Abstract Proceedings

Of

TC17-VRISE2021

A VIRTUAL Topical Event of
Technical Committee on Measurement and Control of Robotics (TC17)
International Measurement Confederation (IMEKO)

Theme:
" Robotics for Risky Interventions and Environmental Surveillance "

Friday, October 8, 2021

Event Coordinators:
Prof em Y.Baudoin (ICI/RMA/ER KC) ,Vice-Chair TC17,
M.Y.Dubucq (Dir ICI), Prof O.Tokhi (CLAWAR), Dr Ir Zafar Taqvi (Chair IMEKO(TC

Logistic Host/Coordinator: IEEE Region 5 Galveston Bay Section

Message from the Event Chairs

Prof EM Yvan Baudoin (TC17 Vice-chair)

Dr Ir Zafar Taqvi (TC17 Chair)

An International workshop on Measurement and Control of Robotics, focusing among others on virtual reality, risky intervention and environmental surveillance. This will follow the successful 7th IARP-RISE'2015 held at the Portuguese Naval Base (BNL), the 8th and 9th RISE' 2017/2019 held at ICI, Belgium , the ISMCR'2018, 2019, 2020 held in Belgium, US ,and Hungary. It is aiming to gather high quality original contributions with the final goal of assessing the most recent developments in this utmost domain of science and technology. The Session scope covers a broad spectrum ranging from advanced conceptual and virtual design and methodology, sensors, actuators, instrumentation, and real-time control algorithms to innovative robotics, mobile (ground/aerial/undersea) robotics, personal and collective protection, multilevel rescue operations and management applications. It will contribute to provide a full picture of the state-of-the-art in the area of increasing risk or industrials

PROGRAM

Friday October 8, 2021

Time- US Central (Houston, Chicago)

6:00AM-11:00AM US-Central, 8:00AM-01:00PM Brazil, 1:00PM-6:00 PM Central Europe, 4:30 PM-9:30 PM India , 8:00PM-1:00AM Japan

6:00 AM US-Central	Welcome Dr Zafar Taqvi, TC17 Chair
6:05 AM	**Keynote: Mobile RobotsSupporting Risky Interventions, Humanitarian actions and Demining in particular- promising DISARMADILLO Tool.** E.Cepolina (Snail-Aid, Italy) patfordemining@gmail.com; Italian Institute of Technology (IIT), Italy) emanuela.cepolina@iit.it G.De Cubber, Y.Baudoin (RMA, ICI, Belgium) geert.decubber@mil.be, yvan.baudoin@ici-belgium.be
6:35 AM	**1-Twisted and Coiled Polymer Muscle Actuated Soft 3D Printed Robotic Hand with Peltier Cooler for Drug Delivery in Medical Management** Pawandeep Singh Matharu[1,2], Rippudaman Singh[1,2], Sanjana Mohapatra[1,3], and Yonas Tadesse[1,2,3,4] [1]The Humanoid Biorobotics and Smart Systems (HBS Lab) [2]Department of Mechanical Engineering [3]Department of Biomedical Engineering,[4]Department of Electrical & Computer Engineering The University of Texas at Dallas Richardson, Texas, USA PSM:psm200001@utdallas.edu, RS: rxs200052@utdallas.edu, SM: sxm200036@utdallas.edu, YT: Yonas.Tadesse@utdallas.edu
6:50 AM	**2-Jelly-Z: Twisted and Coiled Polymer Fishing Line Muscle-actuated Mini-Jellyfish Robot for Environmental Surveillance and Monitoring** Pawandeep Singh Matharu[1,2], Yara Almubarak[1,2], Akash Ashok Ghadge[1,2], and Yonas Tadesse[1,2,3,4] [1]The Humanoid Biorobotics and Smart Systems (HBS Lab) [2]Department of Mechanical Engineering [3]Department of Biomedical Engineering,[4]Department of Electrical & Computer Engineering The University of Texas at Dallas Richardson, Texas, USA PSM:psm200001@utdallas.edu, YA: yara.almubarak@utdallas.edu ,AAG: akashashok.ghadge@utdallas.edu , YT: Yonas.Tadesse@utdallas.edu
7:05 AM	**3-Path planning for data collection robots** Sára Olasz-Szabó, István Harmati. Dept. of Control Engineering and Information Technology Budapest University of technology and Economics, Budapest, Hungary olasz-szabo.sara@edu.bme.hu, harmati@iit.bme.hu
7:20 AM	**4- Adaptation of event systems course to accommodate online teaching with a simulated mobile robot** 1st Adam Sojka *Institute of Robotics and Cybernetics Slovak University of Technology in Bratislava* Ilkovičova 3, 812 19 Bratislava, Slovakia adam.sojka@stuba.sk 2nd Andrej Babinec *Institute of Robotics and Cybernetics Slovak University of Technology in Bratislava* Ilkovičova 3, 812 19 Bratislava, Slovakia andrej.babinec@stuba.sk 3rd Martin Dekan *Institute of Robotics and Cybernetics Slovak University of Technology in Bratislava* Ilkovičova 3, 812 19 Bratislava, martin.dekan@stuba.sk
7:35 AM	**5-Energy autonomy of unmanned ground platforms applied to Robotics for Risky Interventions and Environmental Surveillance** *Authors: Mikołaj ZARZYCKI[1], Magdalena DUDEK[2], Andrzej MASŁOWSKI[1]*

	[1] Łukasiewicz Research Network – Industrial Research Institute for Automation and Measurements PIAP, Al. Jerozolimskie 202, 02-486 Warszawa, Poland [2] AGH University of Science and Technology, Faculty of Energy and Fuels, al. A. Mickiewicza 30, 30-059 Kraków, Poland Co4-rresponding author: mikolaj.zarzycki@piap.lukasiewicz.gov.pl
7:50 AM	**6-An Implementation of Low-Cost System-on-Chip with Neural Network for Surveillance Cameras** Xiaokun Yang, Assistant Professor, Engineering Department, University of Houston – Clear Lake , USA YangXia@UHCL.edu
	Break
8:20 AM	**7-iGrab Duo: Novel 3D printed Soft Orthotic Hand Triggered by EMG signals** Authors: Irfan Zobayed1,2, Drew Miles1, and Yonas Tadesse1,2,3,4 1Humanoid, Bio-robotics and Smart Systems (HBS) Lab, Mechanical Engineering Department, The University of Texas at Dallas 2Biomedical Engineering Department, The University of Texas at Dallas 3Electrical and Computer Engineering Department, The University of Texas at Dallas 4Alan G. MacDiarmid Nanotech Institute, The University of Texas at Dallas Irfan.Zobayed@utdallas.edu
8:35 AM	**8-UAV Assisted Pathfinding in Flooding Area** P. Fadimiroye, J. Lu and D. McDowell, University of Houston-Clear Lake, USA FadimiroyeP9469@UHCL.edu
8:50 AM	**9-Kinematic Redundancy Resolution for Robots used in Disaster Search/Rescue and Medical Operation** Khoa Le, Luong Nguyen, Thomas Harman, Computer Engineering Department,University of Houston Clear Lake, USA khoale0316@gmail.com
9.05 AM	**10-A simple NBV selection method for smoother exploration of unknown environments** Adonisz Dimitriu Department of Control Engineering Budapest University of Technology and Economics Budapest, Hungary d.adonisz96@gmail.com Istvan Harmati Department of Control Engineering Budapest University of Technology and Economics Budapest, Hungary harmati@iit.bme.hu
9:20AM	**11-Micro robot for intravascular therapy**" Divyang Patel, Anand, Gujarat, INDIA kachhiadivyang@gmail.com
9:35 AM	**12-Oil Exploration – Role of numerical simulation and inversion** Dr. Gulamabbas A. Merchant, Electra-Magnetic Research and Development gabbas@flash.net
9:50 AM	**13-Performance Measurement of Open Shortest Path First Protocol with Failure Recovery in IP Networks** Kehinde Gilbert, Sarhan M. Musa, Electrical and Computer Engineering Department Praire View A&M University Prairie View, Texas kkpokpogbe@pvamu.edu; smmusa@pvamu.edu
10:10 AM	**Concluding Remarks**

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KEYNOTE PRESENTATION

“ Mobile Robots Supporting Risky Interventions, Humanitarian actions and Demining in particular- promising DISARMADILLO Tool”

Dr Ir Geert De Cubber
(RMA-Belgium)

Dr Ir Emanuela Cepolina
Snail-Aid (Italy Patfordemining@gmail.com)

ABSTRACT 1 (Dr De Cubber): The Mobile Robotics Systems begin to emerge in applications related to the security and the environmental surveillance: prevention of disasters, intervention during disasters with all possible kinds of mission ensuring the safety of the human beings.

	Necessity of UGV-UAV-USV-UUV
Earthquake – High Magnitude CBRN Incident Forest Fire Flooding Pandemy Terroristic threat Mine Action Others	Ad-Hoc Cognitive (evolving) Communication Network
	Intervention Area delineation and prioritization (UAV)
	Victim detection/localization (3D vision)(UGV,UAV)
	Stability of buildings evaluation (3D vision, UAV)
	Cognitive Crisis management Information System
	Identification of Harbour floating objects,a.o. (USV, UUV)

A crisis or emergency, as described in the previous table, is a sudden and usually unforeseen event that calls for immediate measures to minimize its adverse consequences. An emergency occurs after a disaster when an immediate response is required and local capacity is insufficient to address and manage traumatic events. To make the crisis management successful, there are many factors to take into account and the amount of information about crisis management can be overwhelming; the organization of such information into a model is the first step in the choice of a crisis management model

The current and future R&D activities will respond to the challenges of adaptive cooperative systems that have never been addressed so far offering practical solutions. Heterogeneous micro-systems will be defined as generic building blocks for embedded application payloads (with integrated hardware/software systems) that will support a specific set of functions dedicated to specific types of contextual scenario, to be carried out through different craft platform (terrestrial, marine, submarine, aerial, spatial). The KN mentions some European projects coordinated by the Royal Military Academy (RMA)

ABSTRACT 2(Dr Cepolina): The mine action community suffers from a lack of information sharing among stakeholders. Since 2004, Snail Aid has been working on DISARMADILLO, a dramatic shift in paradigm: an open source hardware platform for humanitarian demining. Developed mainly thanks to volunteers' work across more than 15 years, the machine is now going to get a push thanks to the project Disarmadillo+, in collaboration between Snail Aid- Technology for Development and the Italian Institute of Technology. The new version of the machine will be improved in terms of manoeuvrability, robustness, versatility, without compromising its characteristics features. The re-design will take into account the need of keeping the cost low and the technology appropriate to the context where it will work. The duality of the machine will also be preserved: the machine will keep easily reconvert able to its original agricultural nature, being developed around a commercial off the shelf power tiller.
The KN presents preliminary results of the research work started within the project and future plans (of Dr Cepolina).

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1-Twisted and Coiled Polymer Muscle Actuated Soft 3D Printed Robotic Hand with Peltier Cooler for Drug Delivery in Medical Management

Pawandeep Singh Matharu[1,2], Rippudaman Singh[1,2], Sanjana Mohapatra[1,3], and Yonas Tadesse[1,2,3,4]
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Abstract

Many robotic hands have been presented in the literature having unique designs and capabilities, focusing on basic problems like sensing, actuation, control, and powering. But most of these robotic hands have been manufactured by manual assembly process until recently. Precise manipulation of objects is required for important clinical procedures for drug delivery applications. This paper presents experimental studies of grasping different objects with a soft 3D-printed robotic hand actuated by customized twisted and coiled polymer (TCP_{NCFL}) muscles using fishing line and nichrome resistive wire, driven by resistive heating and cooled by Peltier mechanism (thermoelectric cooling). The hand can be utilized for pick and place applications of important medicines and other important drugs in clinical

settings, which are repetitive work or hazardous for humans. A combination of ABS plastic (for the rigid parts) and thermoplastic polyurethane (TPU) material (for the joints) is used to additively manufacture the robotic hand. This avoids any involvement of additional assembly of components and allows flexing of the joints. Complete CAD design assembly and the manufactured prototype is presented along with the experimental analysis of the one finger motion with different loading conditions (100 g, 300 g, 500 g). The robotic hand length is 380 mm, and it weighs around 560 g. The fabrication, annealing and training of TCP $_{NCFL}$ actuators coiled with 160 µm diameter nichrome wires is given. Full characterization of TCP $_{NCFL}$ muscles coiled with 160 µm diameter nichrome wires with the influence of different parameters like coiling speeds and its effect on the % change in strain in water is discussed in the paper. The actuation frequency in air for the actuators is usually between 0.01 Hz – 0.2 Hz. This study shows the effect of Peltier cooling on improved actuation frequency, hence aiding in quicker 'pick and place' of drugs. Experiments designed to work with extreme TCP $_{NCFL}$ muscle contractions to analyze the effectiveness of different tightness of grasps in correctly holding objects. Experiments for grasping objects have been performed by integrating flex sensor to determine the force exerted at each phalange and palm positions during various grasping actions of different shapes of objects. Experiments have also been performed with flex sensor integrated at the back of each finger to calculate the bend-extent of each finger while grasping different objects. All these experiments are performed with TCP $_{NCFL}$ novel actuators that are driven by Peltier coolers. Overall, a low-cost and lightweight 3D printed robotic hand is presented in this paper, which significantly increases the speed of actuation performance with the help of Peltier cooling mechanism, that can be used in drug delivery applications in medical management.
Keywords*— robotic hand, artificial muscle, TCP muscles, fishing lines muscles, 3D printed hand, Peltier cooling, biomimetic, grasping, drug delivery*

2-Jelly-Z: Twisted and Coiled Polymer Fishing Line Muscle-actuated Mini-Jellyfish Robot for Environmental Surveillance and Monitoring

Pawandeep Singh Matharu[1,2], Yara Almubarak[1,2], Akash Ashok Ghadge[1,2], and Yonas Tadesse[1,2,3,4]
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Abstract

An underwater soft robot capable of continuously monitoring the surroundings is important for surveillance and home security. Soft robots are flexible, produce less noise disturbance in the underwater environment, lightweight and have many degrees of freedom. Environment monitoring sensors, cameras for surveillance and compliant actuators can be integrated in these robots easily. This paper presents a mini-jellyfish soft robot actuated by twisted and coiled

polymer fishing lines muscles with nichrome (TCP NCFL), a self-coiled structure, capable of performing surveillance of its surroundings with a micro-camera in a lab-based environment. A silicone bell with spring steels is actuated with a set of actuators connected at the bell periphery. A mold is created to cast the Jelly-Z bell with embedded spring steels to compliment the flexibility of the silicone bell. Four different bell designs with different parameters are fabricated, actuated with TCP NCFL muscles. The preliminary vertical swimming performance of the Jelly-Z prototype is performed in a 1.2m X 0.75m X 1.06m swimming tank. The 100 mm diameter, 3 mm thickness and 20 mm passive flap, having 7 mm wide embedded spring steels is actuated with 3, 60 mm. long TCP NCFL muscles was found to swim the maximum distance (305 mm.) in least amount of time (48 seconds) comprising of 16 cycles of actuation. This prototype was connected to ultrathin, flexible 30 AWG stranded copper wires. This structure of Jelly-Z comprising of soft silicon bell embedded with 0.5 mm thick, 7 mm wide spring steels and mimics the biological locomotion of a jellyfish in nature. The fabrication, annealing and training of TCP NCFL muscles coiled with 160 µm diameter nichrome wires is described. A full characterization of TCP NCFL muscles coiled with 160 µm diameter nichrome wires with the influence of different parameters such as the amplitude of input current and its effect on temperature change and amount of strain in air and water, is also discussed in this paper. It is observed that an actuation strain of the muscle is ~30% in air and ~8% in water for an actuation frequency of 0.008 Hz and 0.033 Hz, and duty cycle of 4% and 16.67% respectively. The vertical movement is generated with the flapping of the spring steel embedded silicone bell, that creates a rhythmic pulse motion, mimicking the motion of a real jellyfish. An arrangement of synthetic foam is made for neutral buoyancy. A CAD design has been made, integrating a waterproof micro-camera on top, to perform surveillance of the environment surrounding the robot and aid in monitoring operation. This robot can also be operational in community or personal fish tanks for security purposes.
Keywords— *underwater robots, artificial muscles, fishing line muscles, biome metic, jellyfish, swimming, soft robot, surveillance, monitoring*

Path planning for data collection robots

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Abstract— **Using mobile robots to collect data from wireless sensor network can reduce energy dissipation and this way improve network lifetime. Our problem is to plan paths for unicycle robots to visit a set of sensor nodes in a sensing field with obstacles while minimizing the path lenghts. This paper apply a new approach for handling obstacles in path planning. To design the visiting sequence of nodes and obstacle a new algorithm is developed.**

Keywords— Path planning, Mobile robots, Obstacle avoidance

I. Introduction

In paper [1] Shortest Viable Path Planning (SVPP) algorithm is defined, which is smooth, collision free with sensor nodes and obstacles, closed and let the robot to read all the data from sensor nodes. The main steps of SVPP are outlined as **Algorithm 1**. All objects bounded with safety margin and between two objects always defined four tangents. But any tangents that intersect other objects are removed. The path consist of the adequate confiurations of tangents and arcs around objects at the safety distance.

Algorithm 1- Shortest Viable Path Planning

1. Compute permutation of nodes (Σ) without obtstacles (tangents that intersect obstacles are available at this point)–TSP (Travelling Salesman Problem) with nodes $G(V,E)$
2. Compute permutation (Σ') of nodes and obstacles by adding blocking obstacles to the permutation
3. Simplify tangent graph by keeping the edges and vertices related to permutation (Σ') and deleting others of $G'(V',E')$
4. Convert $G'(V',E')$ to tree-like graph
5. Given an initial configuration, search the shortest path

II. Design of object permutations

We propose a new algorithm instead of the second of **Algorithm 1**. The basic idea is calculating not only one permutation to get better solutions. For example in figure 1 between Node-1 and Node-2 there are only one available tangent. When Obstacle-1 is in the permutation, the available tangent between the nodes is not feasible in the shortest path planning. But when Obstacle-1 is not in the permutation, there may be no solution at all depending on the initial configurations. In addition, our approach also working in the case when there are more obstacles between two nodes so that these obstacles block different tangents. For instance in figure 1 Obstacle-2 and Obstacle-3 are blocking different tangents.

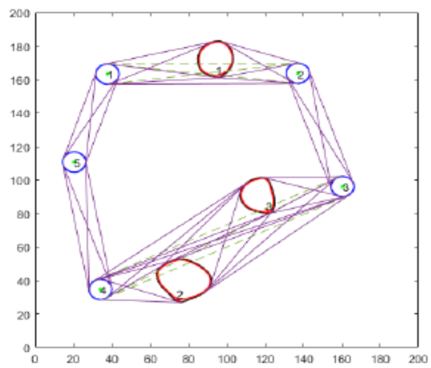

Fig. 1. An example of blocked tangents are illustrated with dashed line

Instead of the second step of **Algorithm 1** we use the following **Algorithm 2**. At first stage we create four copies of Σ, then for every two nodes we determine the blocking obstacles of all the four tangents. When one of the tangents intersects an obstacle, we insert the obstacle to the proper position in the feasible permutation determined by the tangent direction. Note that when more than one obstacles are intersected, they are inserted to the feasible permutation according to their distance from the previous node. Then we eliminate the duplicate solutions, and after this we repeat the previous algorithm as long as we find no new intersected obstacle.

Algorithm 2- Add Obstacles to Permutations

1. Create four copies of Σ permutation
2. For every two nodes determine the blocking obstacles of all the four tangents and insert these obstacles to the proper positions in the feasible permutations according to their distance from the previous node.
3. Eliminate the duplicate permutations
4. Jump to **1.** and repeat the algorithm while there are intersecting obstacles.

Since we have more than one permutations, the tree-like graph became more complex. We construct only one tree-like graph with all permutation nodes and edges. Then we search the shortest path in this graph with Dijkstra algorithm.

III. Simulation Result

We simulate a $200m \times 200m$ virtual field with a set of disjoint 15 obstacles and 40 nodes. The possible tangents to shortest path can be seen in figure 2. Figure 3 shows that the proposed Algorithm uses such tangents also that are not available in the original algorithm. This way we can get shorter overal path length due to the fact that there are more permutations.

IV. Conclusion

This paper studied the problem of planning shortest viable path for unicycle robots. We propose a new algorithm to determine object permutations for path planning.

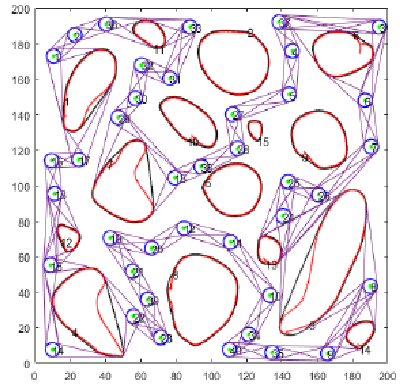

Fig. 2. Simplified Tangent graph

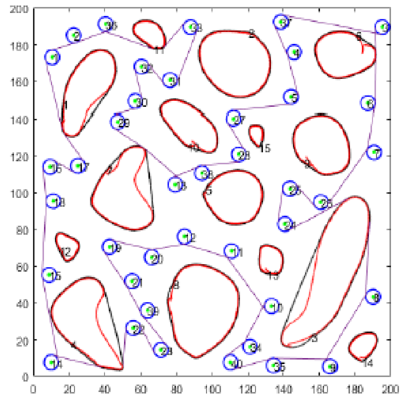

Fig. 3. Planned path

Acknowledgment

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References

[1] Hailong Huang, Andrey V. Savkin Viable path planning for data collection robots in a sensing field with obstacles, Computer Communications 111 (2017) 84-96

4. Adaptation of event systems course to accommodate online teaching with a simulated mobile robot

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Abstract

As the pandemic and closure of all educational institutions continues, an opportunity to solve challenge of teaching university courses online emerges. The biggest challenge educational institutions face is education in the fields that require any kind of hardware interaction. The event systems course brings its own set of challenges in online teaching that we illustrate in this paper. The original university course is focused on teaching event systems and applying the learned principles and technologies directly to hardware.

Originally students used Matlab Stateflow to create control algorithms using modeling tooltatechart which in turn were implemented to a hardware mobile robot to test the algorithms. We have decided to develop a Robot Operating System packages that would simulate the hardware authentically, which will bring a real experience with a hardware to the students. This adaptation of the course will help the students to get a real grasp on issues they may encounter in real applications, like communication latencies, disruptions, security issues, hardware limitations etc. The adapted course teaches the students to control a mobile robot with differential drive over a network and to navigate in a generated labyrinth. The robot has available odometry, range finders in four directions and tactile sensors which suffices for reactive navigation of the robot. All software and materials needed to get the simulations work are available to all interested in online repositories: https://github.com/Smadas/create_control_ros

Key Words – education, ROS, Gazebo, hardware, mobile robot, simulation, event systems, Matlab,

5-Energy autonomy of unmanned ground platforms applied to Robotics for Risky Interventions and Environmental Surveillance

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Abstract

CBRNE incidents take place mostly in the danger zone, where exist real threat to human life or health. In order to prevent or immediate the direct threat, specialized robots equipped with various detectors, actuators and remote control are sent in place of people. This approach is made possible by the implementation of remote control and autonomous work.

Most instrumentation components and drive systems are powered by electricity from built-in chemical cells. Range and operational capabilities are therefore often determined by energy resources, otherwise known as energy autonomy. The efficiency of mobile solutions is also determined on the basis of the time necessary to replenish energy resources, which in the case of chemical cells is a key parameter. This article will present considerations on the possibilities of expanding and replacing chemical cells by using hybrid power supply based on fuel cells. The development of hydrogen technologies, including modern fuel cells, allows implementation in a variety of applications from mobile vehicles to reactors in power plants.

Due to working conditions and application requirements, the article will focus on hydrogen-oxygen, PEMFC type cells, their advantages and disadvantages in reference to classical electrochemical batteries. Parameters such as source energy density, power density of electrochemical batteries will be analyzed to predict the up time and reliability of the power supply system.

The above considerations will be addressed to the example of a small pyrotechnic robot, called PIAP PATROL produced by Łukasiewicz Research Network – Industrial Research Institute for Automation and Measurements PIAP.

6-An Implementation of Low-Cost System-on-Chip with Neural Network for Surveillance Cameras

Xiaokun Yang
Assistant Professor, Engineering Department,
University of Houston – Clear Lake

The tiny system-on-chips (SoCs) are the center units behind an ever-growing array of edge devices, from security cameras and lightbulbs to doorbells and vacuum cleaners. All these chip designs must satisfy several stringent requirements. First, they must be designed to be secure, safe, and provide privacy for their operations. Second, they must consume small amounts of energy for sensing, computation, and communication. Finally, many such devices include artificial intelligence (AI) capabilities at very low-energy levels.

Therefore, this Abstract proposes a low-cost SoC implementation for surveillance cameras, by integrating a single-layer perceptron (SLP) neural network, a security engine, and an on-chip data path including I2C controller, Image Capture module, and VGA controller. All the design modules are based on author's latest publications [*ISQED 2019, JSC 2021*, *JETC 2018*]. Specifically, the data path enables image capturing via an OV7670 camera and displaying the color images, inter-processing matrices, and the final classification results through a VGA interface [*ISQED 2019*]. The Modified National Institute of Standards and Technology (MNIST) data set is employed to train the SLP network for the typical application of handwritten digit recognition. The approximate design with pipelining and parallel processing structure enables to significantly decrease the complexity of the SLP network and provide a low latency of image classification [*JSC 2021*]. The security engine is implemented based on the dominant symmetric-key cryptosystem – the Advanced Encryption Standard (AES). By improving the data pre-processing scheme, the demonstration shows 1.30× throughput and 71.27% dynamic energy consumption compared with the prior implementation [*JETC 2018*].

Seeing all these modules as design intellectual properties (IPs), the SoC integration is mainly presented in this Abstract using an innovative bus architecture [*IET-CDT 2020, US Patent*]. As shown in Fig. 1, the bus protocol contains one control bus and one data bus. The only master of the control bus is the processor model. All the design IPs are the slaves of the control bus. The only slave of the data bus is the memory controller. All the design IPs except for the I2C controller are the masters of the data bus. Creating with the simple topology and high wire efficiency, the SoC implementation is suitable for devices such as cameras and sensors requiring reduced complexity and ultra-low energy dissipation. Below are the contributions:

1) All the design IPs (except for the SLP network) are written with Verilog hardware description language (HDL) in register-transfer level. Application-specific integrated circuit (ASIC) design rules are adopted to the SoC design and integration, so as to create a potential of taping out the chip and/or improving the field-programmable gate array (FPGA) demonstration in future works.

2) Though this Abstract focuses on the applications of the learning-enabled cameras, the platform can be expanded to integrate various sensors and learning models like convolutional neural network and recurrent neural network. The scalability of the platform provides

research activities for a long time as more design IPs are integrated into the SoC, making new improvements possible.

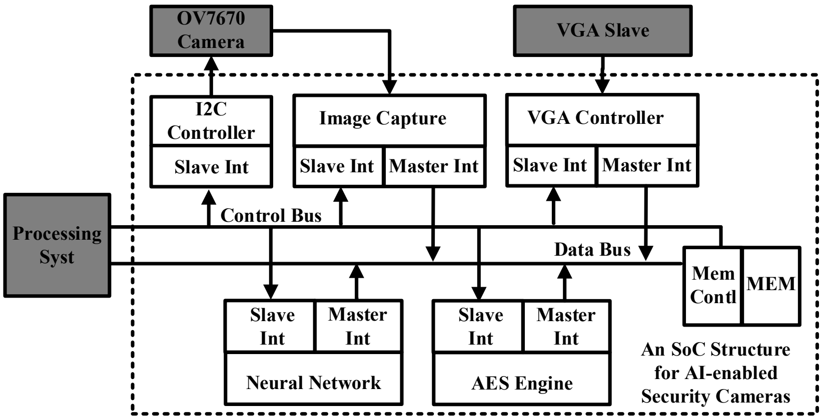

Fig. 1 SoC Architecture

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7- iGrab Duo: Novel 3D printed Soft Orthotic Hand Triggered by EMG signals

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2Biomedical Engineering Department, The University of Texas at Dallas
3Electrical and Computer Engineering Department, The University of Texas at Dallas
4Alan G. MacDiarmid Nanotech Institute, The University of Texas at Dallas

Background

Worldwide, +50 million people suffer from hand motor impairment after stroke or spinal cord injury (SCI), resulting in loss of independence and quality in activities of daily life (ADL) [1]. Unfortunately, these impairments are inevitable – full recovery chances are greatest when treated immediately, but traditional methods require patients to be fully conscious. Hence, concerns regarding the cost of quick and effective treatments are growing globally [2]. Powered hand orthotic devices provide an actuated modular exoskeleton that assist ADL and rehab processes. However, current commercialized designs cost $5k to $80k post-insurance and few designs have been approved for human subject testing, making hand orthotic devices expensive and inaccessible [2]. Furthermore, they utilize conventional actuators, such as motors, that add extra weight, loud noise, and extra weight to the devices, leading to an overall uncomfortable user experience [3].

Experimental Study

At the HSB Lab at UTD, Saharan et al. 2017 [4] developed the iGrab device, which is a 3-D printed powered hand orthotic device that utilizes six novel 2-ply silver coated nylon twisted and coiled polymer (TCP_{Ag}) muscles that are inexpensive and high performance. With an already cost-effective approach, we introduce the iGrab Duo, a fully portable hand orthosis device that uses 4-ply TCP muscles via EMG signals processed with artificial intelligence and powered by custom PCBs and batteries stored in a 3-D printed TPU exoskeleton alongside various sensors.

Traditional EMG signal actuation methods utilize advanced signal processing and pattern recognition; however, the neural control of these devices remains unreliable when attempting to perform muscle actuation similar to natural muscle movement, as discussed by Jafarzadeh et al. [5], who introduces EMG signal processing via deep learning with convolutional neural networks (CNN). Three separate PCBs control the device: (1) the actuation board retrieves filtered EMG signals sent into a 1-D CNN from electrodes, (2) the power board regulates battery to power the device, sensors, and muscles, and (3) the sensor board calculates data points gathered by sensors placed strategically throughout the device. Here we plan to include thermocouples, inertial measurement units (IMU), force sensors, and strain gauges.

Both EMG and sensor signals are processed in the NVIDIA Jetson microprocessor that is powered by a battery pack regulated in a custom circuit that powers each of the six 4-ply TCP muscles and internal sensors – the full relationship is depicted in **Figure 1.** The 4-ply TCP muscles were chosen over 2-ply muscles to increase durability, prolong the life cycle of the muscle and device, and reduce snap-back retention forces while maintaining strong actuation strains.

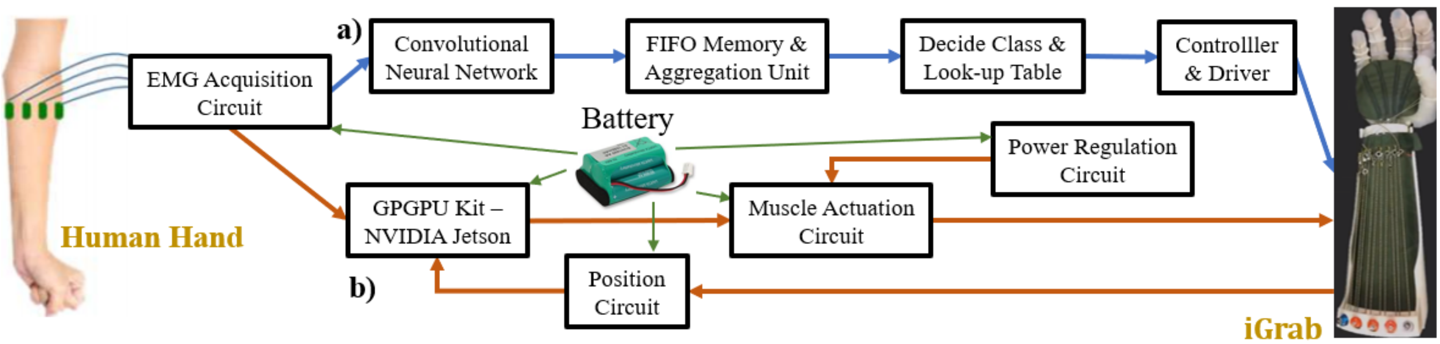

Figure 1. *(a) Block diagram (blue arrows) and (b) hardware diagram (orange arrows) for proposed method to control orthotic hands with raw EMG signals using CNN.*

Greater Impact
Hand impairments are statistically inevitable, and immediate action to rehabilitate these deficiencies is not possible. They decrease quality of ADL, yielding in lost jobs, making rehab unaffordable long-term. The iGrab Duo is portable, high performance, cost effective, and accessible to ensure the greatest chance of recovery. Expanding research in EMG signal processing and its relation to robotic rehabilitation trends will allow researchers and clinicians to develop accessible, cost-effective designs so individuals with hand impairment can return to a regular life.

Word Count (excluding titles, figure captions, and citations): 500

[1] Bützer et al 2020, in *Soft Robotics, Doi: 10.1089/soro.2019.0135*
[2] Yoo et al. 2019, in *Journal of NeuroEngineering and Rehabilitation*, *Doi: 10.1186/s12984-019-0633-6*
[3] Bos et al. 2016, in *Journal of NeuroEngineering and Rehabilitation*, *Doi: 10.1186/s12984-016-0168-z*
[4] Saharan et al. 2017, in *Smart Materials & Structures, Doi: 10.1088/1361-665X/aa8929*
[5] Jafarzadeh et al. 2019, in *IEEE ISMCR, Doi: 10.1109/ISMCR47492.2019.895572*

8-UAV Assisted Pathfinding in Flooding Area

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The ability to provide a rapid response in a time of crisis can be improved with the help of Unmanned Aerial Vehicle surveillance. With the help of High Powered Computer (HPC), more UAV-based applications can be possible. In this project, we will continue using computer vision techniques for multiple targets optimal pathfinding with the assistance of a UAV. The A-star pathfinding algorithm was determined to be the best algorithm for this application due to its use of Edge Weights and Heuristic values. The use of this algorithm is applied in a Graphical User Interface application that converts a real-time image into a grid coordinate system where the “best path” is displayed from a start to an endpoint. An image captured will then progress to a series of still images from a video flyover from the UAV and the algorithm will then cascade the images to create a larger image to map the safest route from point A to point B. It provides a better solution for a path from source to destination. This optimization problem has many real applications such as helping rescue in flooding, fire, or earthquake. The UAV can capture a wider view than humans and with this HPC tested program, the UAV can be an Emergency Service lifeline to provide a robotic birds-eye view for rapid intervention.

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9-KINEMATIC REDUNDANCY RESOLUTION FOR BAXTER ROBOT

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Abstract

A robotic manipulator is said to be kinematically redundant if it has more degrees of freedom than strictly needed for executing a given task. This characteristic is valuable in the design of modern robotic manipulators since kinematic redundancy heavily affects arm motion planning and control, specially for robots used in medical surgery or in disaster search and rescue where dexterity of the robot is essential. In this presentation, we will demonstrate how the redundant degrees of freedom of the manipulator can be exploited to maximize its manipulability, avoid singularities and obstacles while the end effector is following a commanded cartesian coordinates velocity. The subject of applications is the Baxter Research Robot which has two seven-degrees-of-freedom arms.

10. A simple NBV selection method for smoother exploration of unknown environments

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***Abstract*—Next Best View (NBV) method performs well in the autonomous exploration of unknown environments. This paper proposes a novel perspective for selecting the next best position, that effectively deals with corner-like segments of the map and provides a smoother exploration.**

***Index Terms*—autonomous exploration, NBV, search and rescue , surveillance**

I. Introduction

Exploration, search and rescue operations, disaster relief, and surveillance [1] are classical applications of mobile robots, that have been researched actively since robots have the potential to minimize the risks humans could experience in dangerous or hardly accessible environments. For these applications, the robot needs to build a map of the environment in order to execute different tasks (in some cases this task is the exploration itself) in the region.

Frontier-based and information-based approaches are the most studied NBV selection methods in the literature [2]. The information gain method drives the robot towards the area that yields a large amount of new space during exploration. This paper introduces a method that states the opposite: positions with less new information are preferred as the NBV.

II. Methodology

In the current study, an occupancy grid map is utilized to represent the 2D environment. In this representation, each grid has a probabilistic value of being occupied. Based on the occupation values each cell is classified into 3 types of grid cells, which are *occupied cells*, *free cells*, and *unknown cells*. An illustration of such a map can be seen on Fig. 1.

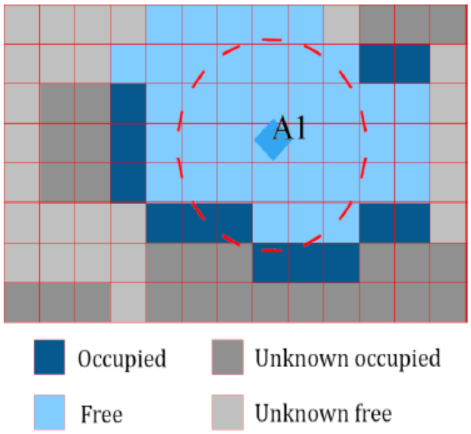

Fig. 1: Occupancy grid map

Frontier-based exploration is motivated by considering frontier cells F (unknown cells that are adjacent to free cells). Information-based NBV algorithms rely on finding the next best position for the agent to efficiently explore the environment. The best position is classically defined by the information gain $I(p)$ of the candidate positions p – typically frontier cells – discounted by the distance from the agent. In the literature, many publications emphasize utility functions that expect large amount of new space at the next best position (*large-gain* NBV). The major disadvantage of these approaches is that they tend to leave out corner-like spaces in the environment, resulting in low-resolution map segments or agents must revisit these particular locations for further exploration. In this paper, a counterintuitive approach is presented: agents are oriented to frontier

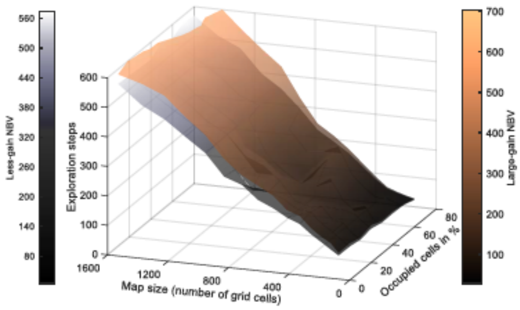

Fig. 2: Comparison of performances on different environments

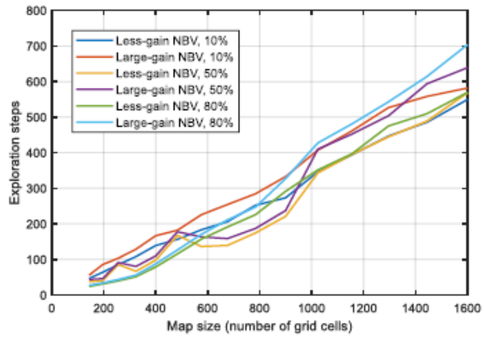

Fig. 3: Performance on 10%, 50%, 80% obstacle concentration

positions with smaller expected information gain (*less-gain* NBV). This means, that corner-like segments of the environment are preferred over large information gain areas. This approach provides a smoother area coverage, because agents do not need to revisit certain parts of the map.

For comparison, we adopt the following expressions for information gain and position selection:

large-gain NBV	less-gain NBV
$I(p) = A(p) \cdot e^{-\lambda_L * c_p}$	$I(p) = A(p) \cdot e^{\lambda_S * c_p}$
$NBV_L = \underset{p\in F}{\operatorname{argmax}} I(p)$	$NBV_S = \underset{p\in F}{\operatorname{argmin}} I(p)$

where the information gain $I(p)$ consists of the new expected area $A(p)$ at position p discounted by its path-cost c_p from the robot. λ_L and λ_S are the tuning parameters of the path-cost, that are determined experimentally. Note, that these utility functions are arbitrarily chosen and are anti-symmetric to each other to illuminate the qualitative difference between the two opposite perspectives.

III. Test Results

Fig. 2 reveals the overall performance of the two concepts in 120 different environments with growing map size and increasing obstacle concentration. Each environment was randomly generated multiple times, with the given parameters and their results were averaged. As the figure illustrates, large-gain NBV required more steps to complete the exploration in all of the averaged instances. Fig. 3 shows that with higher obstace concentration (that means more corners on the map), the less-gain NBV performs increasingly better, than the large-gain NBV scheme.

IV. Conclusion

NBV selection is the most common exploration strategy because it allows a wide spectrum of heuristics to be involved in the planning. Changing the perspective to less-gain NBV provides the means to easily deal with corners of the map and at the same time, it outperforms the concept of the large-gain NBV selection in terms of exploration steps.

Acknowledgment

The research reported in this paper and carried out at the Budapest University of Technology and Economics was supported by the “TKP2020, Institutional Excellence Program” of the National Research Development and Innovation Office in the field of Artificial Intelligence (BME IE-MI-FM TKP2020). The research was supported by the EFOP-3.6.2-16-2016-00014 project - financed by the Ministry of Human Capacities of Hungary.

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11-Micro robot for intravascular therapy

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Abstract

Research in search, rescue, security, risky intervention, and environmental surveillance robotic systems represents a building up challenges for technologies and techniques to benefit human being and enhance quality of life and services. This technology has become the solution to many long-standing problems, and while current technologies may be effective, it is far from fully addressing such huge, complex, difficult and challenging tasks associated with disaster missions and risky intervention. It is well known that disaster locations are too dangerous for human exploration or are physically unreachable while there is a need to make timely decision and extend help for survivors and respond to dangerous situations.

In research and development are needed to enhance performance and reliability of such robotic systems and eliminate/minimize their technical and functional limitations. for suitable and reliable technology along with technical and functional requirements of robotic systems to fulfill task objectives. In addition, it shows that robotic technologies can be used for disasters prevention or early warning, intervention and recovery efforts during disasters with all possible kinds of relevant missions while ensuring quality of service and safety of human beings.

The natural environment while relying only on a single on-board camera as sensory input a dense structure from motion algorithm to calculate a depth map of the environment and a visual simultaneous localization, and mapping algorithm to build a map of the surroundings using image features. The followers try to adapt its own speed according to the information of a generalized along path distance of the leader while minimizing errors. The frontier program of the micro robot for intravascular therapy along with the required specifications and functionalities.

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12-Oil Exploration – Role of numerical simulation and inversion

Oil Exploration - Role of numerical simulation and inversion

Dr. Gulamabbas A. Merchant
Electra-Magnetic Research and Development

Oil is the lifeblood of modern age. There areas on our planet which have been blessed with large deposits of hydrocarbon and then there are places with barely any oil. The search of oil begins with seismic surveys. If potential deposits are detected, wells are drilled in the earth formations. It is important to know how much oil is present, at what depth, whether it is economic to lift it, what contaminants are present. In order to answer these questions measurement tools attached to wires are lowered down the well. The primary parameters of interest are resistivity, porosity and permeability. There are other auxiliary measurements involving such as nuclear, acoustic, micro-seismic, magnetic resonance, mechanical, pressure, temperature etc.

The interpretation of petrophysical data is heavily dependent on numerical simulation of physical processes associated with the measurements. In particular the interpretation of electrical data involves solutions of Maxwell's equations in one, two and three dimensional models of the earth formations.

This presentation will focus on the role of electrical resistivity in determining the presence and quantification of oil. In particular the methods of interpretation and inversion using numerical modeling to quatify the hydrocarbon volume will be presented.

13-Performance Measurement of Open Shortest Path First Protocol with Failure Recovery in IP Networks

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Abstract

One of the most important processes on the internet is the routing of data packets. There are numerous routing protocols that are used on the internet, including OSPF, RIP, IS-IS, EIGRP, IGRP, and others. This paper presents the Open Shortest Path First Protocol (OSPF) convergence time for six routers connected to the same segment using a failure and recovering data scalable model on the topology network. The OSPF protocol demonstrates the performance measurement in terms of network convergence activity time and convergence duration time is illustrate

Keywords: OSPF, routing, convergence, failure recovery and routing protocol

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IMEKO TECHNICAL COMMITTEE ON ROBOTICS (TC-17) ORGANIZATION

https://www.imeko.org/index.php/tc17-homepage/tc17-aims

The TC's main objective is to deal with all aspects relevant to robot sensors, both internal and external ones, such as force sensor, tactile sensor, distance sensor, visual sensor and others, employed in robot motion and navigation control-principle, methodology and applications. Communication sensors interfacing between man and robot are also include.

Sensors and Sensing

- Sensor and Sensing Systems for Vision, Audition and Haptics
- Sensors and Calibration Facilities; Traceability and QS in Robotics
- Sensor Systems in Robotics and Mechatronics
- Signal Processing and Data-Fusion

System Integration

- Robotics and Automation Techniques: Virtual Tools
- Telexistence: Virtual Reality in the real world, Advanced Human Interface
- Mobile Robotics: Locomotion, Actuation, Command and Control
- Multi-agent Robotic Systems

Applications

- Outdoor Applications (environmental surveillance, risky environments, rescue, agriculture, construction, space)
- Indoor Applications (education, entertainment, medical assistance, industry)

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