The Batsheva de Rothschild Workshop on Robotics for Nano-Structure Delivery in Agriculture

Integrating robotics and nano-structure delivery is an exciting new field with promising applications in agriculture. The Batsheva de Rothschild Workshop on Robotics for Nano-Structure Delivery in Agriculture aims to serve as a critical bridge between the fields with in one of their most promising applications fields.

The workshop will bring together leading researchers from the major fields related to robotics and nanostructures in agriculture. It will promote discussion of ideas and development of shared vocabulary and understanding through presentation of key concepts in formal scientific talks, and informal discussions during breaks and social activities.

The workshop will take place August 30-31, 2021, in Akko knights' hostel. The ancient port city of Acre (known to locals Akko) is an UNESCO heritage site with history dating back to the 15th century BCE.

The organizing committee

Sigal Berman (Ben-Gurion University of the Negev), Avital Bechar (Agricultural Research Organization), Elena Poverenov (Agricultural Research Organization), Shlomo Margel (Bar-Ilan University)

Day 1 - lectures			
9:00-10:00	Registration		
10:00-10:20	Welcome - Sigal Berman, Avital Bechar, Elena Poverenov, and Shlomo Margel		
10:20-12:00	**Robotics in agriculture – achievements and challenges - chair: Sigal Berman**		
	10:20-10:40	Prof. Shimon Nof	From Industrial to Agricultural Co-Robotics: The Nano Dimensions and Challenges
	10:40-11:00	Prof. Dionysis Bochtis	Robotized agricultural production - from a "system" perspective
	11:00-11:20	Dr. Victor Alchanatis	Sensing in different scales for site specific operations
	11:20-11:40	Prof. Amir Degani	Aerial and Ground Vehicle Collaboration in Agricultural Applications
	11:40-12:00	Prof. Yael Edan	Robotic harvesting: lessons learned and challenges ahead
12:00-12:45	**Lunch**		
12:45-14:25	**Nano structures for agriculture – achievements and challenges – chair: Elena Poverenov**		
	12:45-13:05	Prof. Shlomo Margel	Engineering of Nano-robotics for medical and agricultural applications
	13:05-13:25	Prof. Antonino Gulino	Nanostructures for Mass-Transport and Delivery
	13:25-13:45	Dr. Guy Mechrez	Pickering emulsions for food and agriculture
	13:45-14:05	Prof. Assaf Yaakobovitz	Physical Nano-Sensors for Monitoring Plants Condition
	14:05-14:25	Dr. Sefi Vernick	Carbon nanotube-based field-effect transistors for bioelectronic nose applications
14:25-14:40	**Coffee break**		
14:40-15:40	**Robotics system engineering – chair: Victor Alchanatis**		
	14:40-15:00	Prof. Francisco Rovira Más	Enabling big data with ground robots
	15:00-15:20	Prof. Nir Shvalb	Swarms Navigation functions
	15:20-15:40	Dr. Avishai Sintov	What's in my/your hand? robot recognition of grasped objects

15:40-16:20	**Coffee break**		
16:20-18:00	**Nano-structure fabrication – chair: Giorgi Shtenberg**		
	16:20-16:40	Dr. Sabine Trupp	Nanomaterials for innovative sensor systems for point-of-care detection and continuous monitoring
	16:40-17:00	Prof. Yossi Shacham	Electrical and Electrochemical plant-based dehydration sensors
	17:00-17:20	Prof. Ester Segal	Nanomaterials for Detection and Mitigation of Microorganisms
	17:20-17:40	Dr. Evgeni Eltzov	Characterization of the selective binding of modified chitosan nanoparticles to Gram-negative bacteria strains
	17:40-18:00	Dr. Giorgi Shtenberg	Nanostructured Optical Biosensors for Agro-pollutants Detection
18:00-22:00	**Tour of Akko and Dinner**		

Day 2 - Round tables - Nano-structure delivery in agriculture			
9:00-10:20	**AVR4Nano - robotic nano-structure delivery for grapes – chair: Sigal Berman**		
	9:00-9:20	Prof. Avital Bechar	AVR4Nano - an agricultural nano-material delivery robot
	9:20-9:40	Dr. Elena Poverenov	AVR4Nano - Biopolymers-based hydrogel delivery systems for robotic application of plant hormone gibberellin
	9:40-10:00	Prof. Sigal Berman	AVR4Nano - Learning perception and motion
	10:00-10:20	Dr. Arjan Boonman	AVR4Nano- Sonar-based perception
10:20-10:40	**Coffee break**		
10:40-11:00	**Division into workgroups (3 to 5 groups) & task presentation - chair: Avital Bechar**		
11:00-12:30	Each group: Definition of gaps and proposals regarding required solutions. Definitions of 4 major terms and preparation of presentations		
12:30-13:30	**Lunch**		
13:30-15:00	Group presentations and discussion		
15:00-15:20	**Coffee break**		
15:20-16:00	Debate: Will nano materials become a major trend in agriculture		
16:00-16:30	Closing remarks		

Batsheva de Rothschild 1914-1999

Batsheva de Rothschild was a biologist, trained at the Sorbonne, Paris and at Columbia University, New York. She worked for a while at the Pasteur Institute, Paris. During World War II, *Bethsabée* joined the Free French Movement at its office in New York and volunteered for its armed forces. Assigned to London, she landed in Normandy during the Allied invasion, eventually reaching Paris, where she served as liaison between the French and the United States military forces. As a frequent visitor to the young State of Israel in the 1950s, she met with Prof. Ephraim Katzir (Weizmann Institute) and Prof. Alex Keynan (Hebrew University), who convinced her of the acute need to support basic research in Israel. In 1958, she established the fund bearing her name, which she personally headed with great devotion until her last days.

The Batsheva Fund was established as a private endowment fund, first in New York City and afterwards, in 1965, in Israel. In 1993 she generously transferred the fund to the Israel Academy of Sciences and Humanities. In 1958 she became the only one ever, from her legendary family, to settle in Israel and became active in public life. Science and the arts were the two loves of this exceptional woman. In 1989 she was awarded the prestigious Israel Prize for her many contributions to Israeli society, among them the founding of Israel's Batsheva and Bat Dor Dance Companies. The Batsheva Fund's purpose is to further Science in Israel for the people of Israel. It operates through a five-member Directorate. A Panel of Advisors, comprised of Israeli scientists of several disciplines, is appointed to guide its scientific activity. The President of the Academy serves as its President.

THE ISRAEL ACADEMY OF SCIENCES AND HUMANITIES
The Batsheva de Rothschild Fund for the Advancement of Science in Israel
The American Foundation for Basic Research in Israel

האקדמיה הלאומית הישראלית למדעים
קרן בת-שבע דה חטשילד לקידום המדע בישראל
הקרן האמריקאית למחקר בסיסי בישראל

The Batsheva de Rothschild Workshop on Robotics for Nano-Structure Delivery in Agriculture

August 30-31, 2021

Acre (Akko), Israel

Book of abstracts

From Industrial to Agricultural Co-Robotics: The Nano Dimensions and Challenges

Shimon Y. Nof

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ABSTRACT

Realizing the theme of this Workshop, Robotics for Nano-Structure Delivery in Agriculture, this presentation focuses on how we can benefit from lessons learned in robotic delivery, Nano manufacturing, and Nano Medicine. Challenges and conclusions are presented in the context of relevant Nano Dimensions:

- Nanotechnology and agricultural intelligence (AI)
- Nano-ag robots and cyber-physical systems
- Nanofertilizers, Nanopesticides, Nanovaccines …

that can enable and improve Ag productivity with Precision Ag goals.

Robotized agricultural production - from a "system" perspective

Dionysis Bochtis

Institute for Bio-Economy and Agri-Technology (IBO), Center for Research & Technology Hellas (CERTH)

ABSTRACT

Over the last century, agriculture has been transformed from a labour-intensive industry towards a power-intensive production system (mechanization), while over the last 15 years has started to move into an information-intensive industry (digitization). IoT, cloud computing, and Big Data have started to drive agricultural production processes. Furthermore, this digital transformation has evolved various aspects of management into artificial intelligent systems for the sake of making value from the ever-increasing data originated from numerous sources. On the other hand, robotics and automation, as constituents of this digital era, can now be used to conduct non-standardised tasks and are also increasingly exploited cognitive skills. All these technological advances have highlighted various notions not-seen before in agriculture production ecosystem, such as human-machine complementarity, human cognition substitution, and job and business polarization. To that effect the three-fold axis of the presentation consists of:

- The expected productivity growth through the production process transformation
- The expected transformation of the agricultural workforce landscape due to computerization and robotization
- The expected business transformation (agri-technology providers: industry, and SMEs)

Sensing in different scales for site specific operations

Victor Alchanatis

Institute of Agricultural Engineering, Volcani Institute

ABSTRACT

Site specific operations can take place in different scales, depending on technological, as well as biological constraints. The technological constraints may include sensing issues, that encompass the edge of the technological state of the art together with economic viability, as well as application issues when coming to apply the selected strategy in variable rate application (VRA).

The presentation will describe cases that illustrate the sensing challenge in different scales. In site specific weed management, weeds detection starts from delineation of large patches from aerial or even satellite sources, and can reach individual weed detection from proximal sensing platforms. Each scale is suitable for a different type of VRA. For variable rate irrigation or fertilization, sensing may vary from individual tree water status, to management zones for field crops. Activities driven by robotic manipulators usually require sensing scales at the plant or fruit level, while for activities based on autonomous navigation larger scale sensing can be sufficient.

Aerial and Ground Vehicle Collaboration in Agricultural Applications

Amir Degani

Faculty of Civil and Environmental Engineering, The Technion

ABSTRACT

This talk will present a method for the localization of ground mobile robots in orchards. The typical localization approaches are not adjusted to the characteristics of the orchard environment, especially the homogeneous scenery. To alleviate these difficulties, we propose to use top-view images of the orchard acquired in real-time. The top-view observation of the orchard provides a unique signature of every tree formed by the shape of its canopy. This practically changes the homogeneity premise in orchards and paves the way for addressing the kidnapped robot problem. Using computer vision techniques, we build a virtual canopies laser scan around the ground robot which is generated from low-altitude top-view video streams. We apply Monte Carlo Localization on this virtual scan to localize the robot against a high-altitude top-view snapshot image which is used as a map. The suggested approach is examined in numerous offline experiments conducted on data acquired in real orchards and is compared against a typical simulated approach which relies on ground-level trunk observations. The canopy-based approach demonstrated better performance in all measures, including convergence to centimeter-level accuracy.

Robotic Harvesting: State-of-the-art, challenges ahead

Yael Edan

ABC Robotics Initiative & Dept. of Industrial Engineering, Ben-Gurion University of the Negev

ABSTRACT

Agricultural robots are being developed for many agricultural applications such as transplanting, cultivating, spraying, trimming and selective harvesting. In practice, current working agricultural robotics systems are limited despite intensive R&D and many feasible technical solutions that have proven successful. State-of-the-art in developments in harvesting robots will be presented based on a 30 year review. Scientific and technical challenges and solutions will be presented. Lessons learned and insights on how to successfully implement agricultural robots in practice and improve performance will be discussed. Future challenges combined with R&D directions that must be tackled will be presented.

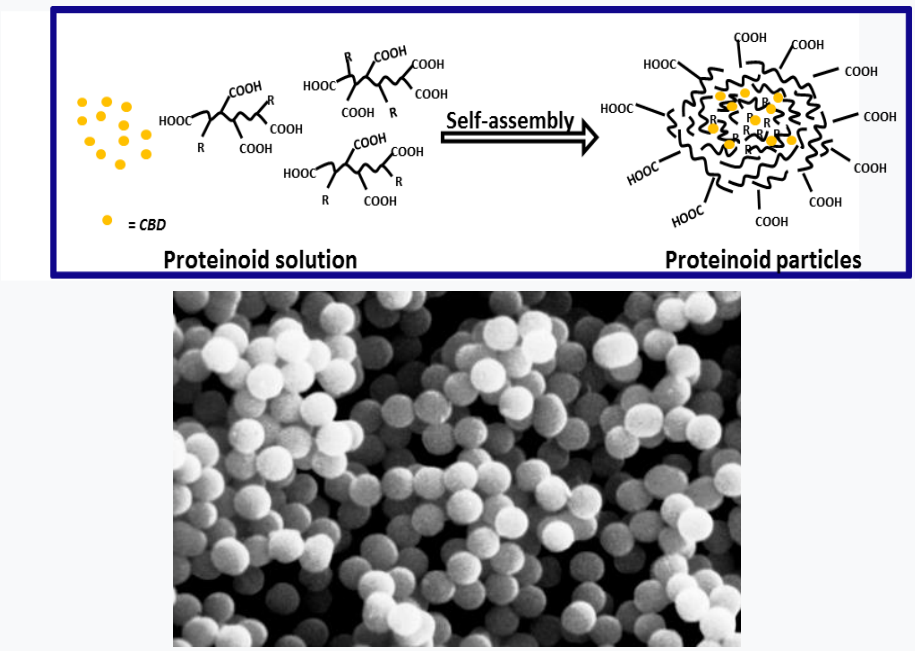
Engineering of Proteinoid Nanorobotics for medical and agricultural applications

Shlomo Margel[1], Elisheva Sasson[1] and Liron Klipcan[2]

Bar-Ilan University, Institute of Nanotechnology & Advanced Materials, Dept. of Chemistry[1] & Volcani Institute, Gilat Research Center[2]

ABSTRACT

Proteinoid polymers are formed by step-growth polymerization mechanism in high temperature (no solvent) of standard and non-standard amino acids in absence or presence of polylactic acid under inert atmosphere. The formed proteinoid – acidic, basic or neutral; similar to protein, but without a secondary and/or tertiary structure. Proteinoid nanocapsules (NCs) were prepared by the process of self-assembly of water-soluble protonoid polymers at a high temperature (60-70°C) and sink slowly to room temperature. Hydrophobic groups (e.g., aromatic rings, or hydrocarbons) are situated at the core part of the capsules while hydrophilic groups (e.g., carboxyls, amines and hydroxyls) are situated at the shell part interacted with the aqueous continuous phase. When the self-assembly procedure is done in the presence of a suitable molecule proteinoid NCs containing the entrapped molecule are formed (Picture 1).



Picture 1. Encapsulation scheme of amphiphilic material in the proteinoid capsule and an SEM image of the nanocapsules

The present lecture will describe shortly the preparation, characterization and use of poly(RGD) proteinoid NCs for personal cancer targeted therapy, since RGD (Arginine, Glycine & Aspartic acid)-based proteinoids are expected to selectively target the tumor microenvironment. In addition, other proteinoid compositions have been used for agricultural applications, as efficient herbicides and biostimulants.

Nanostructures for Mass-Transport and Delivery

Antonino Gulino

Cittadella Universitaria

ABSTRACT

The mass carrier of molecules and/or ions finds applications in many biological fields and, in the plant kingdom, the mass transport is essential to life. Transport phenomena in the electronic and photonic fields have profoundly been influenced by the development of nanotechnology. Can mass transport of metal ions in the agriculture sector be performed and improved by nanotechnology? To give a positive answer, the design of molecular architectures able to transfer mass is a field extremely important to develop. In this context, we have designed and synthesized some nanostructures able to interchange metal ions upon an external trigger, by exposing to a mass transport phenomenon their surfaces. We also have studied the dynamics of this transport phenomenon. These nanoarchitectures can be used to activate the release of different cations and their delivery where and when they are necessary to perform smart fertilizations with metal ions (Na, K, Ca, Mg, Mn, Zn, Cu, Mo, Co, Fe etc.).

Pickering Emulsions and Janus Particles for Food and Agriculture

Guy Mechrez[1,*]

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ABSTRACT

Pickering emulsions are emulsions of any type, for example oil-in-water (o/w) or water-in-oil (w/o), stabilized by solid particles instead of surfactants. In comparison to surfactant-based emulsions, Pickering emulsions show improved stability, low toxicity, adjustable permeability, and diverse functionality according to a variety of particles available, thus making the emulsions suitable for many applications in biomedical and food sciences.

In this research, we have developed Pickering emulsions that are stabilized by functionalized silica nanoparticles, and have implemented them toward challenges in the field of food and agriculture. We present a highly tunable and biocompatible biopesticide formulation, based on a single cell microencapsulation of the conidia enthomopathogenic fungus *Metarhizium brunneum* in an o/w silica-stabilized Pickering emulsion. The Pickering emulsion-based formulation exhibited significantly higher pest control activity against *Spodoptera littoralis* larvae compared to the control systems, thus making it a promising, cost effective, innovative approach to tackling the arthropod pest control challenge in agriculture.

Another approach to prepare stable, homogeneous oil-in-water (o/w) Pickering emulsions is by *in situ* functionalization of silica nanoparticles by two organosilanes with opposite polarities, leading to the formation of silica-based colloidosomes. The introduction of carbon nanotubes (CNT) to the silica based Pickering emulsion enabled us to prepare electrically conductive CNT/silica colloidosomes with controlled porosity and electrical conductivity. CNTs and silica nanoparticles both are located in the interface, as evidenced by confocal laser scanning microscopy and cryo-SEM.

In addition, we have developed a new superhydrophobic coatings based on a silica-stabilized oil-in-oil Pickering emulsion system. The application of the emulsions on a given surface, along with a rapid drying process results in the formation of unique silica-based shells-like structures, which demonstrates a combination of micro- and nanoscale roughness, resulting in a durable and transparent superhydrophobic surfaces. The coating compositions can be tuned to meet the demands and the requirements of the food industry in terms of costs and regulation.

Physical Nano-Sensors for Monitoring Plants Condition

Assaf Ya'akobovitz

Department of Mechanical Engineering, Ben-Gurion University of the Negev

ABSTRACT

Monitoring plants condition is of great importance, as it holds the potential to enhance the quality of the yield, improve pest control, reduce the use of water, and save money. In this talk, we will show our recent efforts in developing composite sensors reinforced with carbon nanotube (CNT) forests that will be used to monitor plants condition in future devices. In the first part of the talk, we will review the development of temperature sensors and proximity sensors that are cheap, accurate, and capable of interfacing with plants or humans. In the second part of the talk, we will review our study on the influence of *Tubamovirus* on the electrical properties of infected tomato plants. Our measurements showed that infected plants demonstrated a significant reduction in their electrical conductance. Moreover, this change can be observed within ~3 days from the time of the infection, which is significantly earlier than nowadays optical detection methods that detect the virus after ~10 days. Thus, our vision that arises from this work is that future nano-sensors will allow us to monitor the physical properties of plants and indicate the existence of stress or disease in an early stage.

Carbon nanotube-based field-effect transistor for bioelectronic nose applications

Sefi Vernick

The Bioelectronic and electrochemistry lab, Institute of agricultural engineering, ARO, Volcani Institute

ABSTRACT

Modern agriculture is facing imminent challenges in terms of productivity and yields. Evidently, a new 'toolbox' is required in the form of miniaturized diagnostic devices providing on-site valuable information to farmers, consumers and policy makers. Such devices are essential in nearly every link of the agro-food chain. Bioelectronic sensors may provide the ultimate solution for the detection of pathogens in agricultural and food products. There are tremendous challenges, however, in integrating solid-state materials and biological systems due to their largely dissimilar physical and mechanical properties. Carbon nanotube (CNT) field-effect devices are particularly promising due to their extraordinary properties making them excellent candidates for exposed gate biosensors. The possibility of using bacterial volatile organic compounds (VOCs) as biomarkers has drawn much attention recently as a new diagnostic approach due to its many advantages. Different pathogenic species produce characteristic VOC profiles. This specific expression pattern, a "bacterial signature", has been extensively studied in the past decade. A bioelectronic device is therefore required, combining the 'E-nose' strengths such as fast response, high sensitivity, amenability for miniaturization and circuit integration along with the specificity intrinsic to biological sensors. We develop 'bioelectronic noses' in the form of a biochip containing an array of isolated CNT-FETs. Bio-functionalization is achieved by covalent immobilization of biorecognition elements such as DNA aptamers that confer ultrahigh specificity on the electronic sensor. Alternatively, mosquito-derived odorant receptors, which exhibit remarkable sensitivities and the ability to detect a vast number of volatile molecules, are being used. The chemo-electronic signal transduction is based on the local electric field effects induced by specific target capture, resulting in an observed change in the overall current

Enabling big data with ground robots

Francisco Rovira Más

Rural and Agrifood Engineering, Universitat Politècnica de València (UPV)

ABSTRACT

Data-driven agriculture has emerged as a way to palliate the lack of meaningful information when taking critical steps in the field. However, many decisive parameters still require manual measurements and proximity to the target, which results in the typical undersampling that impedes statistical significance and the application of many AI techniques that rely on massive data. To invert this trend, and simultaneously combine crop proximity with massive sampling, a sensing architecture for automating crop scouting from ground vehicles was developed along the VineScout Project. At present, there are no clear guidelines of how monitoring vehicles must be configured for optimally tracking crop parameters at high resolution. This talk proposes an architecture for such vehicles to efficiently deliver high-density field data. Its main advantages rest on the real time generation of crop maps that blend the global positioning of canopy location, some of their agronomical traits, and the precise monitoring of the ambient conditions.

Navigation function for robotic swarms

Nir Shvalb

Industrial Engineering and Management, Mechanical Engineering & Mechatronics, Ariel University

ABSTRACT

Missions across a wide variety of disciplines require the interception of multiple targets.For example, in defense scenarios, targets may pose a threat to strategic sites, while in precision agriculture the targets may be invasive pests or fruit ready to harvest. This talk focuses on the cooperative control of a robot swarm for interception missions of multiple static and dynamic targets while avoiding collisions. We consider both deterministic and stochastic scenarios, for which we formulate two specially suited analytical functions. Our scheme provides a simultaneous solution for the problems of target assignment and motion planning as opposed to the classical approaches that solve each problem independently. We base our scheme on a modification of the classical Navigation Function for the deterministic case, which we call the Swarm Navigation Function (S-NF), and on a modification of the Probabilistic Navigation Function for the stochastic case, which we name (S-PNF). In both cases the swarm is required to intercept all targets (static and dynamic) while avoiding collisions with obstacles. We provide analytic proofs for both, the deterministic and stochastic scenarios, convergence which we shall roughly outline. According to these proofs, we show that by following the S-NF gradient, the swarm will intercept all static targets while avoiding agent-agent and agent-obstacles col-lisions. Furthermore, we show that following the gradient of the S-PNF will almost surely converge to a target in finite time, while the probability for agent-agent and agent-obstacles collisions is limited to a predefined value. The complexity of both schemes is linear with the number of targets and robots, and therefore it is scalable. Although the presented solutions are not optimal, they are simple and efficient, making them suitable for an extended set of real-time and real-life applications. To examine the scheme's efficiency, we compare the resulting trajectory following the gradient of the S-NF to a human trajectory in a catch game and an interception virtual game, the comparison indicates that as the trajectories are similar the human decision-making performs better. We conclude the paper with a set of simulated experiments and real-world experiments demonstrating the efficiency of the proposed scheme for dynamic targets.

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What's in my/your hand? Robot recognition of grasped objects

Dr. Avishai Sintov

School of Mechanical Engineering, Tel-Aviv University

ABSTRACT

Robots in real world environments need to perceive objects within their surroundings. In particular, robots are required to recognize objects grasped by humans in human-robot collaboration scenarios, and recognize objects they pick-up by themselves. We approach these two problems with non-visual perception methods. For the first problem, we propose a simple and affordable approach where a wearable Force-Myography device is used to classify objects grasped by a human. The device worn on the forearm incorporates force sensors that can imply about the configuration of the hand and fingers during grasping. Hence, a classifier is trained to easily identify various objects using data recorded while manipulating them. For the second problem, we propose a kinesthetic method where a robot can classify objects with neither tactile sensors nor visual perception, and without data collection on actual objects. Object recognition can be performed with any multi-fingered robotic hand in which the kinematics is known. We utilize a unique and frame invariant parameterization of grasps to learn instances of object shapes. To train a classifier, training data is generated rapidly and solely in a computational process without interaction with real objects. With the proposed approaches, the robot can perceive objects within its own hand or in the human hand, without dependence on complex visual perception or a direct line-of-sight.

Nanomaterials for innovative sensor systems for point-of-care detection and continuous monitoring

Sabine Trupp

LZ Secure intelligent Systems - LZ SiS, Fraunhofer, EMFT

ABSTRACT

Fraunhofer EMFT conducts cutting-edge applied research on sensors and actuators for people and the environment. The over hundred employees in the three locations in Munich, Oberpfaffenhofen and Regensburg possess impressive long-term experience and wide-ranging know-how in the fields of microelectronics and microsystem technology. The technology offering of the research institution ranges from semiconductor processes and MEMS technologies over 3D integration to foil electronics. These production-oriented microtechnologies are the basis for the other competence areas at Fraunhofer EMFT: innovative sensor solutions, safe and secure electronics, and micro dosing. The interdisciplinary interaction of these competencies enables the development of truly novel solutions, putting Fraunhofer EMFT in an ideal position for tackling the current challenges in the areas of IoT and Smart Systems. Since 2017, the Fraunhofer EMFT has been part of the nationally coordinated and BMBF-funded Research Factory Microelectronics Germany (FMD). The presentation will give an overview about materials development and processing in industrial level infrastructure.

Electrical and Electrochemical plant-based dehydration sensors

Yosi Shacham

School of Electrical Engineering, Tel Aviv University

ABSTRACT

In this presentation, we will present our recent results of two types of sensors that are being investigated in our lab. The first one is a plant-based sensor, where an enzyme, that is expressed under dehydration conditions, reacts with a substrate generating an electrochemically active species that can be detected by a miniature leaf-mounted device. A short introduction of the device technology and the results of lab experiments will be presented. In the second part of the presentation a novel four-point probe impedance spectroscopy (4PP-EIS) the method will be described. Finally, the results and interim conclusions of a continuous monitoring experiment in a greenhouse where both 4PP-EIS and gravimetry experiments were conducted on the same plant simultaneously under controlled cycles of irrigation over a few weeks will be presented.

Characterization of the selective binding of modified chitosan nanoparticles to Gram-negative bacteria strains

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ABSTRACT

Chitosan is a nature-sourced polysaccharide widely used in numerous applications. The antimicrobial potential of chitosan has attracted researchers to further develop and utilize this polymer for the formation of biocompatible antibacterial agents for both the food and healthcare industries. However, no study was yet able to clearly demonstrate the selectivity of chitosan to Gram-negative bacteria strains. In this study, the phenomenon of the selective binding properties of N-alkylaminated chitosans nanoparticles (CNPs) to Gram-negative bacteria strains was examined. Various bacterial strains were tested of five Gram-negative bacteria including E. coli, Salmonella, P. aeruginosa, S. marcescens, and E. carotovora, as well as three Gram-positive bacteria strains including B. subtilis, B. licheniformis, and B. megaterium. The fluorescence microscopy characterization showed that the presence of CNPs caused the aggregation of E. coli bacteria cells, where modified CNPs with a lower degree of substitution caused a higher aggregation effect. Moreover, it was found that the CNPs exhibited a selective binding behavior to Gram-negative as compared to Gram-positive bacteria strains, mainly to E. coli and Salmonella. Also, the scanning electron microscopy characterization showed that CNPs exhibited selective binding to Gram-negative bacteria, which was especially understood when both Gram-negative and Gram-positive bacteria strains were within the same sample. In addition, the bacterial viability assay suggests that CNPs with a lower degree of substitution have a higher inhibitory effect on bacterial growth. CNPs with longer side chains had a less inhibitory effect on the bacterial growth of Gram-negative strains, where a concentration-dependent response pattern was only seen for the cases of Gram-negative strains, and not for the case of Gram-positive strains. To conclude, the further understanding of the selective binding of CNPs to Gram-negative bacteria strains may produce new opportunities for the discovery and characterization of effective antimicrobial agents.

Nanostructured Optical Biosensors for Agri-pollutants Detection

Giorgi Shtenberg

Institute of Agricultural Engineering, Agricultural Research Organization, Volcani Institute

ABSTRACT

Our latest developments in the field of agricultural pollutants monitoring and detection will be presented. These include label-free optical biosensors and bioassays based on nanomaterials, nanoparticles and thin films for monitoring environmental contaminants. Moreover, our platforms are utilized for early diagnosis of animal diseases (bovine mastitis, botulism and brucellosis), field crops quality control and food safety by targeting mycotoxins, pathogenic bacteria and other hazardous substances. The analytical performances will be compared to common practices and techniques, thus exemplifying the potential use of the developed schemes for systematic monitoring of a wide range of composite systems.

AVR4Nano - an agricultural nano-material delivery robot

Avital Bechar*, Sigal Berman, Elena Poverenov, Yossi Yovel, Roni Azriel, Yasmin Brettschneider

*Institute of Agricultural Engineering, Agricultural Research Organization, Volcani Institute

ABSTRACT

A major challenge in modern agricultural crop production is containing and treating biotic and abiotic stresses in order to prevent epidemics, and to avoid significant yield losses. One of the most common treatment measures is spraying active compounds, but this procedure is currently highly inefficient. To significantly improve the capabilities of active compound application, we propose an innovative robotic solution for application of nanostructures in agriculture.

We will present a system engineering of a mobile robotic manipulator with integrated sonar and optic sensory modalities for deposition of Nano-formulated Gibberellin in vineyards. Development of the task oriented end-effector and a framework for the design and development of an optimal manipulator.

AVR4Nano - Biopolymers-based hydrogel delivery systems for robotic application of plant hormone gibberellin

Rafael Ischakov, Sigal Bergman, Yossi Yovel, Avital Becher, Elena Poverenov*

*Agricultural Research Organization, Volcani Institute

ABSTRACT

Hydrogel-based delivery systems are emerging as promising and innovative biomaterials for various agricultural, food, and biomedical applications, ranging from delivery of bioactive molecules, through gene therapy to tissue engineering. The biocompatible and biodegradable polysaccharides such as chitosan, are ideal materials for the formation of hydrogel-based nanoparticulated delivery systems. In most cases, the crosslinking reaction of chitosan occurs using toxic glutaraldehyde that may impair the overall biocompatibility of the nanoparticles. In the current work, chitosan-based nanocarriers for the plant growth regulator gibberellic acid (GA3) were developed using oxidized sucrose as a biocompatible cross-linker. To reach these goals, the work program comprises the following main parts. (1) Development of optimal methodology for the preparation of functionalized saccharide-based cross-linker; (2) comprehensive characterization of the obtained cross-linker; (3) applying the prepared cross-linkers to form green non-toxic hydrogel-based delivery systems; (4) examination of the encapsulation efficiency and release kinetics of these systems using bioactive molecules; (5) applications of the prepared formulations in agriculture and other fields.

AVR4Nano - Learning perception and motion

Edo Moran-Wexler, Omer Dadon, Yossi Yovel, Avital Becher, Elena Poverenov Sigal Berman*

*Dept. of Industrial Engineering and Management, Ben-Gurion University of the Negev

ABSTRACT

The combination of nanostructures and mobile manipulators can lead to increased yield and quality, reduced production and operation costs, increased sustainability, reduced environmental impact, and improved working conditions with reduced health risks. However, accurate perception modules and advanced motion planning are essential for facilitating nanostructure application by mobile robotic manipulators, as nanostructures must be applied precisely according to the specific plant geometry, within the challenging agricultural environment. As part of a mobile robotic system for specific spraying of table-grape fruits with nano-encapsulated Gibberellin we present a perception module combining sonar and optical sensors with a tracking database and a motion planning algorithm. The combined system was tested in the laboratory and initial tests were conducted in the vineyard.

AVR4Nano - Sonar based perception

Arjan Boonman

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ABSTRACT

After the discovery of chirp-radar in the 1950s, engineers were surprised by the uncanny resemblance of the then known bat sonar calls with the chirp signals they had just invented. This resemblance led to a long series of studies on the possible ability of bats to possess nano-second accuracy, as well as Doppler tolerant signals. A wide range of bat signal designs have been found all over the planet, some of them suited to aid bats in tasks that surpass those of sonar-robots. Bat-inspired bio-sonar robotic heads can become an interesting source of information in darkness, fog or smoke when light sensors are impaired or when light penetration-depth is limited. Creating sonar-based maps for general navigational tasks is still a topic of investigation and exploration. This presentation will provide a historical technological context to bat-inspired sonar research.