well as employing AI for process automation of repetitive low value-added tasks. Data management, data visualization, predictive modeling, data mining, forecasting simulations, and optimization are some of the tools used to create insights from data. Advances in AI in recent years have created opportunities for the inclusion of AI technology and tools within ERP systems for the purposes of:

- Production Planning
- Materials Management
- Sales and Distribution
- Marketing and E-commerce
- Warehouse Management

- Logistics Execution
- Financial Accounting and Control
- Human Capital Management
- Information Management and Cybersecurity

Our current reserch revolves around the implementation of intelligent robotic process automation (iRPA) for document extraction and information extraction within the most widely distributed ERP system SAP Business Technology Platform with the goal of reducing human workers' involvement in time-consuming low value tasks. A use case scenario quantifying the business value of integrating iRPA bot chains in small and medium-sized enterprises was developed. The research was summarized in two papers and presented at the International Conference Automatics and Informatics (ICAI 2022):

Intelligent Robotic Process Automation for Small and Medium-sized Enterprises,
Stoykova, S., Hrischev, R., Shakev, N., indexed in: IEEE Xplore, Scopus.

Bot Development for Intelligent Automation in ERP Systems,
Stoykova, S., Hrischev, R., indexed in: IEEE Xplore, Scopus.

A related reserch topic in the field of process automation, data management and decision-making for ERP systems is workflow modeling. Our findings regarding the capabilities of the workflow modelling service of the world's largest vendor of enterprise application software and cloud-based ERP services were summarized in a paper, which was presented at the 11th International Scientific Conference: "TechSys 2022" – Engineering, Technologies and Systems, Technical Ubiversity of Sofia, Plovdiv Branch:

Modeling Workflows and Processes in the Cloud ERP Platform SAP BTP,
Stoykova S., Hrischev R.

Further research directives and opportunities were summarized in reports for the Fourth International Conference on Artificial Intelligence and e-Leadership (AIEL 2022):

Services with integrated AI in the SAP Business Technology Platform,
Hrischev, R., Stoykova, S.
Application of Artificial Intelligence in ERP Systems,
Shakev, N., Hrischev, R., Stoykova, S.

The growing field of AI implementation in Management Information Systems allows

for extending the reach of future research into the application of: chatbots and generative pre-trained transformers for customer interaction services, process automation for human experience management, workflow modelling, sales forecasting and client targeting for marketing, operational data analytics and bottleneck forecasting for production planning, threat detection for informational security. Opportunities for transitioning to edgeAI applications within MIS can be considered as current trends lean towards creating compact AI models that allow for computations to be done at the edge of a given network, usually on the device where the data is created, instead of in a centralized cloud computing facility or offsite data center.

Katya Madzharova - Atanasova is 2st year PhD student at the Technical University Sofia branch Plovdiv, Department of Control Systems. She has a MSc and BSc degree in Automation, Information and Control Equipment from Plovdiv branch of Technical University of Sofia. Her PhD research interests and activities are in “New algorithms for intelligent control of industrial robots in a shared workspace”.

ARTIFICIAL INTELLIGENCE SYSTEMS

KATYA MADZHAROVA-ATANASOVA

Control Systems Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
kmadzarova@tu-plovdiv.bg

In the era of Industry 4.0, the improvement and deployment of robotics and artificial intelligence are key not only for industry but also for people's daily lives. Human safety when working in a shared workspace with robots remains a top priority. In this regard, new artificial intelligence algorithms are being sought to ensure the safe performance of tasks in this shared environment.

Collaborative robots are an evolutionary offshoot in industrial robotics. Their main advantages are based on the ability to work together with a human, guaranteeing the highest degree of safety, without dividing into work cells. This in turn guarantees fast and inexpensive reconfiguration of work lines, efficient robot-human collaboration, optimization of work areas and spaces, etc. In parallel, collaborative robots pose a number of challenges, mainly related to ensuring both safe robot-human interaction [5] and information security [6].

A speed control algorithm has been developed based on the consideration of two main factors: the robot position and the recognition of a human and/or an object in the robot workspace. The current position of the robot and the sensor information collected from the laser barrier and magnetic sensors in real time were used for speed control. Experiments

were conducted with a Mitsubishi RV-5AS-D collaborative robot to verify the effectiveness of the proposed algorithm. The experiment involves controlling the cobot in different predefined areas and forcibly activating one/some of the sensors to investigate the motion velocities.

The experimental results show that the developed algorithm provides an increase in the safety performance of the Mitsubishi RV-5AS-D manipulator. Logical speed control by defining work zones and imposing constraints as a result of sensor information collected from the laser barrier and magnetic sensors in real time were used for speed control. Experiments were conducted with a Mitsubishi RV-5AS-D collaborative robot to verify the effectiveness of the proposed algorithm. The experiment involves controlling the cobot in different predefined areas and forcibly activating one/some of the sensors to investigate the motion velocities.

The experimental results show that the developed algorithm provides an increase in the safety performance of the Mitsubishi RV-5AS-D manipulator. Logical speed control by defining work zones and imposing constraints as a result of sensor information collected from the laser barrier and magnetic sensors in real time were used for speed control. Experiments were conducted with a Mitsubishi RV-5AS-D collaborative robot to verify the effectiveness of the proposed algorithm. The experiment involves controlling the cobot in different predefined areas and forcibly activating one/some of the sensors to investigate the motion velocities.

The experimental results show that the developed algorithm provides an increase in the safety performance of the Mitsubishi RV-5AS-D manipulator. Logical speed control by defining work zones and imposing constraints as a result of sensor information received about the presence of an object in the range of motion ensures a higher level of safety when working in the shared workspace between human and robot. The application of the algorithm is successful under properly defined conditions, depending on the specific case and application, requiring a good knowledge of the manufacturing process technology. The precise definition of work zones, the correct selection of movement speeds in each zone, and the imposition of an appropriate speed limit when an object is detected within the workspace are of utmost importance to achieve optimal collaboration for high process performance and increased operational safety for humans and machines.

Tihomir Stoyanov is 1st year PhD student at the Technical University Sofia branch Plovdiv, Department of Control Systems. He has MSc and BSc degrees in Automation, Information and Control Technology from Plovdiv branch of Technical University of Sofia. His PhD research interests and activities are in Robotics, Artificial Intelligence, and Machine Vision.

Position-based Visual Control of Mobile Manipulator

Tihomir Stoyanov

Control Systems Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
stoyanov.tihomir@tu-plovdiv.bg

Robots are getting more and more in our lives. The trends are that robots and humans should work together, sharing the same environment. Numerous companies are working on consumer robots that can navigate their surroundings, recognize common objects, and perform simple chores. In the industry many companies are developing collaborative industrial robots. With all those inventions comes the question of safety and its implementation.

Usually those robots are assembled with variety of sensors to ensure the safety of the people that are collaborating with the robot. Force sensors are used for collision detection, so if the robot collapse with a human or surface to not damage either, visual and lidar sensors are used for recognition of humans, objects, environment and moving through the environment, etc.

A mobile manipulator system is in development that consists of: mobile robot - KUKA YOUBOT, robot arm - KINOVA JACO 2, lidar sensor - SICK TIM 551 and visual sensor - COGNEX 7402C. The task that the system is currently used for is recognizing and opening a door. For that task the lidar sensor is used for recognizing the door and moving the mobile robot to the door and orienting the mobile robot infront of the door. The visual sensor is used for detecting and locating the door handle. Thereafter, the robot arm is used to open the door, manipulating the handle.

Antoniy Petrov is a 2nd year PhD student at the Technical University of Sofia, branch Plovdiv, Control Systems Department. He has a MSc degree in Software technologies from University of Plovdiv and BSc degree in Electronics from Plovdiv branch of Technical University of Sofia. His PhD research interests and activities are in Development of Algorithms and Programs in Control and Automation systems.

Algorithms and Programs development to Ensure Production System operation with Network Communication

Antoniy Petrov

Control Systems Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
a.petrov@std.tu-plovdiv.bg
antoniy.petrov@gmail.com

The field of information and communication technologies is defined as one of the current areas of development of science and innovation in the world. Modern industrial automation is based on the integration of achievements in the fields of information, control, and communication technologies. In this meaning, the work is focused on developing solutions, algorithms, and programs to ensure the operation of intelligent production systems with network communication. The tasks are aimed at designing specialized modules for data collection and processing for diagnostics and notification in the maintenance and management of production processes. The research and analysis provided in the dissertation are focused on developing a comprehensive system for predictive support to help operators to make adequate decisions based on the accumulated, summarized and stored in a special database experience. It is planned to analyze in detail the existing methods for maintenance of technological facilities and sites, and their positive and negative sides will be analyzed. Existing software systems and standards for predictive diagnostics and maintenance will be thoroughly researched and analyzed. Based on the requirements for the predictive support system, the aim of this dissertation will be formulated. A widely used approach is based on data from previous developments and the current state of the forecasting process to determine how much time is left before failures occur. The time remaining until the failure occurs is called "Remaining Useful Life (RUL)", which means "remaining useful time". Predictive maintenance is based

on the condition, performed as a result, of a prognosis obtained from the analysis and evaluation of significant parameters of degradation of an element of the facility. It is planned to develop a software module to support decision-making on the condition, using intelligent methods for predictive diagnostics. The idea is to develop a module for analyzing production and reducing losses by using various algorithms and methods. The prognosis development for of the RUL, the ways of decision-making in the presence of alternatives and proposals for a model will be goal finding solutions and applying to the industrial system. The requirements for automated systems are becoming higher, and their performance is improved through the methods of self-optimization, self-configuration, self-organizing logistics, adaptive diagnostics.

So far the recent work is presented and published in two papers:

1) A. Petrov, A. Taneva, Network Design for Gathering Data in Manufacturing Process, International Conference AUTOMATICS AND INFORMATICS`2022, October 06 - 08, 2022, Varna, Bulgaria (ICAI'22), **DOI:**10.1109/ICAI55857.2022.9960027

2) A. Petrov, A. Taneva, Process Inspection and Data Collection for Manufacturing, International Conference AUTOMATICS AND INFORMATICS`2022, October 06 - 08, 2022, Varna, Bulgaria (ICAI'22) **DOI:**10.1109/ICAI55857.2022.9960000

Pavel Radev is 2nd year PhD student at the Technical University Sofia branch Plovdiv, Control Systems Department. He has a MSc and BSc degree in Automation, Information and Control Systems from Plovdiv branch of Technical University of Sofia. His PhD research interests and activities are in the field of robotics.

ALGORITHMS AND METHODS FOR INCREASING THE OPERATIONAL EFFICIENCY OF INDUSTRIAL MANIPULATORS

PAVEL RADEV

Control Systems Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
pavel_radev1@abv.bg

Research related to increasing operational efficiency and efficiency in the operation of industrial manipulators is essential in modern industrial production, which is extremely competitive and dynamic.Many requirements are placed on robotic productions, such as: high productivity (time for execution of operations), high accuracy and repeatability of operations, the highest degree of safety, energy efficiency, spatial optimization and others. Decisions to meet such requirements often lead to mixed results.

In the present dissertation will be considered algorithms and methods to increase the operational efficiency of industrial manipulators, based on the appropriate choice of control laws, technological parameters and modes of operation. The aim is to analyze and evaluate existing dependencies, as well as to propose algorithmic solutions in the field of control of industrial manipulators.

The considered problem is extremely topical with wide possibilities for industrial implementation of the obtained technical solutions. The dissertation would be essential as a theoretical summary and systematization of algorithmic solutions based on rapidly evolving technical solutions in the field of industrial manipulators.

Velyo Vasilev is a third year PhD student at the Technical University Sofia branch Plovdiv, Department of Computer Systems and Technologies. He has a MSc and BSc degree in Computer Systems and Technology from Plovdiv branch of Technical University of Sofia. His PhD research interests and activities are in algorithms for virtual agents in high-risk environments.

New Algorithms And Models For The Work Of Intelligent Assistant Agents in a High-Risk Environment

Velyo Vasilev

Computer Systems and Technologies Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
velyo.vasilev@tu-plovdiv.bg

The goal of the dissertation work is to develop and research new models and algorithms for the operation of intelligent assistant agents in a risky environment. Research is focused on the modeling of a virtual 3D simulator and virtual 3D intelligent agents to be assistants in an electric substation or an object of the electric power system for medium and/or high voltage. For the training of the virtual agents, it is planned to develop and study the work of a modification of the Reinforcement Learning algorithm, which is expected to be useful for finding an optimal evacuation route in the event of dynamic accidents. The environment model includes: visualization of the electrical equipment; visualization of signs that indicate damage to their surface such as cracks, oil stains, rust, etc.; visualization and sound signal in case of an emergency such as fire, corona discharge, sparks, broken connection, etc. It is necessary to study the behavior of intelligent agents in a familiar environment that includes uncertainty and dynamism, which is due to the randomly occurring emergency situations.

The expected results of the dissertation work will be of a scientific and applied nature in the field of artificial intelligence and intelligent systems. Such a simulator, a model of a smart electric substation and virtual agents-electricians would contribute to improving risk analysis

when working in these environments, to increasing the situational awareness of personnel, as well as to making organizational decisions regarding the construction and operation of electrical objects and facilities. The research in the dissertation work covers a large part of the technologies indicated as key in the "Concept for Digital Transformation of the Bulgarian Industry" adopted in Bulgaria (Industry 4.0), such as: artificial intelligence and cognitive systems, machine self-learning, autonomous agents, simulations, virtual reality (VR), digital platforms and others. Augmented, virtual and mixed reality technologies are considered strategic and open up new opportunities for science and scientific researchers.

Milka Kuceva is third year PhD student at the Technical University of Sofia, branch Plovdiv, Faculty of Computer Systems and Technologies. The subject of her PhD thesis is „Methods and tools for building cloud-based intelligent sensor systems". Milka holds a MSc degree in Computer Science from the same university. Her PhD research is related to energy efficiency in Smart Home.

Achieving Energy Efficiency in Smart Home by Using Machine Learning Algorithm for Prediction

Milka Kuceva

Computer Systems and Technologies Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
m.kuceva@std.tu-plovdiv.bg

Smart Home system utilizes the network connections between users and devices and offering monitoring and management of the devices and logging their measurements (if any) to be used for further analysis for various purposes such as predictions or anomaly detections. The focus is on applying machine learning algorithms to make predictions in order to achieve energy efficiency in smart homes.

The operation and control of the conventional energy grid system can be considerably improved by the IoT-enabled Smart Energy Grid system that is equipped with intelligent two-way data communication. These enhancements target the conventional grid system's dependability, adaptability, and efficiency. The system in a smart grid environment must offer services like the extensive integration of distributed renewable energy sources, real-time data communication between customers and service providers regarding tariff information and energy consumption, the facility to collect and transfer statistics of system parameters for analysis, and infrastructure to carry out necessary actions based on those analyses. Machine learning projects can be used to predict future energy use.

The proposed approach for a smart solution provides the prediction of the monthly energy consumption of Smart Home, using ML.NET. In order to achieve energy efficiency in Smart Home is used machine learning approach, including Forecasting and more specifically SSA algorithm. Forecasting task uses past time-series data to make predictions about future behavior.

A machine learning framework for .NET is called ML.NET. Machine learning may be incorporated into .NET applications using ML.NET, in both online and offline settings. A machine learning model is the foundation of ML.NET. The model outlines the procedures necessary to convert the input data into a prediction.

Stefan Lishev is PhD student at the Technical university of Sofia - branch Plovdiv, Faculty of Electronics and Automation (FEA). He received B.Sc. degree in "Computer Systems and Technologies" in 2008 and a M.Sc. degree in 2010. The subject of his PhD is „Methods and means for remote measurements of atmospheric air parameters . He works now at the Department of Computer Systems and Technologies. His main interests are embedded systems, artificial intelligence, digital signal processing, Internet of Things. In the last year Stefan has two published articles in the field of his PhD thesis.

Methods and Means for Remote Measurements of Atmospheric Air Parameters

Stefan Lishev

Computer Systems and Technologies Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
stefan_lishev@tu-plovdiv.bg

Measuring different parameters of atmospheric air is important for air pollution control, monitoring of CO2 in the light of global warming, weather forecasting, environment monitoring for public safety and etc. Air quality is one of the most important factors for human life. It is vital to monitor indoor and outdoor air parameters and to do appropriate measures. In the recent years the technology advances increasingly and that makes possible to produce many types of low-cost sensors and microcontrollers that have low power consumption.

Poor air quality is one of the key factors that contribute to low quality of life and also to number of diseases, including cardiovascular and pulmonary. The pollutants that contribute to poor air quality in cities are mainly from on-road vehicles and can be classified in two groups – primary and secondary. The first group are produced directly by pollution sources like gases from combustion, some of which are Nitrogen Oxides NO2, Sulfur Dioxide SO2, CO and CO2, or particulate matter (PM) with various sizes, for example fine particles PM2.5. PM in atmosphere are complex mixtures of elemental carbon (EC), organic carbon (OC), mineral dust and water aerosols. Within this group are organic compounds, classified as Volatile Or-

ganic Compounds VOC. Some of them are benzene, toluene, ethylbenzene, and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and polychlorinated dibenzo–p–dioxins and dibenzofurans (PCDD/Fs). They are mutagenic and possibly carcinogenic. The other group – secondary pollutants are produced not directly but as a reaction in the atmosphere from the primary contaminates. One example is Ozone O3, which is toxic. So, it's important to monitor outdoor as well as indoor air quality in order to take appropriate measures such as frequent ventilation, managing traffic in big cities or increasing green spaces in urban areas.

Sensors that are examined are of different types – from the metal oxide class as well as low-cost particulate matter sensors. Meteorological parameters of atmospheric air are of interest because of their link with air pollution. The system under development uses heterogenous LPWAN wireless protocols like LoRaWAN, 802.15.4 for different use scenarios – stationary and mobile measurements. The results from the measurements are stored in database and presented to the user in the form of web page.

Georgi Iskrov is PhD student in his third year at the Technical University of Sofia - branch Plovdiv, Faculty of Electronics and Automation (FEA). He has a Msc degree in Automation and System Engineering from the Aviation Faculty "Georgi Benkovski" of the National Military University. His PhD research interests and activities are in the security provided by blockchain technology.

Research And Implementation Of Blockchain-Based Network Security

Georgi Iskrov

Computer Systems and Technologies Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
g.iskrov@std.tu-plovdiv.bg

A blockchain is a distributed ledger that is completely open to any and everyone on the network. Once an information is stored on a blockchain, it is extremely difficult to change or alter it. Each block in a blockchain network stores this information along with the hash of its previous block. A hash is a unique mathematical code which belongs to a specific block. If the information inside the block is modified, the hash of the block will be subject to modification too. The connection of blocks through unique hash keys is what makes blockchain secure.

For the realization of the practical task and the demonstration of the properties of smart contracts in combination with blockchain technology, an appropriate example was the creation of an election system.

The concept of the voting system is this: A hypothetical case of student council elections is being considered. Where each candidate struggles to garner as many votes as possible under the proportional system. In general, the system has the possibility to have elections on a majority basis, but therefore a two-round vote will be required for the First to be on the proportional system and to proceed to the second round only the first two. The second round will be held on a majority basis, with the winner to win having to collect 50 + 1% of the votes.

For the program itself, whether it will be on the proportional system is a matter of setting up the already created smart contract. Using the Solidity programming language, along with a javascript application as the start of the process. In combination for seamless operation, the following applications will be used simultaneously to build the structure and interconnections of the project. Different text editors can be used for text editor encoding using the Solidity language. For my convenience, I used Sublime Text Build 4.1.2.6 portable version. For the purpose of the experiment, Ganache v2.5.4 win x64 was used to simulate blockchain locally in the background with simulated accounts each with 100 ETH, which are virtual, useless in a real Ethereum chain because they are not real and are quite safe to operate. The 10 accounts will simulate our voters in student elections. In parallel used MetaMask, this plugin for Google Chrome, this application essentially allows to connect to the local blockchain simulated by Ganache or in other words turns Google Chrome into blockchain browser. Node Pakade Menager (NPM) can be used, but javascript engin Chrome's V8 node v16.16.0 x64 was used for the purpose of the experiment to create the node file.js. Truffle v 5.5.24 will be used to create the decentralized application in the Ethereum blockchain. In this environment, the smart contract will be tested on the local copy of the blockchain and the contract in the main blockchain will be implemented.

In conclusion, I will note that smart contracts are a revolutionary and interesting way to demonstrate the capabilities of blockchain technology. It is undeniable that the decentralised system stores the data in the distribution book, the integrity of the data is guaranteed and undeniable. Vices of modern times such as corruption and cyber attacks are not a threat to the ability of smart contracts to guarantee data privacy. A very important aspect is drastic cost reductions as the parties involved are reduced while giving more control to more people. This not only saves money, but also shows the reduced environmental impact, because a drastically smaller amount of documentation is needed, and thus fewer resources to complete the electoral process.

Radoslav Furnadzhiev is a 3rd year PhD student at the Technical University Sofia branch Plovdiv, Faculty of Computer Systems and Technologies. He has experience with rapid development of enterprise applications for Continuous Integration & Deployment. His PhD research interests and activities are in exploring Orchestration and Coordination architecture patterns for achieving scalability and availability in modern containerized applications. Radoslav holds an MSc degree in Computer Science from the same university.

SCHEDULING AND RESOURCE ALLOCATION OF CONTAINERIZED APPLICATIONS

RADOSLAV FURNADZHIEV

Computer Systems and Technologies Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
rfurnadzhiev@tu-plovdiv.bg

Cloud computing has gained a major foothold in information technology in recent years. It has allowed for easy on-demand access to computational resources and provides many advantages to its users like automatic scaling, ease of management, and dynamic resource pooling. Several architectural styles have been developed that leverage these technologies for developing and deploying complex software solutions.

Containerization is an increasingly popular technique for packaging and deploying cloud-based applications. It involves encapsulating an application and its dependencies into a container image that can be run consistently across different environments. Wide adoption of containerization technologies like the container orchestration platform Kubernetes that enables the deployment, scaling, and management of containerized applications in a cloud environment. The process of scheduling containerized applications on a Kubernetes cluster is a complex and challenging task that requires advanced algorithms and techniques. Scheduling can be designed to be reliable and predictable, ensuring that workloads run smoothly and without disruption.

Teodora Mecheva completed the work on her PhD thesis at the Technical University Sofia branch Plovdiv, Department of Computer Systems and Technologies in January 2023. The objectives of her research are the study of the methods and means of implementing an Intelligent Road Transport System, the opportunities for transferring concepts for analysis and design, and the applicability of technologies for achieving efficient traffic.

Road Network Throughput Evaluation via Network Calculus

Teodora Mecheva

Computer Systems and Technologies Department
Technical University of Sofia-branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
teodora.mecheva@std.tu-plovdiv.bg

The road traffic congestion issue is deepening every year due to economic growth and urbanization. Limiting the impact of congestion would influence the environmental footprint, road safety and good user experience. Road traffic optimization measures include both conventional means such as promoting the use of public transport and traffic lights optimization, as well as high-tech solutions such as automated driving, advanced navigation systems and cloud-based traffic control systems.

Due to the complexities of the road traffic systems and safety regulations real-life experiments and even test-beds are rarely applicable. The main approaches for road traffic analysis are mathematical and simulation modelling. The degree of correspondence between the model and the real system determines the validity of the model. The results of the two approaches are usually compared. Most often graphs or queues are used to represent the network.

The present study explores Network Calculus applicability to road network throughput evaluation. As an use case is build SUMO (Simulation of Urban MObility) simulation model over the road network of the central part of the city of Plovdiv based on synthetic data. Two road traffic optimization methods are investigated - autonomous vehicles and intelligent traffic lights.

Network Calculus (NC) is a tool often applied in Quality of Service analysis of computer

networks. It is used for worst-case analysis of differentiated flows. Network calculus is based on systems theory, but applying Min-Plus algebra (where addition is substituted by finding the minimum and multiplication is substituted by addition). Basic quantities are arrival curve and service curve - non-decreasing cumulative functions representing the number of units entering or leaving the system at time. Other commonly used metrics are departure curve, virtual delay and backlog. Due to the analogy with computer networks, NC can also be applied to transport networks.

Present work analyzes the influence of optimized traffic lights and autonomous vehicles via two NC metrics - virtual delay and backlog. Maximal values of virtual delay and backlog based on departure and arrival curves extracted from simulation are compared. The juxtaposition of various ratios between conventional and autonomous vehicles and adapted and coordinated traffic lights show that autonomous vehicles and adapted traffic lights would increase road traffic throughput.

Jordan Genoff is a PhD student at the Department of Computer Systems and Technologies in the Technical University of Sofia. He has a MSc degree in Computer Engineering from the same university. His PhD research is in the computational aspects of the biological nano-structures simulations.

Localization of Intensive Floating-Point Computation Kernels by Mixed Static and Running Code Analysis

Jordan Genoff

Computer Systems and Technologies Department
Technical University of Sofia, branch Plovdiv
Tsanko Dyustabanov 25, 4000 Plovdiv, Bulgaria
jgenoff@tu-plovdiv.bg

There is a vast amount of existing scientific software available these days, in which tremendously massive and complex floating-point computations take place. For a variety of reasons, that all fit in the concept of code reengineering, it is often necessary to revise the most computationally intensive parts of the program text, and these, as a rule, are saturated with floating-point numerical values processing. Hence the inevitable need for efficient solution to the problem of localizing such computation kernels.

The approach presented here is aimed at cases where the target software is available in source code, preferably in C/C++ language. The basic idea is to embed multiple counters in the executable code, one for each line or each procedural block of source code. Each counter undergoes an update every time the execution passes through the corresponding row or block. There are different types of counters, depending on execution of what exactly they count, e.g. lines/blocks of code at all or lines/blocks containing floating-point operations, etc. All counters are available for reading their current values at any time during execution, especially at its end. It is perfectly clear that all of the above must not affect in any way the basically inherent program operation, as it is without any counters. Thus collected counter values are fed to a sophisticated analysis, which gives a quantitative assessment about how much each code line/block may comprise a computationally intensive floating-point kernel.

List of Authors

List of Topics