Use of modern digital technologies in agriculture in Slovenia

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MARDS Training in Maribor, Slovenia on „Quality Assurance of Doctoral Studies“
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There are two faculties in Slovenia offering Ph. D. study in agriculture

Faculty of Agriculture and Life Sciences – University of Maribor and

Biotechnical faculty on University of Ljubljana

- The beginner of Faculty of Agriculture and Life Sciences was an Agricultural High School (founded in 1960)
- 1995 - with the act of parliament of Republic Slovenia the Agricultural High School was transformed into the Faculty of Agriculture
- In the academic year 2000/2001 the first Ph.D. students were matriculated at the 6 semester studying program.
- First Ph. D. degree was defended in 2006 by Tatjana Unuk
- *The analysis of interaction between crop load and nitrogen rates and its use in optimisation of apple (Malus domestica B.) cv. golden delicious yield*

- In the academic year 2006/2007 the first Ph. D. students were matriculated at the 6 semester study according to Bologna studying scheme
- For the academic year 2020/2021 the first Ph.D. students will start 8 semester study according to Bologna

Development of agricultural Ph. D. studying programme

- With additional elective couses starting in academic year 2020/2021 we focused on actual problems connected with modern agriculture:

- Selected topics from organic agriculture
- Behavioural ecology of domestic animals
- Functional foods
- Selected topics in physiology of agricultural plants
- Trends in pre – and postharvest treatment of fruit
- Management of weeds and invasive plants
- Soil management in viticulture in relation to climate change
- Factors And Risk Assessment In Nutrition
- Selected topics of Grassland management and Forage production
- Selected chapters of precision agriculture

Selected topics from organic agriculture

- Specifics of organic farming (principles, environmental issues), legislation, inspection and certification, labelling.
- Organic production and processing. Quality and diversity of organic food, organic food in gastronomy and functional biodiversity.
- Selected examples of research and different practices in production, processing and marketing.
- Development trends worldwide, in Europe and in Slovenia.

- Evolutionary basis for domestic animals (or theirs wild relatives/ancestors) behaviour due to ecological (selection) pressures.

Functional foods

- Definition of functional foods, major food constituents with functional properties
- Dietary fiber (soluble and insoluble fiber), resistant starch, their properties, and functions; cereals.
- Polyphenols (the chemical properties, structures, free radicals).
- Valuable sources of food bioactive compounds and bioavailability.
- Methods of their detection and quantification.

- The impact of natural and anthropogenic stress factors on physiological processes in plants with the special emphasis on agricultural plants.
- Disturbances in carbon metabolism
- Disturbances in mineral nutrition
- Environment-related aspects of mineral metabolism; the disturbances in supply of less mobile elements; the impact on symbiosis with the microorganisms in rhizosphere
- Defense and reparatory mechanisms, detoxification of reactive oxygen species with antioxidants and enzymes;

- Technological measures to reduce the use of plant protection products in fruit production
- Technological measures to reduce the use of mineral fertilizers in fruit production
- Methods for determining the physiological state of fruit plants
- Measures for establishing the physiological balance of fruit plants
- Measures to raise the competitiveness of fruit production
- The influence of the production systems on the storage capacity of the fruits

Management of weeds and invasive plants

- Researches in weed science, controlling and mapping of invasive plants.
- Possibilities of reducing the use of herbicides by changing production technology.
- Effects of invasive plants on ecosystems and on human and animal health.
- New invasive alien plants.
- Techniques of controlling invasive plants in different ecosystems.

- Soil management systems and the development of the vine in viticulture according to the climate change
- Soil management systems in vineyards in the continental and Mediterranean climate
- The impact of the soil management systems to life in the ground with an emphasis on the development of earthworms
- The possibility of adjusting the soil management system in the vineyards to the climate change and their impact on reducing of soil erosion

- Biological risk factors in foods: pathogenic bacteria, viruses, molds, algae, prions.
- The effect of storage, packaging, chemical and physical conditions on the growth of pathogens and spoilage bacteria in food.
- Monitoring of chemical risk factors in food: toxic elements and organic pollutants.
- Science-based methods for risk assessment of chemical and microbial contaminants according to the methodology of the European Food Safety Authority (EFSA)

- Morphophysiological and cytogenetic properties of forage plants and their characteristics in the plant breeding
- Grassland management and forage production in the 'low input' systems and in the organic production.
- The impacts of grassland management and forage production on the biodiversity, pollutant emissions into the environment, and effects on climate change
- New methods for non-invasive evaluation of the quality of the forage

- Increasing the efficiency in agriculture by using modern digital technologies
- Use of modern RTK navigation technology in agriculture
- Remote - not invasive determination of crop yield and draught stress
- Possibilities of using drones in agriculture
- The core of robotics and its use in the agriculture

Digitalisation of agriculture

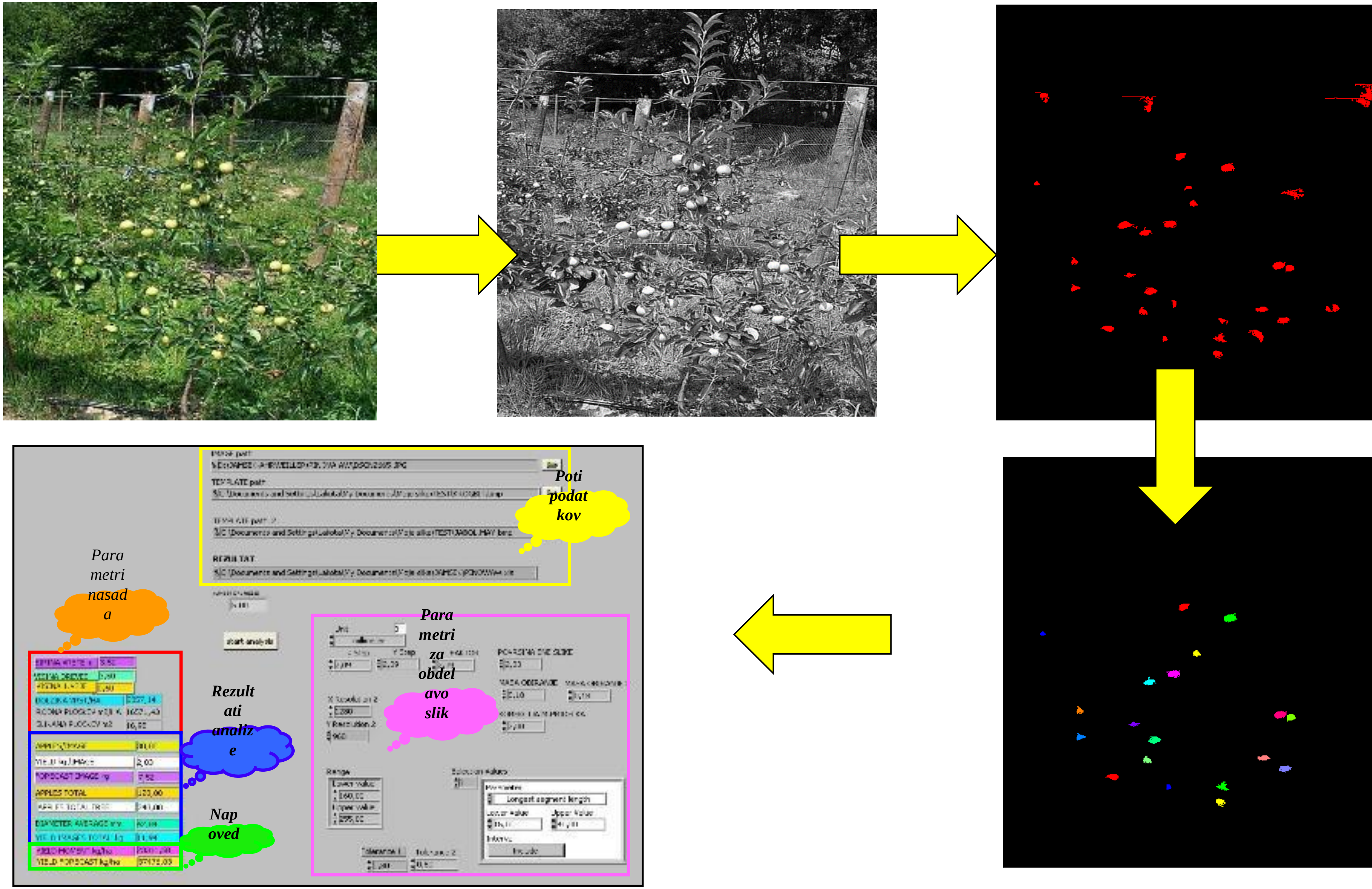
Digitalisation of agriculture - definitions

- Digital technologies—including the Internet, mobile technologies and data analytics, artificial intelligence, digitally-delivered services and apps, is changing agriculture and the food system.
- The world's first entirely machine-operated crop known as "smart farming" – a crop sown and tended without a human ever entering the field – was harvested in 2017.
- Digital technologies can also help governments to improve the efficiency and effectiveness of existing policies and programs. For instance, freely available and high-quality satellite imagery dramatically reduces the cost of monitoring many agricultural activities.

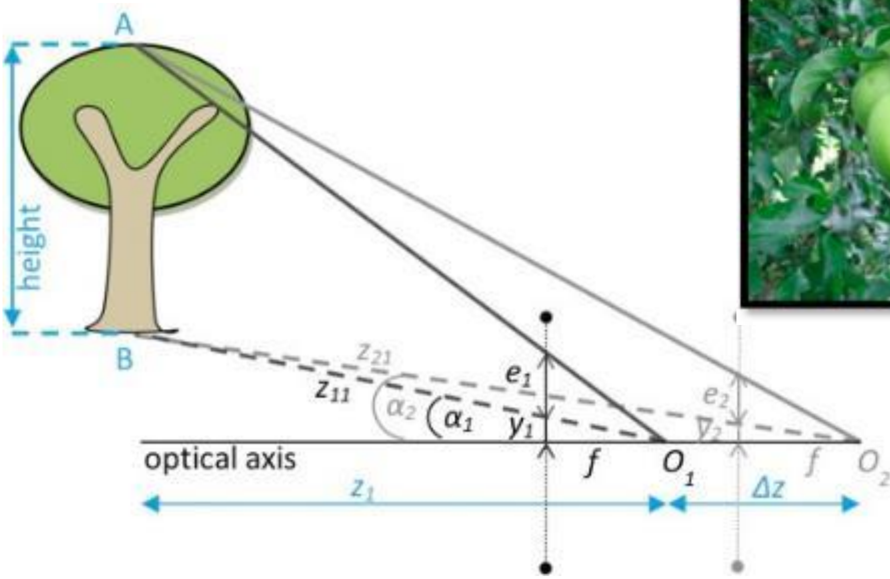
The first Ph. D. was defeted already in 2004 by Stajnko. The thesis about application of digitalisation in apple production

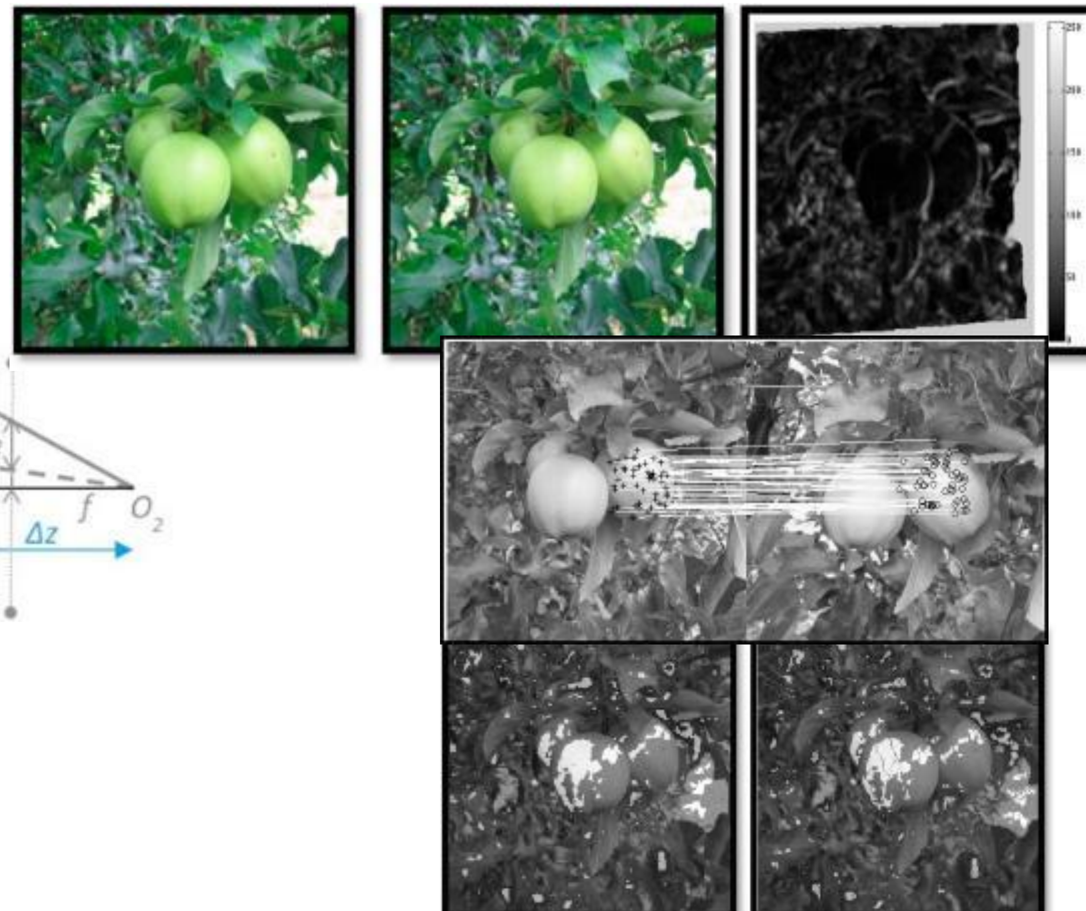
Application of image analysis for potential monitoring of growth and development of apple fruits 'Malus domestica' Borkh

Application of image analysis for potential monitoring of growth and development of apple fruits *‘Malus domestica’* Borkh

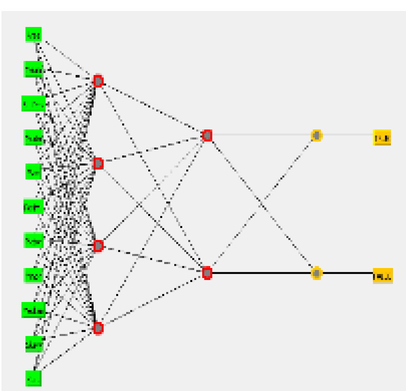


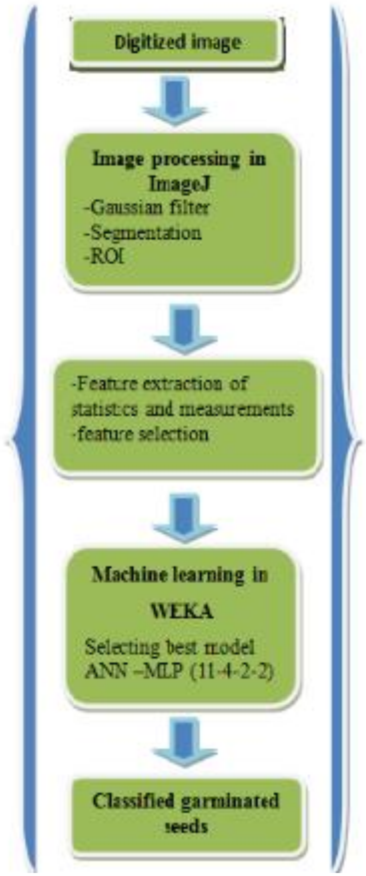
Detecting objects in natural environments using spatial-frequency analysis and multiview geometry (Jurij Rakun)

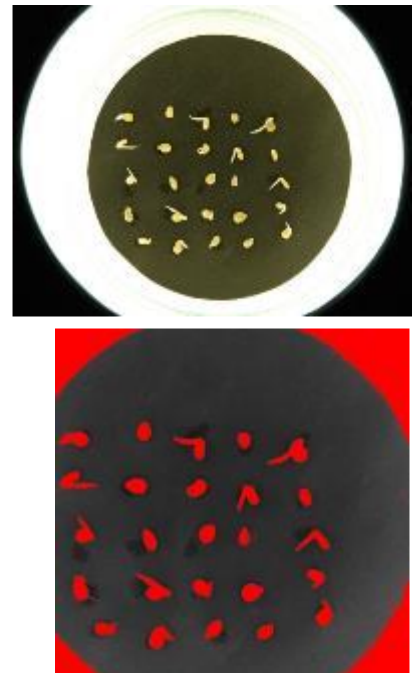


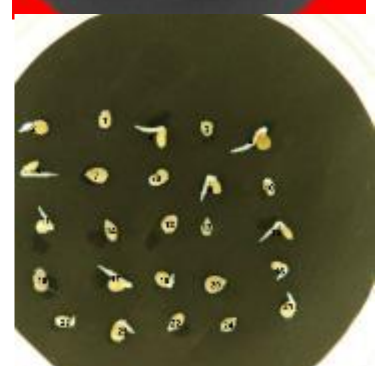


The use of image processing and machine learning methods for the assessment of germination of the tomato (Lycopersicon lycopersicum L.) [Uroš Škrubej]









Ability of NIR spektroscopy to predict meat characteristics/ Maja Prevolnik (2011)

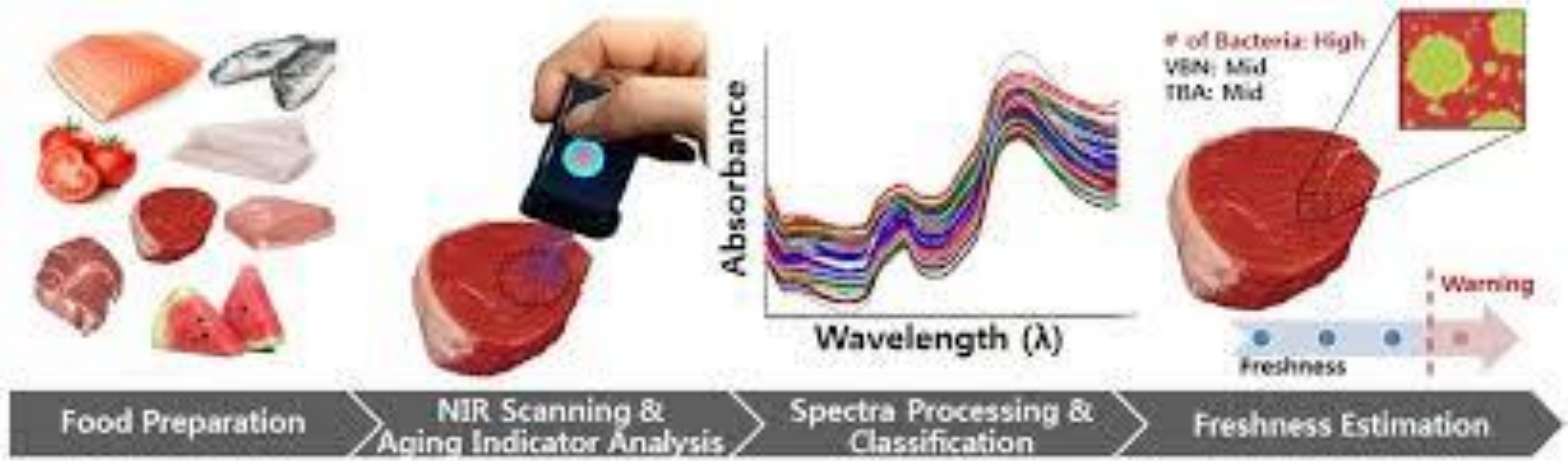


Table 2. Predictive ability of chemical composition of fresh meat using NIRS

	Pork LD muscle					Pork – different muscles				
	Calibration		Cross-validation			Calibration		Cross-validation		
Constituent (%)	R^2_C	se_C	R^2_{CV}	se_{CV}	RPD	R^2_C	se_C	R^2_{CV}	se_{CV}	RPD
Intramuscular fat	0.99	0.14	0.95	0.25	4.6	0.98	0.23	0.97	0.30	6.6
Water	0.90	0.39	0.63	0.75	1.8	0.91	0.45	0.82	0.65	2.6
Protein	0.45	0.92	0.28	1.05	1.2	0.92	0.48	0.81	0.73	2.1

LD – *longissimus dorsi*, se_C – standard error of calibration, se_{CV} – standard error of cross-validation, R^2_C – coefficient of determination of calibration, R^2_{CV} – coefficient of determination of cross-validation, RPD – ratio between standard deviation of the reference values and se_{CV}.

Digitalisation of agriculture case Ph.D. Thesis

Using machine learning methods for apple quality forecasting [Blaž Germšek], 2017

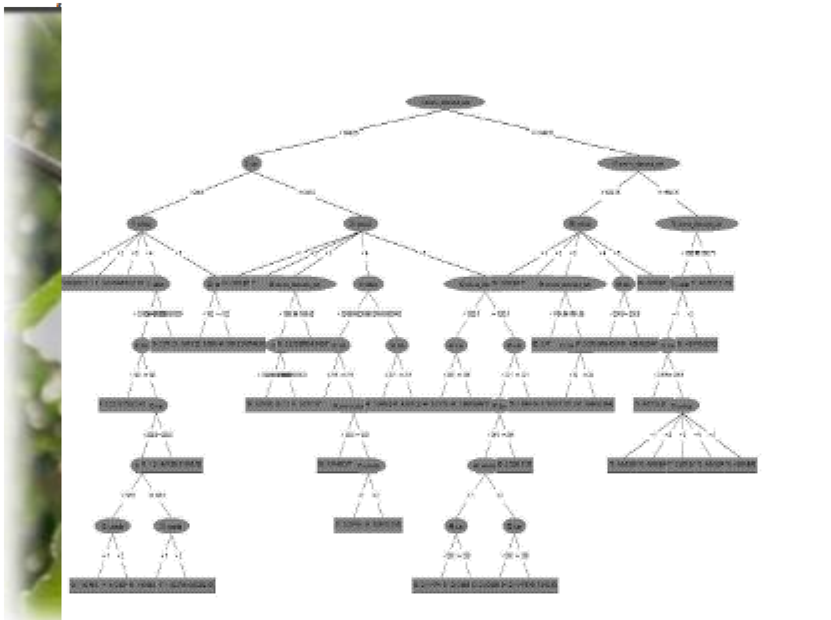
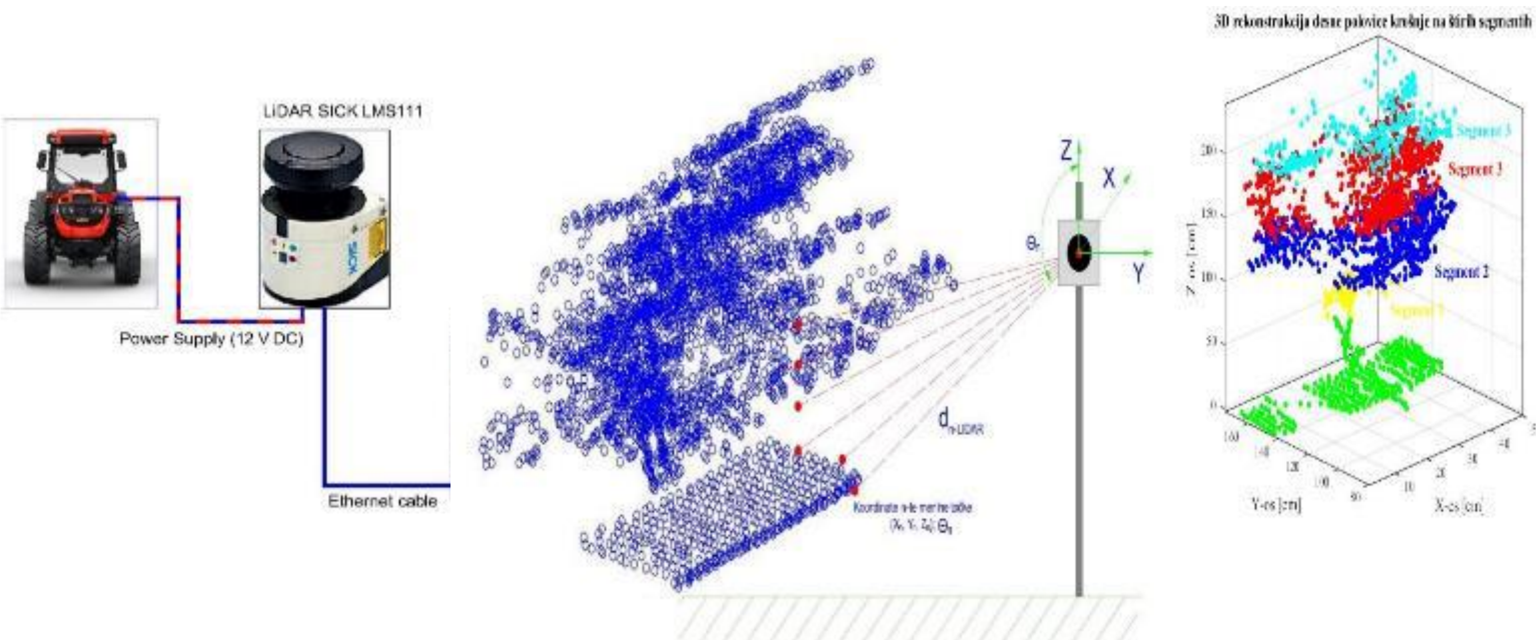


Table 3 Accuracy (in %) of prediction models for all varieties tested with both methods of verification using a test dataset

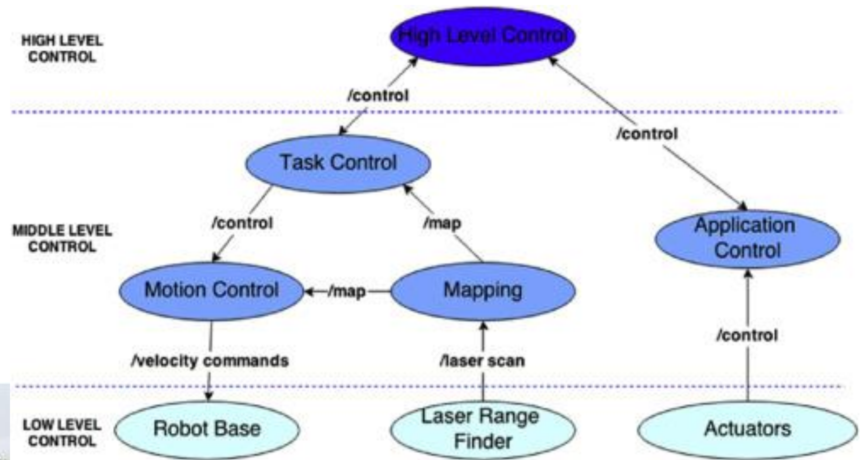
Apples varieties	cv. 'Gala, Brookfield'		cv. 'Fuji, Kiku 8'		cv. 'Braeburn, Maririred'	
The accuracy of models/model validation	10 FCV	70 PS	10 FCV	70 PS	10 FCV	70 PS
DECISION STUMP	74.61	75.97	82.88	82.15	90.88	89.95
J48	89.13	89.01	90.57	89.40	94.82	91.75
LMT	88.24	88.98	90.99	91.73	96.65	94.18
RANDOM FOREST	87.95	87.43	90.56	90.90	96.00	92.01
RANDOM TREE	87.82	87.16	90.68	89.49	95.94	92.67
REP TREE	89.13	89.10	90.15	89.00	95.00	92.98

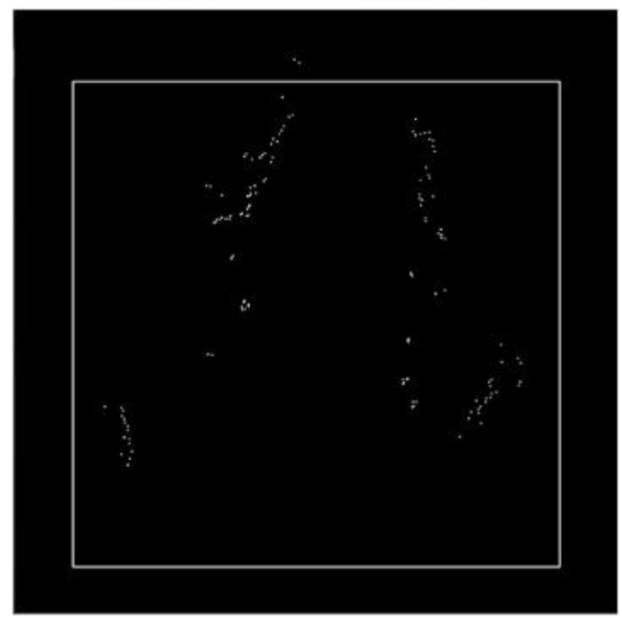
Researches connected with digitalisation in agriculture

Reconstruction of the tree crown on the principle of measurement with the LIDAR measuring system



Simultaneous localization and mapping in a complex field environment





Autonomous navigation algorithms of the new robotic platform Rovitis 4.0 at

- https://www.youtube.com/watch?v=AZ9kDcwoAjs

Farmbeast – student project FRE2019 1st place – free style

Thank you for your attention

and warmly wellcome to

Faculty of Agriculture and Life Sciences