Poljoprivreda potpomognuta robotskim sustavima

Matko Orsag

Imagine, Create, Innovate:
Smart Agriculture

Inovacijski centar Nikola Tesla

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Structured Ecological CULtivation with

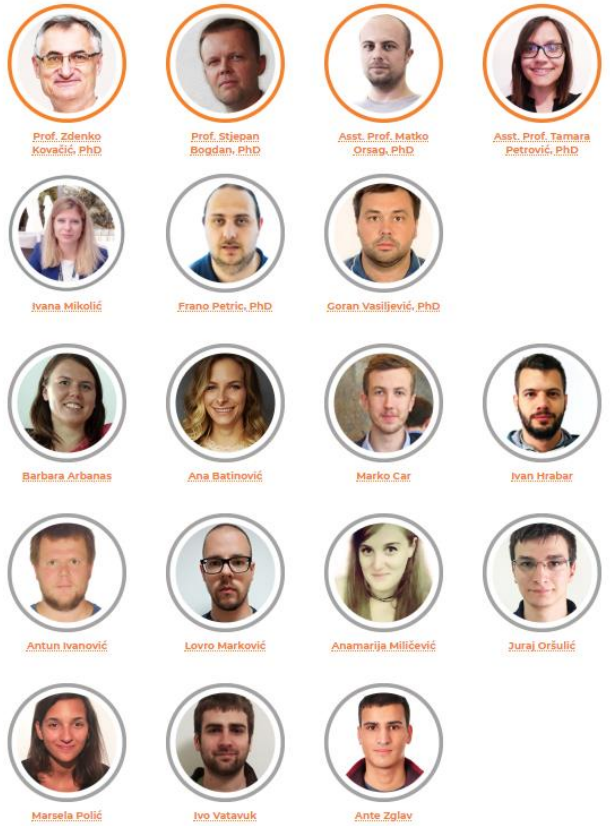
FER
LARICS

Laboratory for Robotics and Intelligent Control Systems - LARICS

Faculty of Electrical Engineering and Computing
Department of Control and Computer Engineering

University of Zagreb

- One of the first laboratories in FER founded 1996
- 20 people (researchers, PhD students, professors)
- LARICS research is focused on **control**, **robotics** and **intelligence** in the areas of flying, walking and driving robots, manipulation, warehousing, as well as collective and automotive systems.



ABOUT

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Future of indoor

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Future of indoor agriculture

LABOR  INTENSIVE

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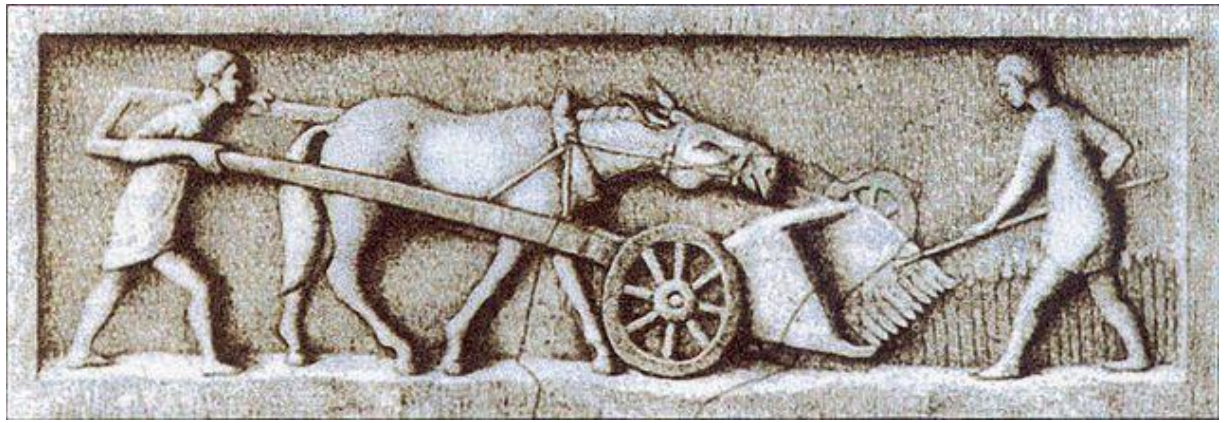
Emperor Tiberius (42 BC–37 AD)

Although glassmaking still wasn't advanced enough to produce sheets large enough for use in a greenhouse, that didn't stop Roman Emperor Tiberius's insistence that his gardeners find a way to cultivate cucumbers year round. Their best efforts yielded the Specularium : a south facing heated cold frame made with pieces of semi transparent mica.

Imperial gardeners made sure that Tiberius had cucumbers every day of the year, even though they ripen naturally only in the summer. By taking the beds in which the cucumbers were planted and mounting them on wheels (imagine a kind of wheelbarrow), the gardeners could keep moving them around to follow the sun. During the cold months, they covered the cucumber beds with sheets of mica, a transparent stone (sheet glass had not yet been invented).



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Autonomous Robots in Indoor Agriculture

robot

Origin

CZECH

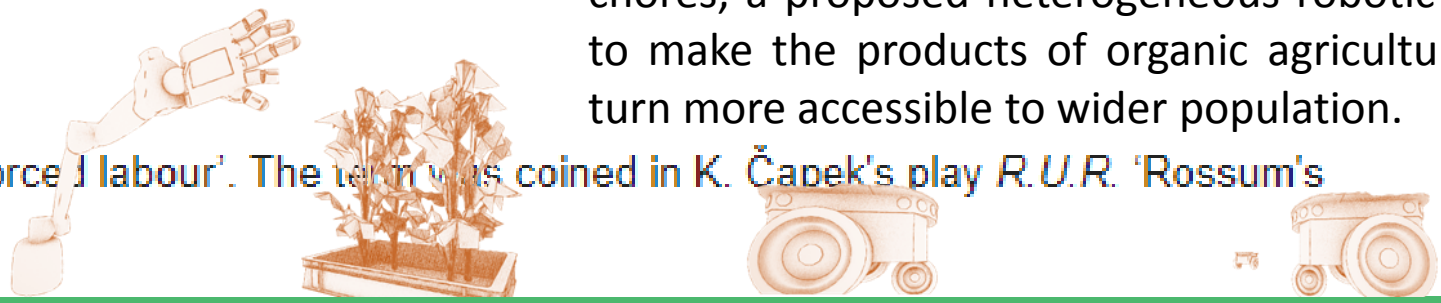
robota
forced labour

R.U.R
Rossum's
Universal
Robots

→ robot

from Czech, from *robota* 'forced labour'. The term was coined in K. Čapek's play *R.U.R.* 'Rossum's Universal Robots' (1920).

In the world that is suffering from ever more obvious pollution consequences, organic farming represents a step towards reducing the pollution with an environment friendly solution. Unfortunately, to reduce the use of pesticides and GMO cultures, organic agriculture becomes ever more labour intensive, with a comparably smaller agricultural output. The obvious economical consequence of such a production system is a higher cost of organic food. The labour input in organic agriculture fits the description of dull and dirty jobs, and therefore ideally fits the use of robots. By aiding farmers in their daily chores, a proposed heterogeneous robotic system has the potential to make the products of organic agriculture less expensive, and in turn more accessible to wider population.



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Autonomous Robots in Indoor Agriculture

Deploying robots on big farms is not a new concept. It is rather a fast growing industry, that focuses on big machines applied for specific crops and use cases. The proposed system goes beyond current state of the art, in a sense that it proposes a system comprised of small robots with specific abilities that can execute certain tasks only when they are introduced to work together. Such a system surpasses current farming robots in its scalability and versatility, which makes them ideal for small family run organic farms. Each robot has specific abilities, but when put to work together they can be applied to achieve versatile goals in an unstructured and challenging environment.

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Autonomous Robots in Indoor Agriculture

- multi-robot systems, where robots work (move) together to accomplish tasks that would be otherwise unachievable by a single robot.
- We study a symbiotic UAV-UGV robotic
- UGV can provide a UAV with a safe landing area and transport it across large distances,
- UAV can provide an additional degree of freedom for the UGV, enabling it to negotiate obstacles.
- We propose an overall system control framework that includes high-accuracy motion planning for each individual robot and ad-hoc decentralized mission planning for complex missions.

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Unmanned ground robot (UGV)

This robot is equipped with a mechanism allowing it to transport
growth unit containers. These containers, are the smallest organization unit within the farm consisting of a single or variety of plants, that are used in the structured greenhouse environment, designed to suit the robot aided farming paradigm.

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Compliant multi degree of freedom manipulator

The key issue in dealing with sensitive plants is to ensure the necessary compliance from the manipulator motion. This will ensure the robot can execute certain tasks, and at the same time make sure that the plant is not harmed. This requirement also fits within the Soft robotics paradigm, that focuses researchers to build better sensing machines, capable of dexterous human like motion. Testing the robots on such a challenging application, represents an interesting research opportunity that will certainly lead to new results in a rapidly expanding field of research.

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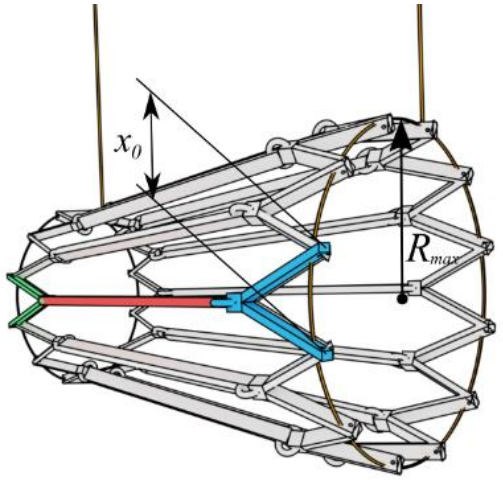
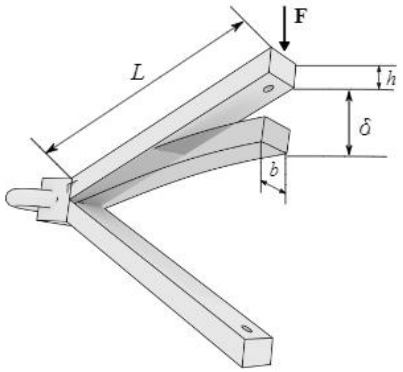
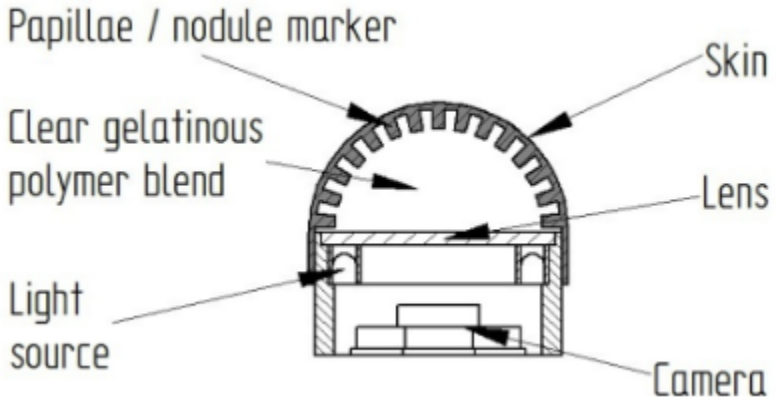
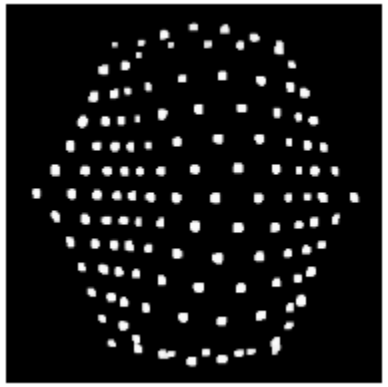
Compliant multi degree of freedom manipulator

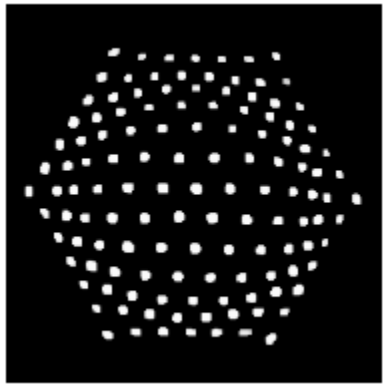


1. Soft and flexible constructions
2. Sensory apparatus
3. Force control









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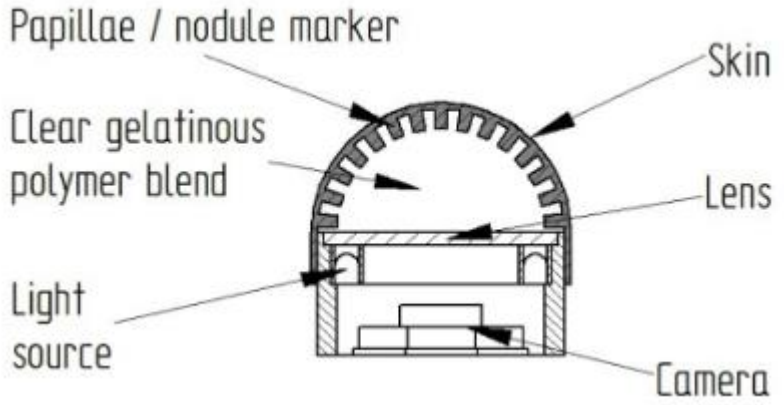

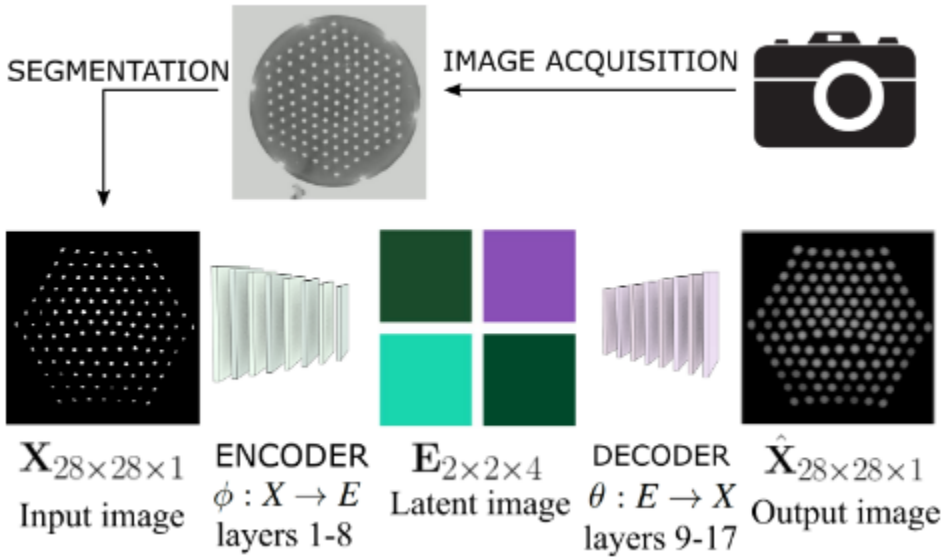

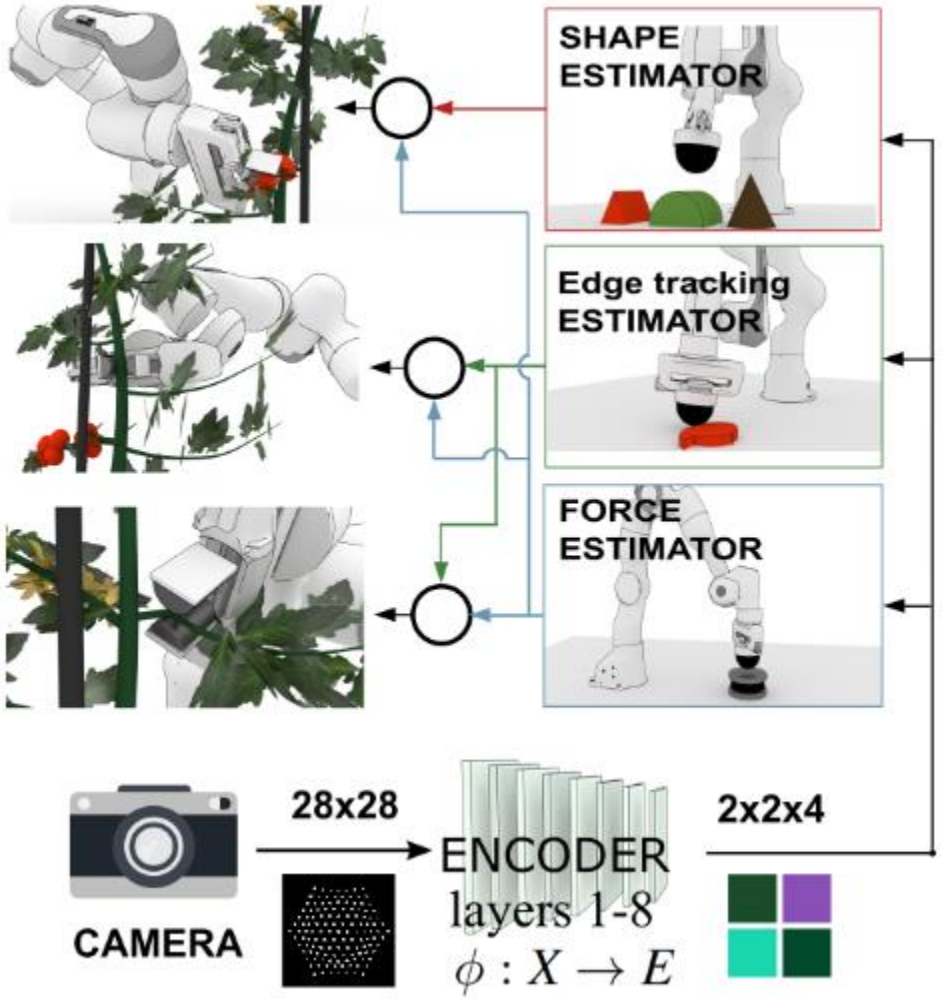

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Unmanned aerial robot (UAV)

Our UAV is equipped with a multi degree of freedom manipulator carrying sensors for plant surveillance. The multi degree of freedom manipulator enables the robot to fly outside the danger area, where its prop wash wind gust can damage the plant.

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Unmanned aerial robot (UAV)

- Bring UAVs in contact with the environment
- Peg-in-hole example
- Force feedback control (Impedance controller)
- Limited payload and torque capabilities
- Tool design -> planting?

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