Project Title:

MODERNIZING AGRICULTURAL PRACTICE USING INTERNET OF THINGS

Project Acronym:
MAPIoT

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Subject:

Summer School Activity Report
25 July-7 August 2022
MELSOM, SANDEFJORD, NORWAY[1]

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ULBS/ USN

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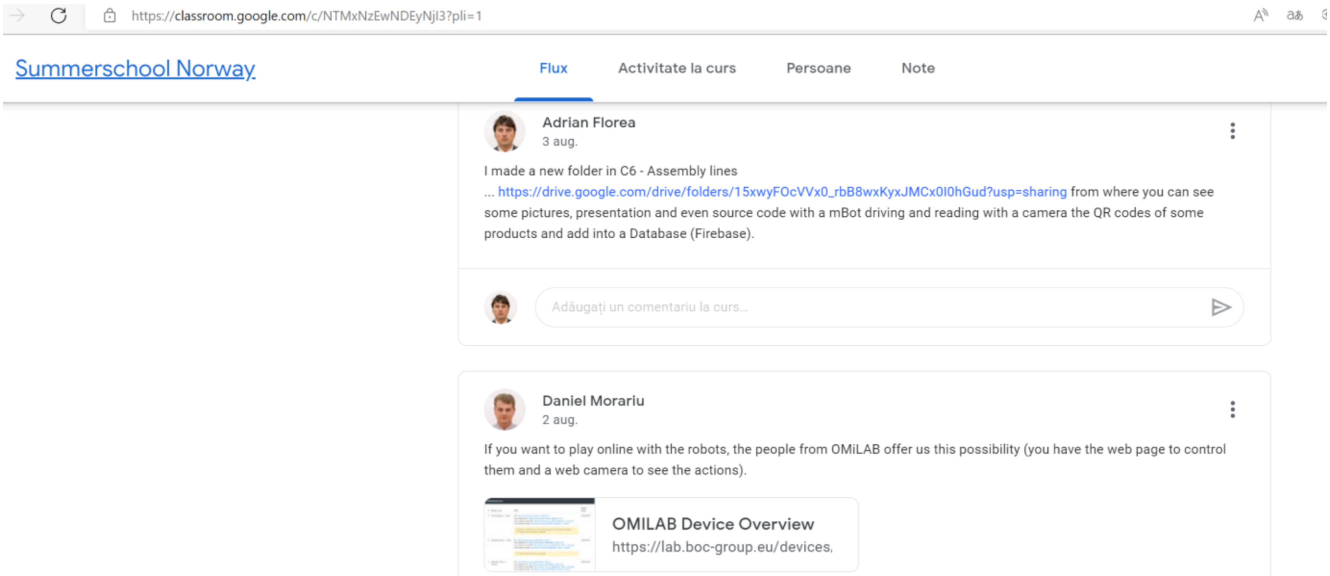
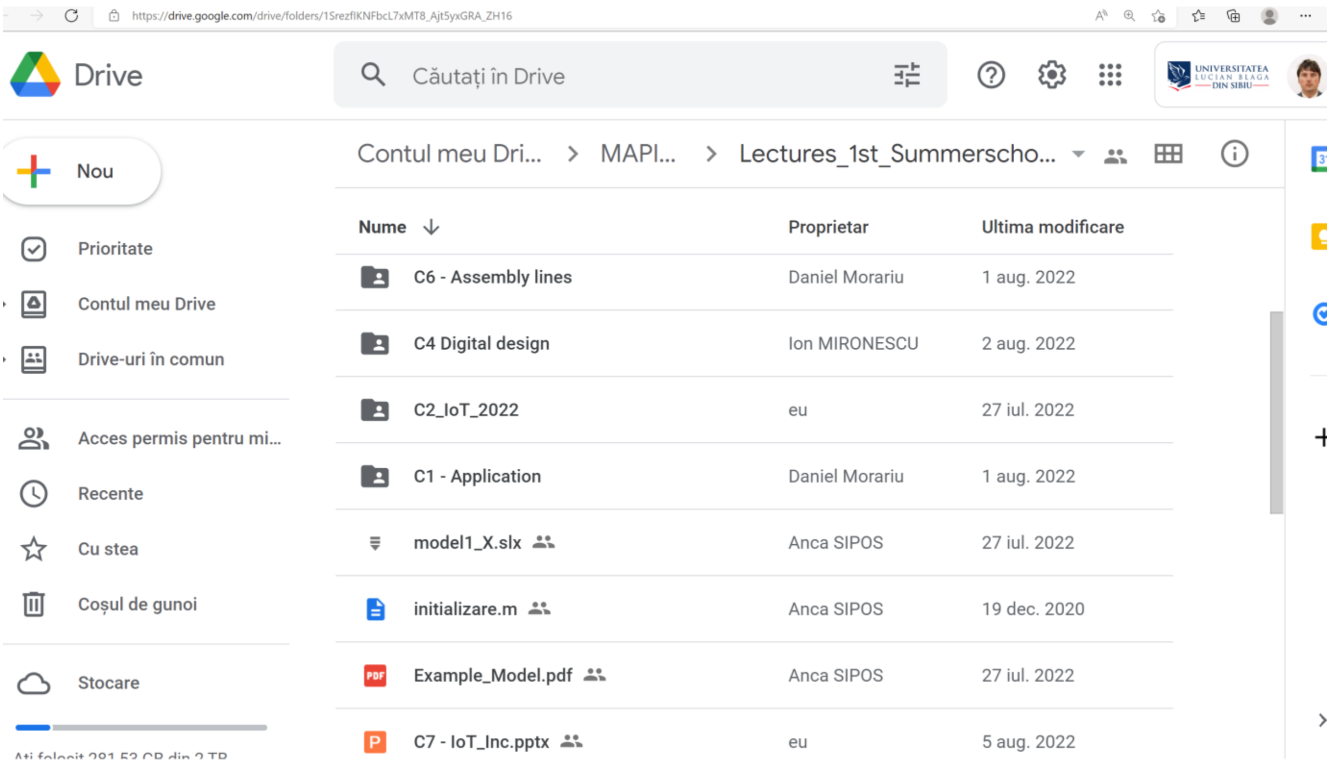
1. Teaching lessons about summer school topics: IoT, AI, GA, FR, controlling processes with robots, using drones in agriculture

The summerschool activities took place at Melsom videregaende skole (Melsom High School) in Melsom, Sandefjord, Norway. The school is placed inside a large farm where grows letuces, cereals and cows.

Before starting the teaching activities the MAPIoT manager provided a solution for allowing the opportunity for students to access all materials from the summer school. For this, a Google classroom called "*Summerschool Norway*" - https://classroom.google.com/u/0/c/NTMxNzEwNDEyNjI3 was created and the possibility of Norwegian students who do not have a google account to access this classroom was discussed.



Also, it was created the drive with all documents (*.docx, *.pptx, *.xslx, *.avi, *.mp4, etc) required for studying the summerschool topics - https://drive.google.com/drive/folders/1SrezfIKNFbcL7xMT8_Ajt5yxGRA_ZH16. The lectures were also uploaded on MAPIoT project web platform - http://digifof.omilab.ulbsibiu.ro/psm/content/mapiot/info?view=activities.



1.1. The course **C2a Internet-of-Things: sensors and actuators – theory and applications** discusses about using sensors and Arduino processors for developing applications on Internet of Things topic, how to connect sensors to Arduino and send the information to a browser using a WEB Server as ESP8266.

Practical work conssisted in:

- Switching On / OFF and blinking a LED
- Connecting an external LED display
- Read DHT11 sensor from Arduino Uno
- Use 4-Digit Display (TM1637)

After lunch was continued the practical work with the WEB Servers topics:

- Connecting to ESP8266 WEB Server to receive a message
- Command a LED using ESP8266 WEB Server

The students were organized in 4 interdisciplinary and international teams and worked together at specific tasks.

Accessing the following link it can be seen the students work in every day of summer school - MAPIoT - Modernizing agricultural practice using Internet of Things | Groups | LinkedIn.

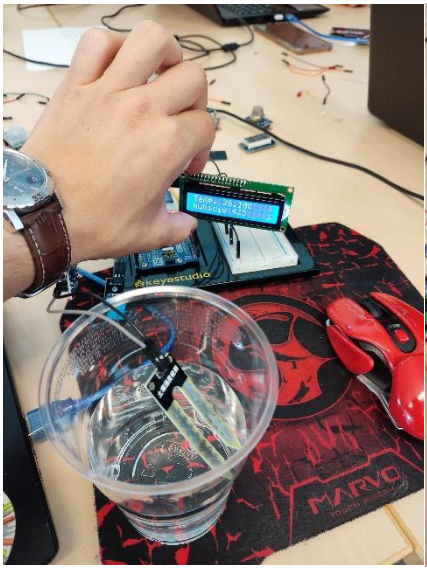
1.2. The second course about IoT, **C2b Internet-of-Things communication – theory and applications** continues the concepts described in IoTs sensors and actuators and emphasized more on connectivity and communication part.

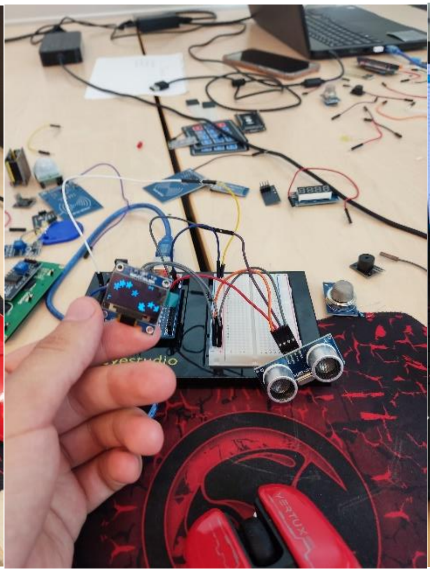
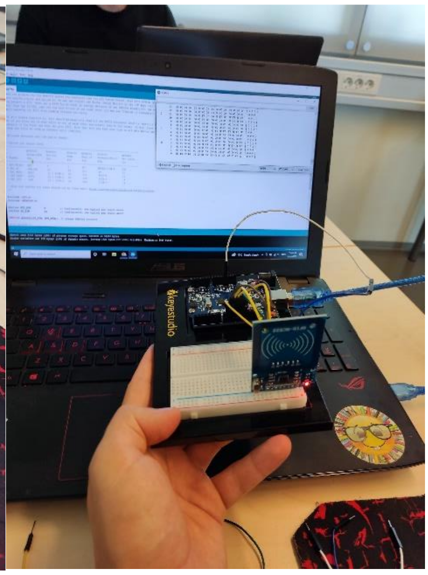
The practical work emphasized the implementation of **I2C communication protocol**:

- Using LCD1602 display with I2C communication protocol
- Using a moisture sensor and an adaptor
- Using Gas sensor MQ2 and a buzzer
- Adding OLED display SSD1306

The practical work was continued with the following topics:

- Building a distance measurement device
- Using AC Powered Components – The Relay
- Controlling a relay through web
- RFID – Radio Frequency ID



1.3. The third course of Internet-of-Things, divided in 4 modules C2c P1, P2, P3 and P4 - **IoT cloud integration – theory and applications**, was focused on connecting to webserver and collecting data. The main activities aimed:

1.3.1. Understanding Infrared Communication

- Infrared communication Frequency/ Types
- Using IR Receiver TSOP
- Detect remote control type
- Using IR Receiver SM0038

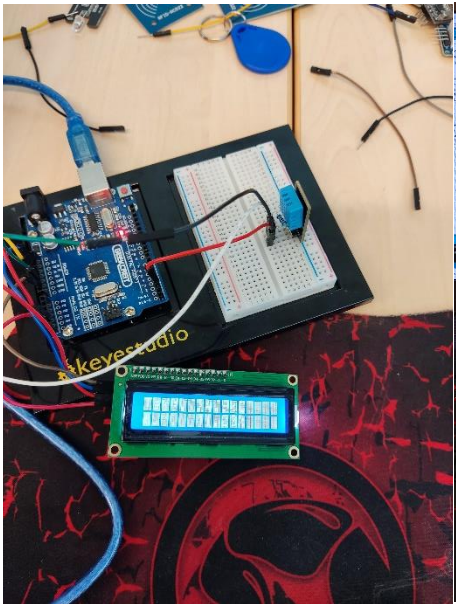
1.3.2. Understanding RFID

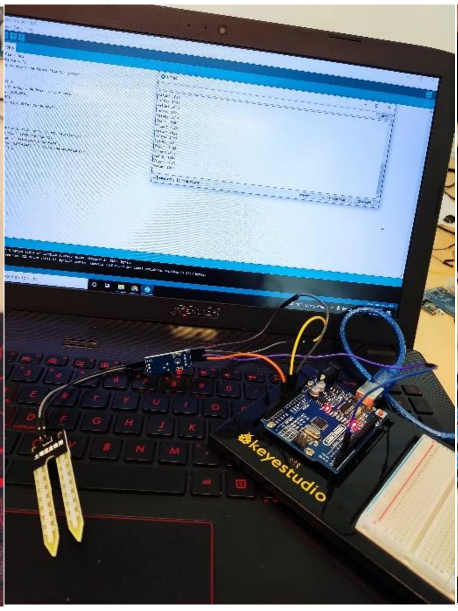
- Results Not as Expected?
- The TC522 component
- Using NRF24L01

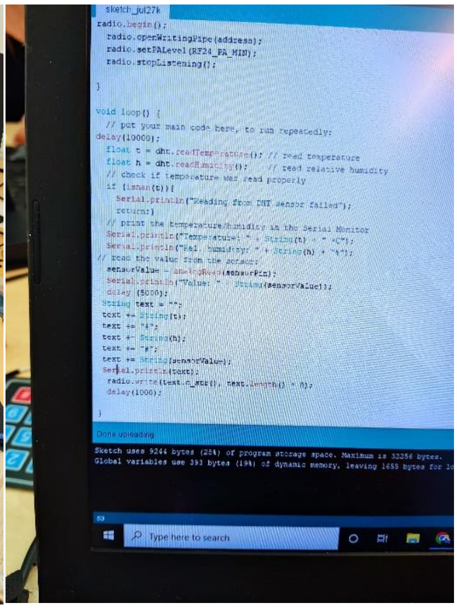
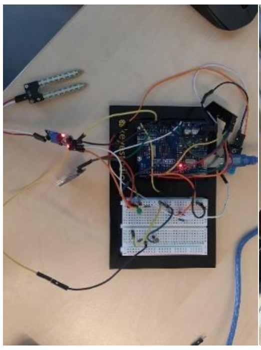
1.3.3. Cloud integration

- IoT cloud platform
- Steps for IoT prototyping
- Using ThingSpeak

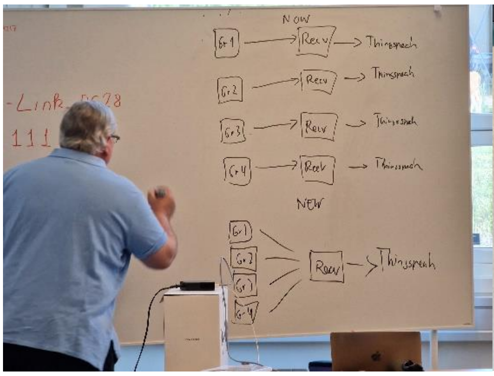
1.3.4. Develop your unit for measure temperature, humidity, light and moisture and show all the information in cloud using ThingSpeak platform.

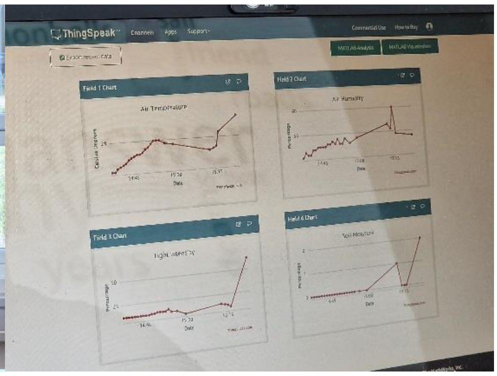




The students were organized in 4 teams'work and after finalizing their stations they inserted in boxes and distributed outside of the buildings in 4 different places and were collected data about temperature, humidity, light and moisture and put them in different places, outside. Then, they analysed the data obtained.



1.4. The summerschool activities continued with **C1 AI (Artificial Intelligence) + GA (Genetic Algorithms) & Fuzzy Rules – applied in Modelling, Control, Predicting and Managing of processes from Agriculture and Food Engineering domains – theory and applications** course presented by professor Adrian Florea. This course starts with the basic theory regarding Artificial Intelligence, Genetic Algorithms and Fuzzy Rules (FR) and specific applications in Agriculture and Food Safety Processes of monitoring and control. The course starts with societal and technical challenges and MAPIoT project motivation and continues with AI solutions like machine learning algorithms in plant monitoring, soil analysis, prediction process in agriculture, and GA in farm model and economic environment, GA for irrigation optimization and the identification of optimum cultivation rules, optimizing productivity and energy consumption, and Fuzzy Rules for modelling of imprecise concepts like automate and control the irrigation process and detecting the fermentation phase of white wines. It was structured in 3 sections:

1.4.1. Introduction to AI with emphasize on Neural Networks (NN)

- Short history. AI domain affiliation.
- What are NN? Advantages. Challenges.
- Types of Neural Networks.
- Structure of an artificial neuron.
- Activation functions.
- Simple perceptron and Multi-Layer Perceptron. Constraints.
- Learning Mechanism: Backpropagation.
- Source code examples: MATLAB and C#.
- Application & Results.

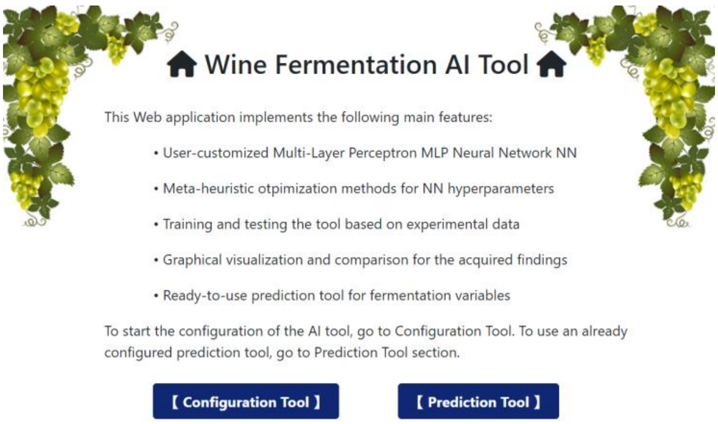
1.4.2. Introduction to GA

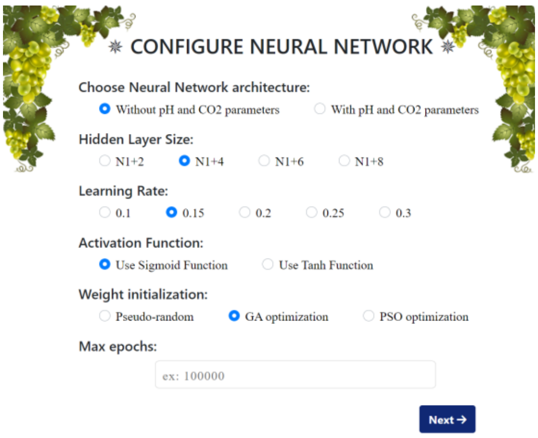
- Quick overview. Terminology
- Advantages of GA. Limitations of GA.
- Structure of a Genetic Algorithm (pseudocode).
- GA: Representation; Fitness & parents selection.
- Genetic operators: Recombination & Mutation.
- GA: Survivor selection.
- GA simple example.
- Application: Training weights of a NN & Results.

1.4.3. Introduction to Fuzzy Rules

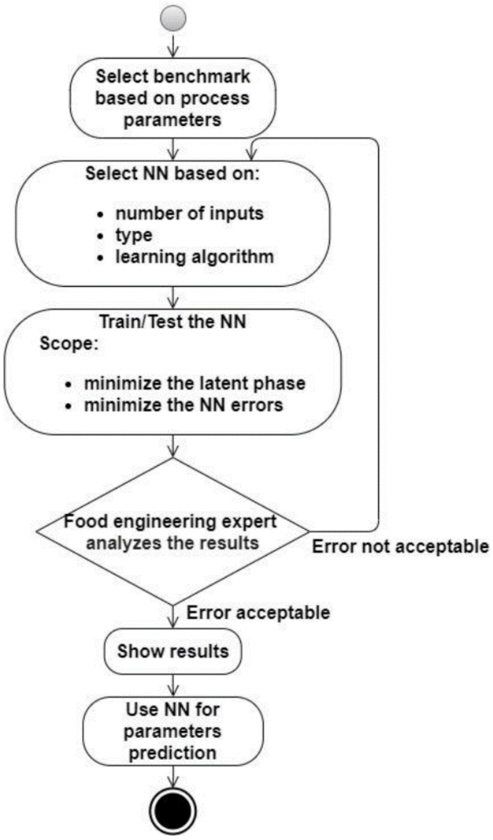
- Quick overview. Terminology: Input, output, membership functions
- Fuzzy Rules: Fuzzy Inference and Defuzzification
- Application: Irrigation system automate control


The practical work consists in configuring and running the software application that models, controls, predicts and manages the fermentation phase of white wines. The application may be retrieved from MAPIoT web platform - http://digifof.omilab.ulbsibiu.ro/psm/content/sacwwfpe/info and http://193.226.29.27/WineFermentation/.

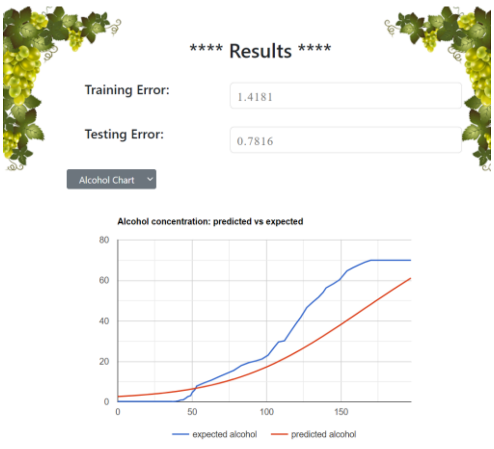


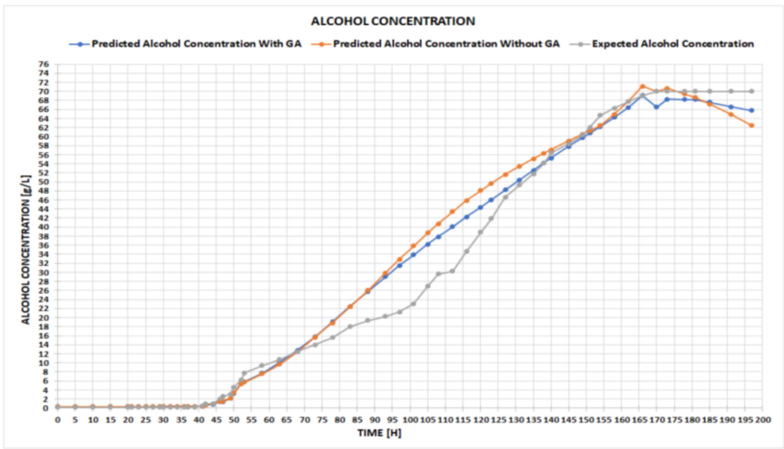


The students were organized in 4 teams' work. They should follow the next steps:



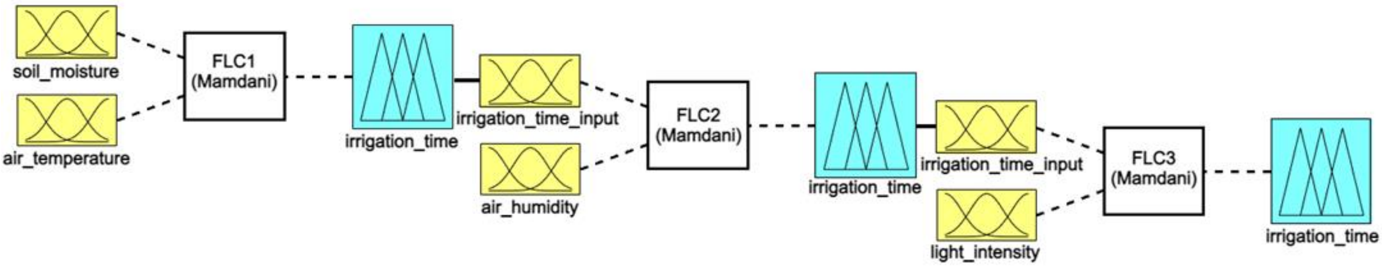
One team simulate a Neural Network (NN) with pseudo-random weights initialization, other team using Genetic Algorithms for weights initialization, other for using Particle Swarm Optimization algorithm for weights initialization. The results were collected and graphical illustrated and analysed by the fourth team.





Regarding the course section 1.4.3 “**Introduction to Fuzzy Rules**” professor Adrian Florea reveals the last application developed during the MAPIoT project, namely the IoT System for Irrigating and Monitoring a Thuja Conifer Nursery - http://digifof.omilab.ulbsibiu.ro/psm/content/imtcn/info. It was exemplified the automatic irrigation mode, when the system automatically calculates and starts the irrigation process, based on the information received from the sensors and future weather conditions.

Mamdani Fuzzy Inference Logic systems are used to calculate the time for irrigation based on collected data from the nursery: soil moisture, air temperature, air humidity, and light intensity. Fuzzy Mamdani systems were originally designed to mimic the performance of human operators in charge of controlling certain industrial processes. The aim was to summarize the operator's experience into a set of IF-THEN (linguistic) rules that could be used by a machine to automatically control the process.



1.5. The summerschool activities continued with the course **C3 Using AI in fermentation process – theory and applications** developed by professor Anca Sipos. The course presents the basic theory regarding the fermentative technological processes in winemaking, different advance automatic control methods of the alcoholic fermentation process and a sustainable software application for the supervision and intelligent control of this process. The course starts with a short presentation regarding the fermentative technological processes and of the models applicable to oenology. Then, continues with a comparison between classical automatic control and the logic' fuzzy system, a method using filtering techniques to obtain more information about the fermentation process and a knowledge-based system as a software application for the supervision and intelligent control of the alcoholic fermentation process from winemaking. It was structured in 4 sections:

1.5.1. Fermentative processes in winemaking

- Short presentation of the fermentative technological processes
- Advances in the management of the wine fermentation process
- Short presentation the models applicable to oenology

1.5.2. The alcoholic fermentation process temperature automatic control

- Objectives and aspects
- The structure and the model of the process used in the temperature automatic control
- Comparison between classical automatic control (PI) and the logic' fuzzy system
- Source code example: MATLAB
- Results and discussion
- Conclusions

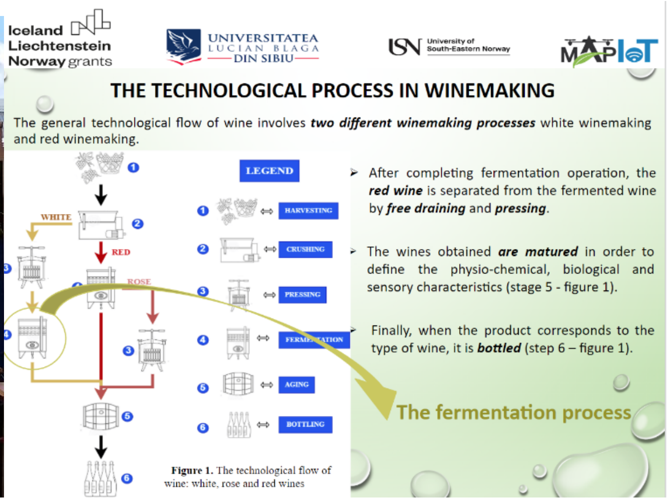
1.5.3. Sustainable method using filtering techniques for a fermentation process state estimation

- Defining the system structure of the process
- Developing the extended observer for state estimation of the exponential growth phase
- Developing the EKF for state estimation of the exponential growing phase
- The state estimation of the decay phase
- Source code example: MATLAB

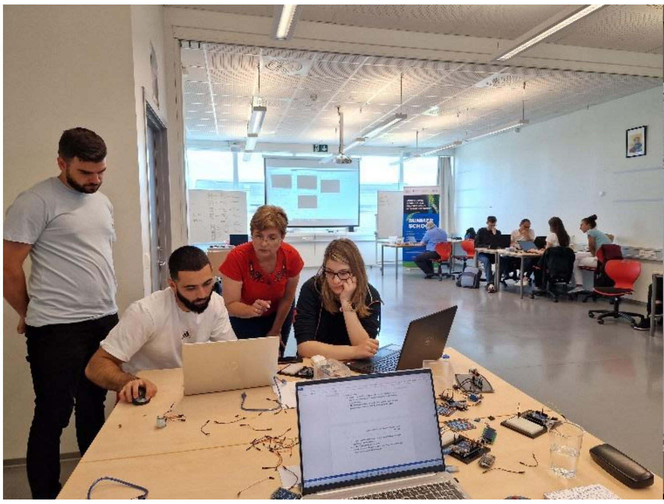
- Results and discussion
- Conclusions

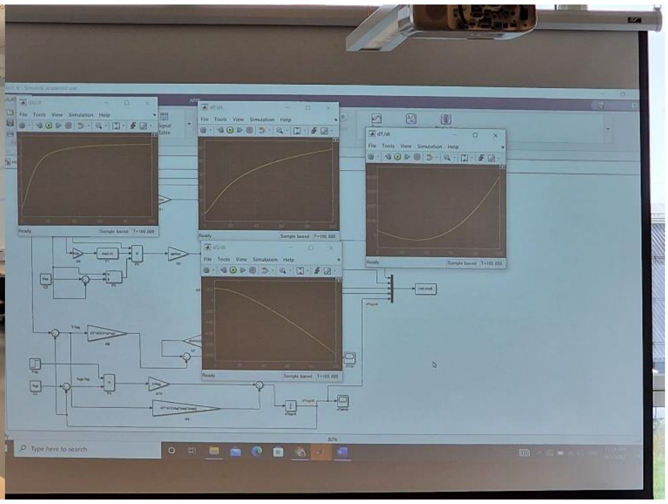
1.5.4. A knowledge-based system as a sustainable software application for the supervision and intelligent control of the alcoholic fermentation process from winemaking

- Introduction
- Information on alcoholic fermentation processes obtained from a representative experimental data analysis
- The automatic control of the alcoholic fermentation process
- Presentation of the application
- Results and discussion
- Conclusions



Practical work consisted in designing a Simulink diagram on a fermentation process analitical model and simulating diffrent cases. Students had to previously installed MATLAB and Simulink. Both ULBS and USN students benefits by MATLAB campus licenses (MATLAB, Simulink and learning resources) provided for academic use, free of charge.





The students were organized in 4 teams' work. They should test different sequences of rules for controlling the fermentation process, visualize the results in a graphical form. The evolution of the monitored and controlled variables of the fermentation process can be observed.
Accessing the following link it can be seen https://www.linkedin.com/groups/9164050/ can be find many pictures from classes.

1.6. The summerschool activities continued with the course **C4 Digital design of food manufacturing processes – theory and applications** sustained by professor Ion Mironescu. The course presents a hands-on introduction to the modelling and simulation based digital design of flexible food manufacturing processes. The course starts with a practical introduction to modelling and simulation of discrete event systems using the Petri net modelling language. The modelling of the building elements of a flexible food manufacturing line are then presented through practical examples. These elements are then integrated in the model of a complete manufacturing line. The complete model is used as starting point and testbed for the practical learning of digital design concepts. The course Is accordingly structured in 3 sections:

1.6.1. Introduction to modelling and simulation using Petri Nets

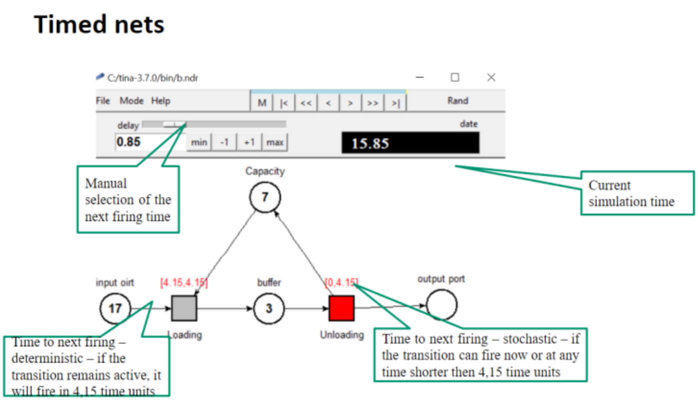
- Basic elements: places, transitions , arcs
- Simulation
- Modelling concurrency
- Timed nets
- Determinism vs stochastic
- Special arcs

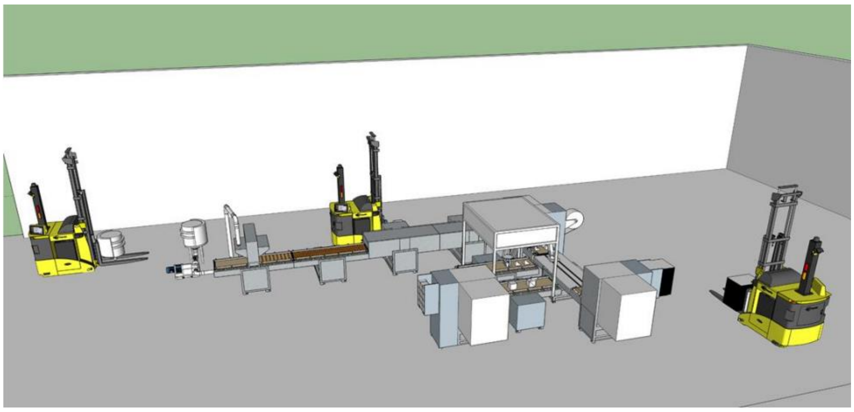
1.6.2. Introduction to modelling and simulation of food manufacturing processes

- Modelling processing equipment
- Modelling transport equipment
- Modelling control
- Modelling robots
- Modelling human operators
- Modelling a complete manufacturing line
- Simulating a complete manufacturing line

1.6.3. Introduction to digital design manufacturing processes

- Designing the layout
- Designing the operation of the line
- Designing the command and control system





1.7. One practical course followed by students was **C6 - Assembly lines for picking fruits / vegetables – applications** based on modelling and simulations with the robotic arm and a mobile robot. The lecturer was Professor Daniel Morariu. **T**he course introduces the students in the modelling and simulation of industrial processes involving cyber-physical systems (CPS) like robotic arms and autonomous guided vehicles. The first part introduces the students to the modelling techniques used to develop the control system for a cyber-physical system. The next part presents the possibilities of interfacing the modelling and simulation environment (Bee-Up) with the cyber-physical systems (small scale robots). The acquired knowledge is used in the third part for the development of a practical application a simulation of an assembly lines that picks and transport fruits to a specific place. The course structure is as following:

1.7.1. Modelling and simulation on the ADOxx platform:

- Short introduction in modelling languages and ADOxx.
- Bee-Up tool for modelling.
- Modelling CPS components
- Controlling CPS components

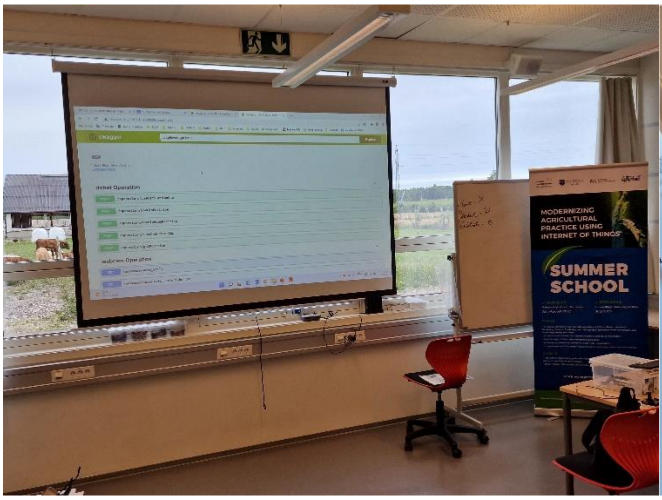
1.7.2. Interfacing with cyber-physical systems

- Architecture of the combined systems (Bee-Up + CPS)

- ADOxx/Bee-Up interfaces with cyber-physical systems
- AdoScript commands and feedback
- Developing a command and control model in Bee-up

1.7.3. Developing practical application

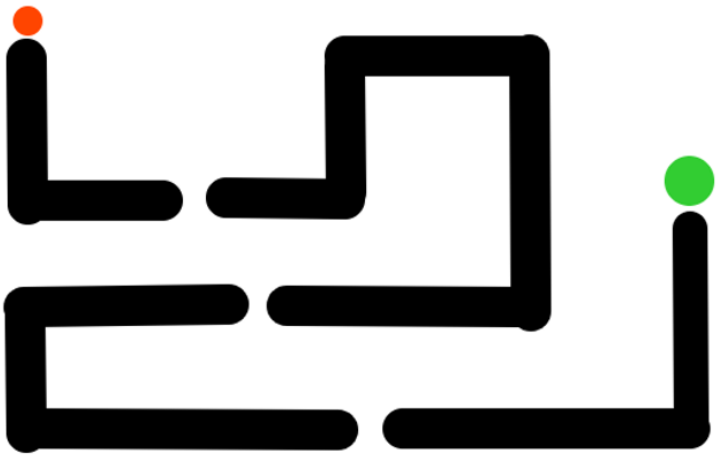
- Developing an application for the Dobot robotic arm.
- Developing an application for the mobile robot.



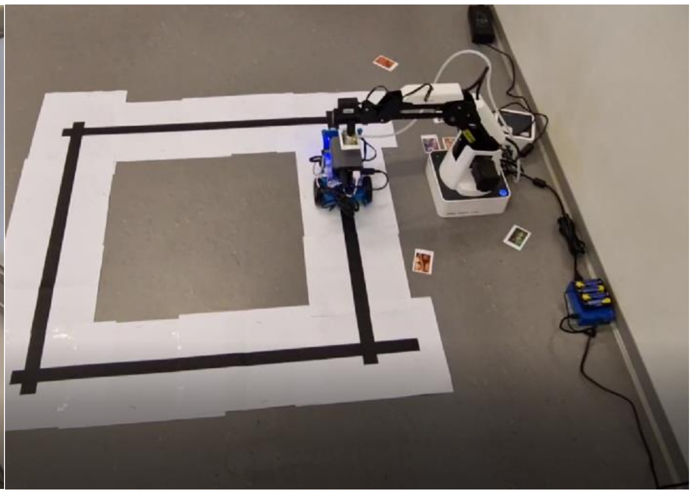
The students were organized in 4 teams' work. The teams should solve the following exercises.

Exercises

1. How does Bee-Up communicate with robots?
2. Develop the model that solves the following route in Bee-Up (Start from the red point and want to reach the green point):



Accesing the next link it cand be seen also some video files with robots in action: https://www.linkedin.com/groups/9164050/

1.8. The summerschool activities continued with the course **C5 Drones for gathering images and Computer Vision – theory and applications** presented by Professor Lasse Berntzen. He was assisted by MSc student Abouzamel Tareq. It was presented a drone, its facilities and the controlling mode of the drone, the basic theory regarding using drones and their capability of images gathering, a short introduction to Computer Vision and the programming requirements for image processing. The course describes technical challenges and solutions applied in agriculture. The course is structured in 3 sections:

1.8.1. Drones

- What is a drone? The components of a drone; The accessories
- Applicability. Using the drone model DJI MAVIC 3.

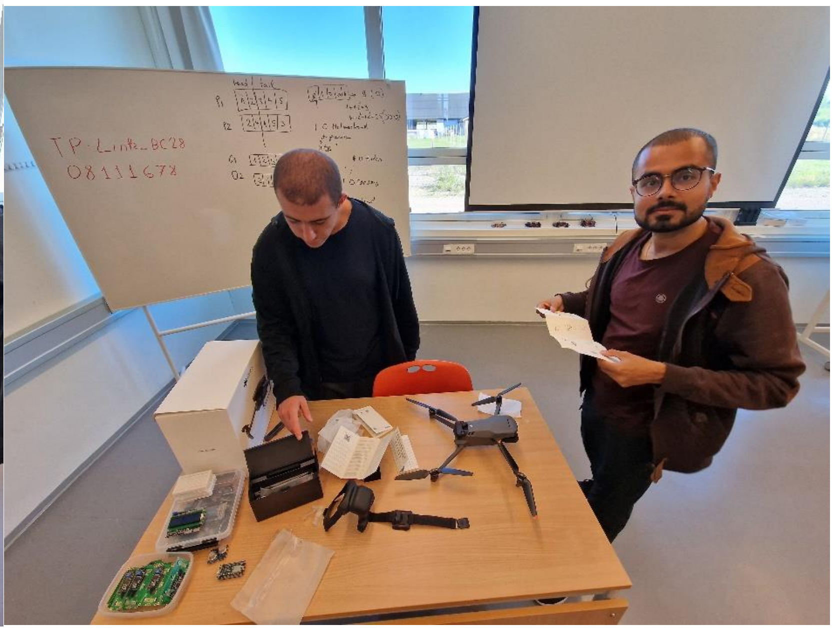
1.8.2. Drones and precision agriculture

- Agriculture and the usage of the drones
- Controlling a drone
- Monitoring the agriculture cultures
- Application: identification of areas affected by problems (floods, pests, etc.) from agricultural crops.

1.8.3. Processing the imagines obtaining by the drones

- Quick overview. Introduction to Python & OpenCV
- Features extraction.
- Transformations: image processing for extracting the region of interest, Thresholding, binarization, outline extraction, etc.

In the beginning of the second part students manipulated themselves the drone.




1.9. The last course of the summerschool was **C7 Develop your own business in agriculture and food industry – theory**, presented by Professor Lasse Berntzen. He emphasised the challenges and some general solutions regarding business perspectives using IoT in agriculture. The course content is structured in 6 sections and 2 examples:

1.9.1. The Business End of IoT

1.9.2. IoT Tech Defined from a Value Perspective

- The system integrator view; The design house view
- The business view; Network fabric; Bringing it together

1.9.3. Creating Value with IoT

- Make products better; Operate products better
- Support products better; Make new products

1.9.4. Modernizing IoT Value

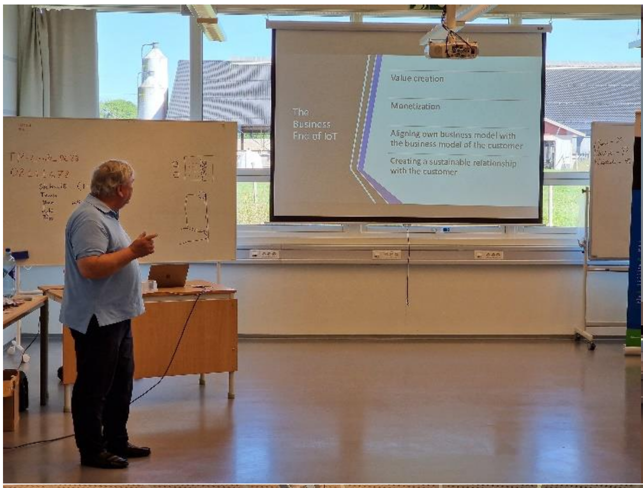
- The B2B IoT business model
- The IoT business model continuum
- The business model as a feature

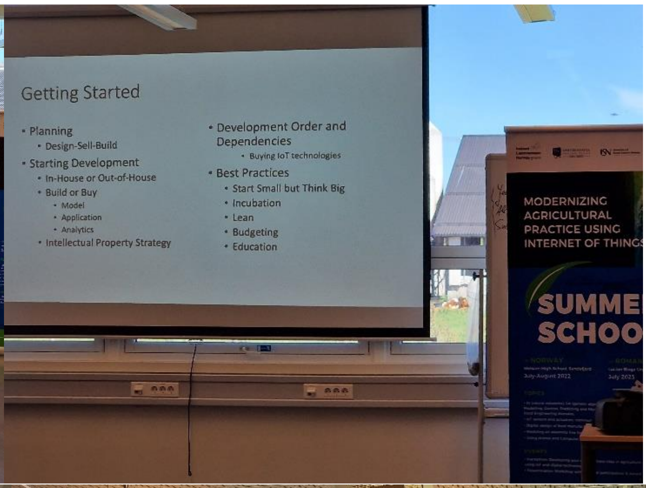
1.9.5. Analyzing your Business through the IoT Lens

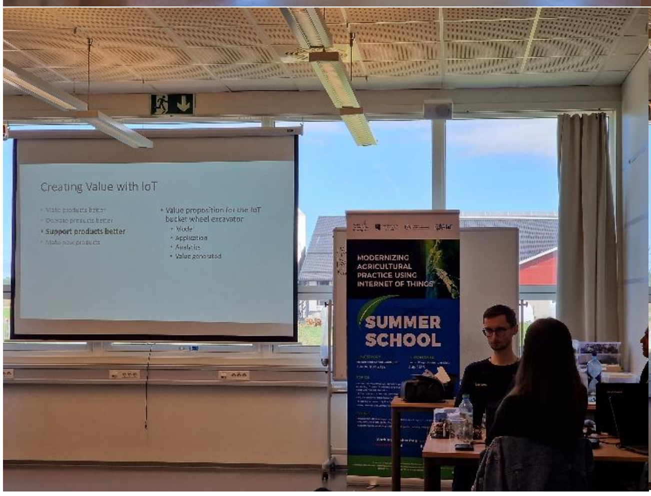
1.9.6. IoT Industry and the changes coming

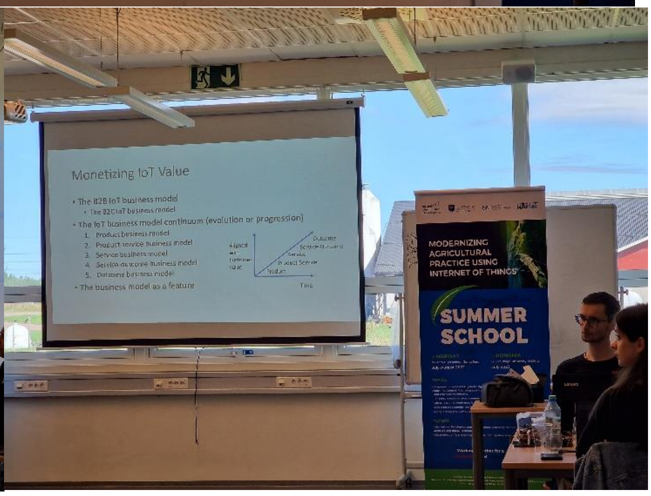
1.9.7. Example: All traffic Solutions

1.9.8. Example: IoT frying pan









At the end of courses students filled the Participant Feedback Form assigned for every course. The form reveals the participants satisfaction degree about the training (format, duration), the teaching method, the equipment resources used and available, the relevance of the subject matter(s) and knowledge brought by the teacher regarding summer school topics, the availability of additional materials, etc.

2. Visiting companies

Very important activities developed during summer school were the **visits to companies.** Two of these were responsible for collecting the waste food remained from restaurants and waste from population or animal garbage (from cows and pigs) and transform it in biofuel and the third was a farm of producing lettuces and potatoes, clean, sort, pack and delivery to food distribution chains.

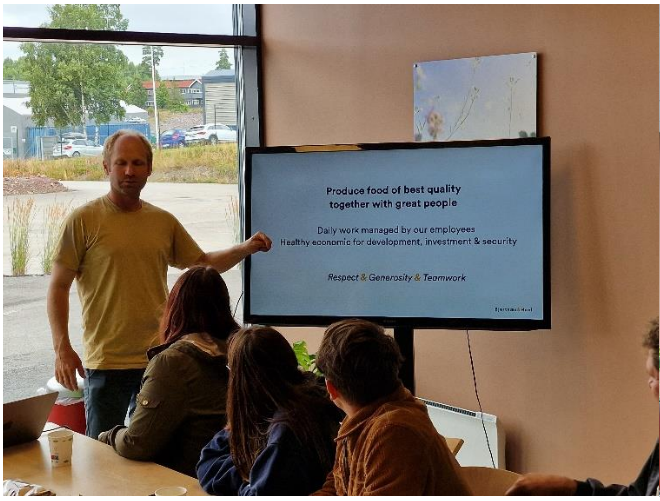
We visited first Vesar (Vestfold waste and resource) - https://vesar.no/media/ibzf1ikg/2s_vesar_kildesortering_original_engelsk_a4_nett.pdf, a larger company which dates since 2018 specialized in biochemical processes in organic waste handling. We were welcomed by Bjørn Erik Rui, the director for development. He explained the process of collection, sorting and mixing waste and generating further the biogas used in many processes like fuel for the fleet of busses and household waste collection machines in Vestfold County. Also we were introduced in “The magic factory” where students, pupils and visitors can learn about the necessity of collecting and proper sorting of waste, about the chemical process of biogas making (reminding also Mendeleev system - table of chemical elements).

Furthermore, we saw how biogas can help to accelerate the growing process of tomatoes. According to Anders Iversen, the responsible of tomatoes farm who was very kind and explained also the gas filtering and cleaning process, the prototype farm implemented at Vesar is capable to produce between

25 to 30 kg of tomatoes on square meter and the quality and taste are very good (we can confirm that we tasted)! The company will extend in February 2023 with another factory on larger area of 3500 square meter!
Based on what we saw there and the pictures that we made we may confirm that the Vesar Company represented a perfect and real implemented example of circular economy!

Later we visited the farm of Halgrim Stendal, Holmestrand. Halgrim is a farmer, innovator and entrepreneur that has implemented his own biogas production facility (from manure produced by animals). Actually, he intend to protect his idea by applying for a patent. He presented the prototype of his installation but also the 3D design of his small factory that he intends to develop! His idea is different from that of other companies and is based on keeping manure at relative warm temperature isolated from outside environment allowing an accelerated fermentation process! He also has shown us few examples of gas produced! This visit was a lesson of entrepreneurship but also we understood the challenges that he faced needing also investors who should believe in his idea!

The third visit was to Bjertnæs & Hoel farm where potatoes are cleaned, sorted, packed and prepared for selling! A lot of attention is paid both to the soil that produces the vegetables and to the people who work here! Respect, Generosity and Teamwork is the motto of company! Cleaning, sorting and packaging tomatoes was done using image processing! Also we learnt about transversal skills related to efficiency in agriculture, namely keeping a closer relations between farmers and consumers. This creates a new dynamic which makes the innovation process more likely to succeed at Bjertnæs & Hoel. Thank you very much for this lesson today!

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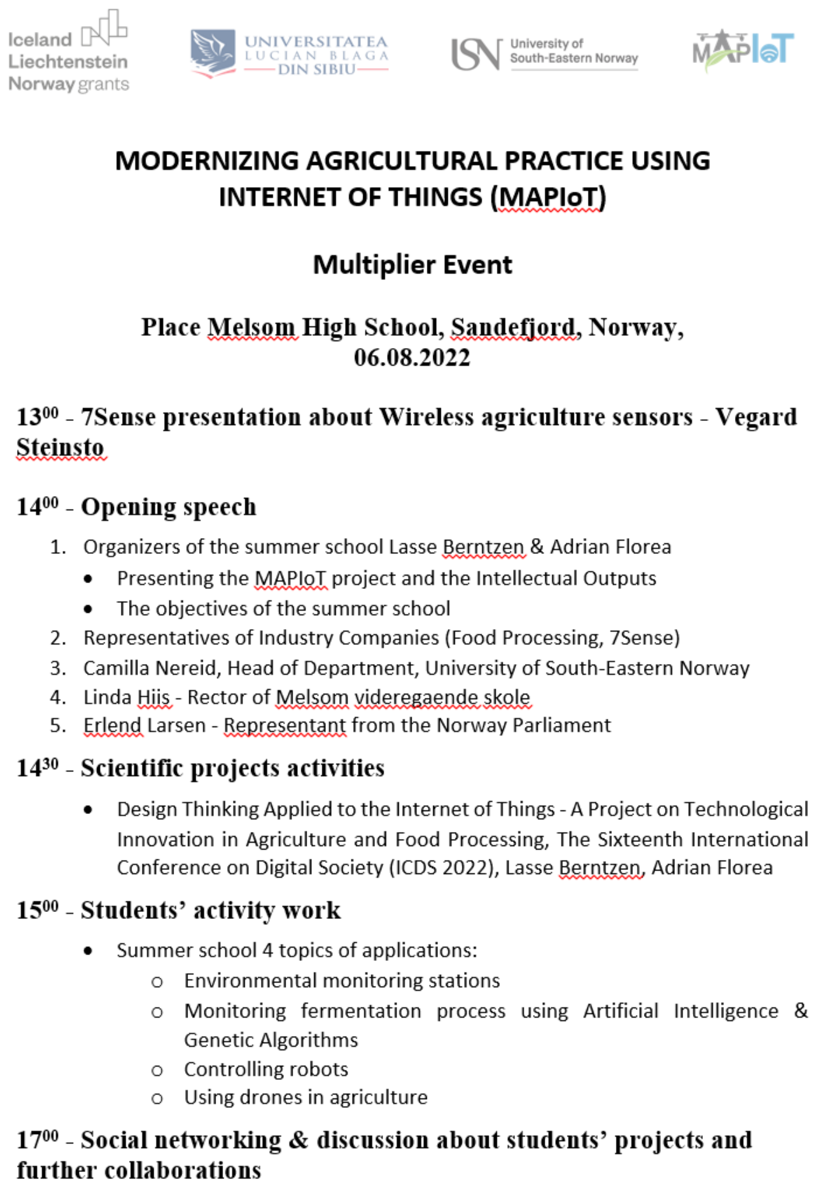
3. The Multiplier Event

In 06.08.2022 took place the Multiplier Event at Melsom High School, Sandefjord, Norway. For this event, the project manager realized the agenda.


Iceland Liechtenstein Norway grants
UNIVERSITATEA LUCIAN BLAGA DIN SIBIU
USN University of South-Eastern Norway
MAPIoT

MODERNIZING AGRICULTURAL PRACTICE USING INTERNET OF THINGS (MAPIoT)

Multiplier Event

Place Melsom High School, Sandefjord, Norway, 06.08.2022

13^{00} - 7Sense presentation about Wireless agriculture sensors - Vegard Steinsto

14^{00} - Opening speech

1. Organizers of the summer school Lasse Berntzen & Adrian Florea
   - Presenting the MAPIoT project and the Intellectual Outputs
   - The objectives of the summer school
2. Representatives of Industry Companies (Food Processing, 7Sense)
3. Camilla Nereid, Head of Department, University of South-Eastern Norway
4. Linda Hiis - Rector of Melsom videregaende skole
5. Erlend Larsen - Representant from the Norway Parliament

14^{30} - Scientific projects activities

- Design Thinking Applied to the Internet of Things - A Project on Technological Innovation in Agriculture and Food Processing, The Sixteenth International Conference on Digital Society (ICDS 2022), Lasse Berntzen, Adrian Florea

15^{00} - Students' activity work

- Summer school 4 topics of applications:
  - Environmental monitoring stations
  - Monitoring fermentation process using Artificial Intelligence & Genetic Algorithms
  - Controlling robots
  - Using drones in agriculture

17^{00} - Social networking & discussion about students' projects and further collaborations

In order to express their main results obtained during the two weeks of summerschool students prepared their report and presentations for multiplier event.

The students were organized in 4 teams' work. The topic for each team were: **Environmental monitoring stations**, **Monitoring wine fermentation process using AI & GA & FR**, **Controlling robots & Automation**, **Using drones in agriculture.**

Accessing the following link https://www.linkedin.com/groups/9164050/ it can be seen many pictures and video recordings from the speeches, lecture and exhibition from Multiplier Event.

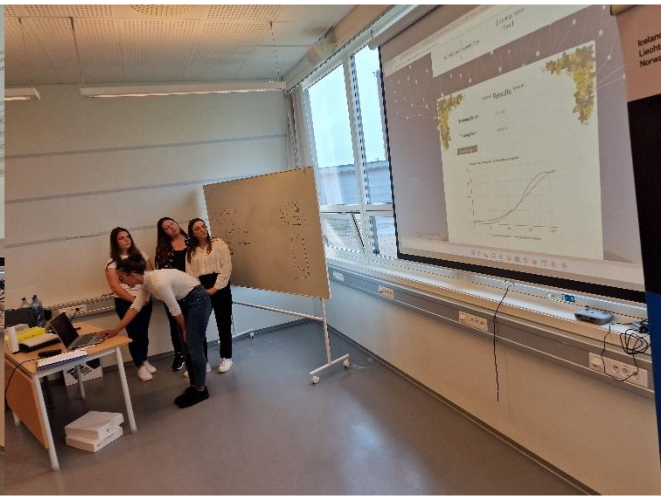
The event started with the lecture of Mr. Vegard Steinsto from 7Sense Company about **Wireless agriculture sensors**. After the welcome speech of MAPIoT summerschool organizers professors Adrian Florea and Lasse Berntzen who briefly presented the MAPIoT project and the Intellectual Outputs, the objectives of the summer school, every guest says few words. Among others we nominate representatives of Companies (Bjertnæs & Hoel farm, 7Sense), Ms. Camilla Nereid, the Head of Department, University of South-Eastern Norway, Ms. Linda Hiis, Rector Assistant of Melsom videregaende skole and Mr. Erlend Larsen, Representative of the Norway Parliament.

After the opening speeches, the two professors Lasse Berntzen, Adrian Florea presented the scientific projects activities and mainly the paper "*Design Thinking Applied to the Internet of Things - A Project on Technological Innovation in Agriculture and Food Processing*", given at The Sixteenth International Conference on Digital Society (ICDS 2022) where received the Best Paper Award - https://www.iaria.org/conferences2022/awardsICDS22/icds2022_a2.pdf!

The most interested and expected part was the presentation of students' activity work, what skills they achieved after two weeks of summerschool.

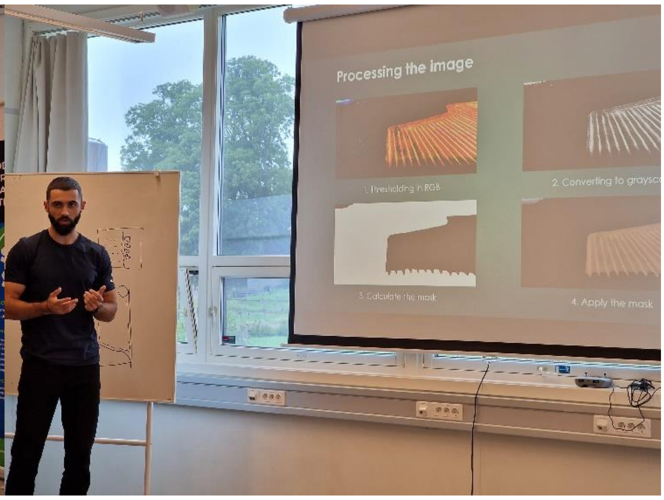
Team 1 presented the work on **Environmental monitoring stations** (detailed report is below in Annex 6.1).

Team 2 presented the work on **Neural networks in white wine fermentation** (detailed report is below in Annex 6.2).



Team 3 presented the work on **Controlling Robots & Automation** (detailed report is below in Annex 6.3).

Team 4 presented the work on **Drone - a possibility of aerial monitoring of crops in modern agriculture** (detailed report is below in Annex 6.4).



4. Hackathon

For the hackathon we allow students to create their own team and also to propose a specific theme that focuses around concepts like IoT, smart agriculture and food processing but that include a business plan and business idea. The applications proposed by students were:

a. Implementing a smart green house
b. Using AI into a pickle factory for tuning the right amount of salt
c. Using robots and IoT systems to find the proper time for harvesting
d. Mobile robot scarecrow for scaring different animals that attack the crop

Below there are one picture from each team presentation!

5. Challenges

However we faced a lot of challenges that we will detail further, we may say that both teams of teachers and organizers from USN and ULBS made efforts such that all activities to be developed according with the plan (as was written in the application)!
Briefly we mention these challenges:

a. Infrastructure challenges (long distances between accommodation and other objectives/cities, even for local students was difficult to be every day at summer school – the buses are running not every hour and taxis are very expensive). The costs of 275 Euro per traveling is very small and does not cover neither the flight with a low cost company between Bucharest and Oslo. There are many costs regarding traveling to Norway – from Sibiu to Bucharest, then Bucharest – Oslo (flight), from Oslo to Stokke (train), and bus from Stokke to Melsom. Also, these routes should be used conversely at return. Other challenge that we need to tackle relates also to train transport. During the summerschool period was a lot of maintenance on the Norwegian railway network and we need to runtime change routes or adapt to new situations and additional costs.
b. Heavy costs for living or traveling in Norway. Based on previous collaboration between USN organizer (prof. Lasse Berntzen) and NESTOR accommodation manager (Tom Erling Dahl-Hansen) we obtained the accommodation and breakfast and dinner at approximatively 65 Euro per day. But the lunch was not included. Also the project provided 58 Euro per student (that means at least 30 Euro per student less than should be for a decent daily life in Norway).
c. Not every day, the 20 students could attend to the courses either for infrastructure reasons (mentioned above) or for health reasons. The Norwegian partner had a total of 9 students of which one did not attend at all (due to costs, as the Norwegian students were not allocated funds for meals and transport to this summer school) and one student fell ill and could not attend to all the courses. However, she attended the dissemination event at the end of the summer school.
d. It was difficult to set up visits to certain companies or to attract more participants from the host university (USN) to the summer school activities because between 1st of July to 15th of August most of them are on holiday.

6. Annexes

6.1. The Team 1 report

Environmental monitoring stations

Team Members

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Mihăiță Ciucă

Deborah Ruxandra Maria Florea

Summer School, 2022
Melsom, Vestfold, Norway

Table of Contents

I. Abstract

The main target of this report is to present the advantages of using Internet of Things (IoT) technologies in the agriculture sector. We developed a system of environmental data collecting stations by connecting sensors, microcontrollers, radio frequency (RF) communication and cloud services. Multiple stations, powered by batteries, send data to a central node through radio frequencies where it is uploaded to the IoT platform ThingSpeak, over WiFi. Collected data, such as temperature, air humidity, soil moisture and light intensity, from the outside environment can be visualized in graphs in a web application provided by Thing Speak. Based on the collected data, many useful applications can be developed, which can help both the humans involved in agriculture and the agriculture itself. On one hand, these applications can ease the immense amount of work that farmers everywhere have to do, by using the obtained data to develop systems such as automated irrigation or smart greenhouses. On the other hand, the information collected can be used, for example, to monitor the crop living environment, better than a human could, in order to maximize the quantity, as well as the quality of the production. The main scope of developing such a system during this Summer School was to help Computer Science students exercise and deepen their knowledge in the explored areas, as well as offer an opportunity for students outside of this field to explore new technologies and become familiar with this type of systems.

II. Introduction

As part of the ongoing process of agriculture digitalization, computerized technology is being added with the goal of automating labor-intensive tasks, reducing labor expenses or adapting the production system to create value. The integration of software components as well as mechanical and electrical hardware components that may send information across a network is the primary characteristic of industrial digitalization. It is possible to manage computer working processes in such a way that they may be automated and controlled from distance using sensors, actuators and software algorithms that are all integrated into a cyber-physical system (CPS) (Marinchenko, 2022).

With food security becoming an important issue, higher yield and improved food quality needs to be assured globally. Agricultural industry is the main source of food production and by improving the agriculture sector, it will directly have an impact on the world hunger problem. Industry 4.0 with combining IoT, automated systems, wireless sensor networks, big data and analytics and cloud solutions in agriculture will create an efficient environment which provides better yield, food quality and quantity (R. Abbas, 2022).

According to author Kondaveeti et al. 2021 *“The Arduino Uno is a great tool for creating successful executable programs and enabling users to test out cutting-edge ideas they want to put into reality”.* The use of Arduino is a safe and economical way for prototyping various agricultural tools. A system developed in North Karnataka, India for monitoring soil moisture integrated Arduino sensors with IoT capabilities and neural networks to improve farmers' soil management and to forecast periodic rainfall. (Kondaveeti et al., 2021).

During the Summer School, we developed multiple applications using Arduino Uno and NodeMCU with various sensors for temperature, humidity, soil moisture, distance, smoke and local web servers displaying collected data. As a final project to strengthen our knowledge, we developed multiple environmental monitoring stations that collect data, send the information to a central node, where it is uploaded to the ThingSpeak IoT platform.

III. Models, Methodology, Tools and DataSets

The system is based on 2 types of microcontrollers: Arduino UNO and NodeMCU. Multiple Arduino boards are used to collect data from the environment and send it over RF to the NodeMCU which uploads this data in ThingSpeak. An Arduino Board is a mini-computer that consists of a physical programmable circuit board based on the ATmega328P microcontroller. NodeMCU is a low-cost open source IoT platform, which includes firmware that runs on the ESP8266 Wi-Fi System on a Chip (SoC) from Espressif Systems, and hardware based on the ESP-12 module. These 2 microcontrollers are perfect for developing DIY IoT projects, due to them being low-priced, easily programmable and having a wide variety of libraries. The code was written in C++ programming language using Arduino IDE, an open source platform available on Windows, Linux and MAC.

Each collecting station has 3 different types of sensors: a DHT11 for air temperature and humidity, a photoresistor sensor for light intensity and a soil moisture sensor to measure the water levels in the soil. For the RF communication, we connected a nRF24L01 module, that is a RF multiple transmitter and single receiver which operates at 2.4 GHz at a maximum range of 100m in plain sight. The Arduino is powered by 4 1.5V AA batteries, the reasons behind choosing this type of power source being ease of transport and handling, as well as the lack of electric plugs located outside. The Arduino with all sensors and the RF module drains 26.75mA. The total capacity of the batteries is 4*2.95A=11.8A, so the running time of the collecting station is 11.8A/0.026755A=441.12 hours.

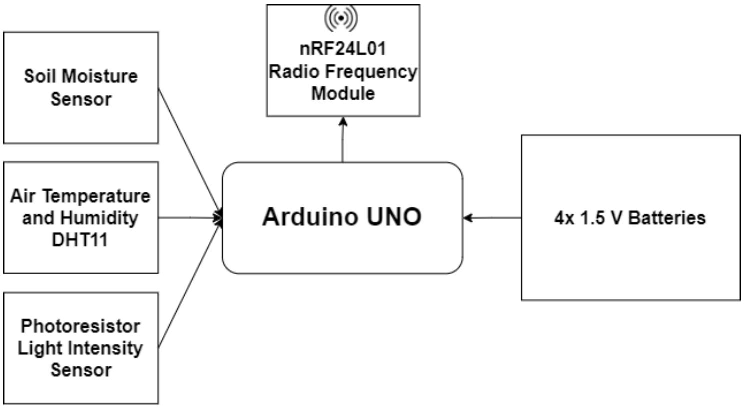

Fig. 1. Collecting station with Arduino, sensor, RF module and batteries

The central node, whose purpose is to receive all the data sent by the collecting stations and upload it to ThinkSpeak, also has a nRF24L01 module. The NodeMCU is powered by a 10000mA power bank, but it could also be powered by batteries.

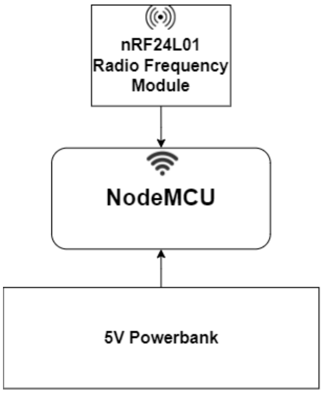

Fig. 2. Central node with NodeMCU, RF module and powerbank

The communication between the collecting stations and the central node is wireless, using radio frequency. At 1 minute intervals, samples of data are collected and sent to the central node. In order to connect and send data to the ThingSpeak platform, the NodeMCU is connected to a Wireless Local Area Network (WLAN) and Hyper-Text Transfer Protocol (HTTP) is used.

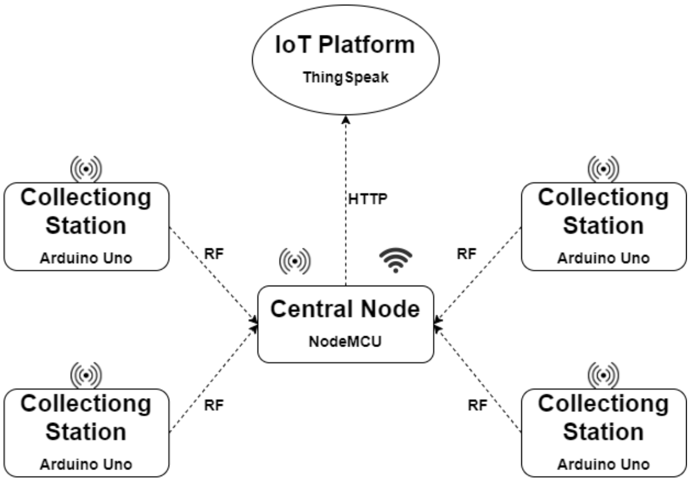

Fig. 3. Communication between collecting stations, central node and ThingSpeak

Each collecting station has a specific identifier (ID). In order to differentiate the packages of data received in the central node, the collecting stations also send the ID. The format of the packages contains ID, soil moisture, light intensity, air temperature and air humidity separated by the '$' character (e.g. data sent by station 1: "1$50.00$75.00$33.00$15.00").

ThingSpeak offers 4 channels for free, where each channel can contain a maximum of 10 fields. As we collect 4 factors, we need only 4 fields. After creating the channels, each one is accessible through an API key. Having only 4 collecting stations, these channels are enough for our system. The central node keeps a record of each collecting station's ID and its API key, so after receiving a data package over RF, it gets the station's ID and uploads the data to its channel via its API key. Uploading data to ThingSpeak is made with HTTP requests. A GET method is called to the ThingSpeak platform's URL with parameters as: the API key and the values for the 4 fields (e.g. url for station 1: "http://api.thingspeak.com/update?api_key=0XC9N487XRR333AE&field1=50.00&field2=75.00&field3=33.00&field4=15.00"). The method of uploading data from the central node was chosen due to the fact that connecting the collecting stations to the internet would increase the power consumption of the microcontrollers, therefore sending the data over RF is more efficient than using internet protocols. In this way, the running time of the stations increases.

IV. Results

The four environmental monitoring stations that have been assembled were placed in the school garden in four different locations and have collected data for two hours, at one minute intervals.
The graphs presented below were generated in the ThingSpeak platform, based on the data collected by one of the stations:

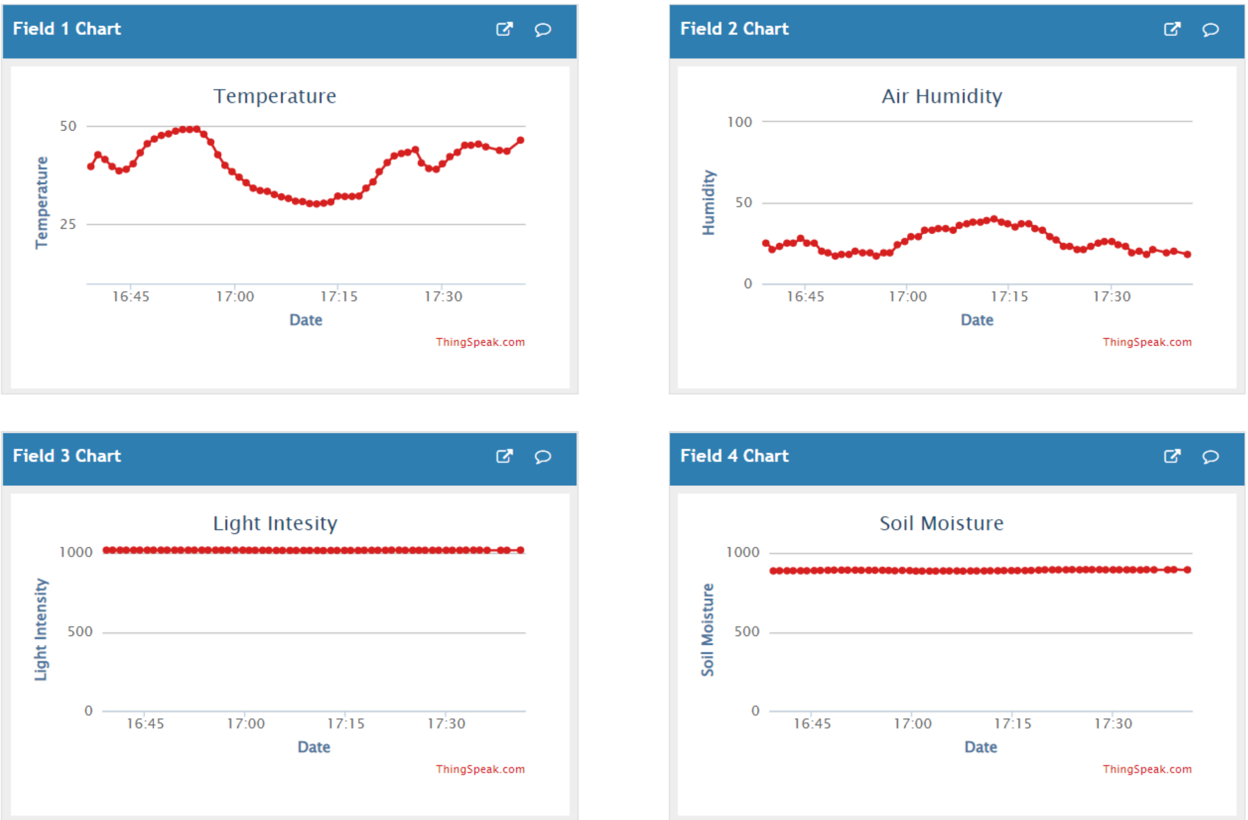

Fig. 4. Graphs generated in ThingSpeak web application

As can be observed, the chosen station has collected data only for 2 hours, as a result of technical problems that have been encountered regarding the Arduino Uno. The solution was replacing the Arduino entirely.
Another interesting fact that can be seen on the graphs is the high level of the temperature (up to 50°C). This is due to the fact that the temperature sensor was in direct sunlight, heating it up. However, a drop in temperature can be observed in the graphic at the same time as a rise in humidity. This type of information can be further analyzed during a longer period of time and more complex applications can be developed using this data.
Moreover, the light intensity did not change due to the fact that the experiment took place during the day, remaining at maximum value due to direct sunlight. The soil moisture did not vary, as a result of the soil not being irrigated and it not raining during the experiment.

V. Conclusions

The data that were collected (humidity, temperature, light intensity and soil moisture) are of great importance in the agriculture industry, as they can influence the quality and safety of the final products. The obtained information can be used to determine the best course of action for achieving the finest results, as vegetables, cereals and fruits are very fragile to environmental changes. For example: if a parameter is increasing or decreasing compared to the optimal values, we can act and change that in time, without risking the quality of the product.

The accuracy and efficiency of the system is limited due to a few factors:

- The sensors used are low-priced, which reflects on their lower accuracy in collecting data.
- The data is transmitted via radio frequency using the nRF24L01 module, which has a small distance range (100m) and can easily interfere with other nearby radio devices, resulting in the module failing to send/receive data for short periods of time.
- The collected data is uploaded to ThingSpeak, an online platform which can receive only a maximum of 8219 daily HTTP requests. Having 4 different stations, each with its private channel on ThingSpeak and collecting data every minute, a total of 5760 requests can be made daily. A real farm would have more than 4 stations, making it impossible to manage with only 8219 daily requests.
- The stations work for a limited period of time (441 hours), as they are powered by 4 low-capacity batteries. Moreover, the stations do not have a system that detects and announces low-battery level, making it impossible to know when a station runs out of power besides checking manually.
- The central node needs a stable connection to the internet and good WiFi signal to be able to upload the collected data to ThingSpeak, which should also always be online.

References

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- R. Abbasi, P. Martinez, R. Ahmad. (2022). *The digitization of agricultural industry – a systematic literature review on agriculture 4.0*. https://doi.org/10.1016/j.atech.2022.100042

6.2. The Team 2 report

Neural networks in white wine fermentation

Team Members

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Summer School, 2022
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Motto: "Life is too short to drink bad wine."

Table of Contents

I. Abstract

The purpose of this technical report is to show the use of neural networks in the white wine fermentation process by supervising and controlling the variables' evolution.

Neural networks try to simulate the neurophysiological structure of the human brain. Neural networks allow computer programs to recognize patterns and solve common problems. So, it can be viewed as defining a function that takes an input (observation) and produces an output (decision).

For supervising the variables evolution in white wine fermentation we used an application made by a master student with the help of professors Anca Șipoș and Adrian Florea, created at the „Lucian Blaga" University of Sibiu.

This Web application implements the following main features:

- User-customized Multi-Layer Perceptron (MLP) and Neural Network (NN)

- Meta-heuristic optimization methods for NN hyperparameters
- Training and testing the tool based on experimental data
- Graphical visualization and comparison for the acquired findings
- Ready-to-use prediction tool for fermentation variables

After the simulations we have been able to observe the overall results; the differences between the predicted and expected concentration of alcohol and substrate.

II. Introduction

Wine is an alcoholic drink typically made from fermented grape juice. For the fermentation to take place the yeast consumes the sugar in the grapes and converts it to ethanol and carbon dioxide, releasing heat in the process. Different varieties of grapes and strains of yeasts are major factors in different styles of wine. These differences result from the complex interactions between the biochemical development of the grape, the reactions involved in fermentation, the grape's growing environment and the wine production process.

Following the knowledge gained at the Faculty of Agricultural Sciences, Food Industry and Environmental Protection we have concluded that we can bring the food industry and agriculture to a higher stage by using artificial intelligence.

So, in order to supervise and control the proper fermentation of white wine we use an application that is using neural networks and multi-layer perceptron. Neural networks try to simulate the neurophysiological structure of the human brain. The name and structure are inspired by the human brain, mimicking the way that biological neurons signal to one another. It means that a computer program is allowed to recognize patterns and solve common problems that it learns.

The alcoholic fermentation process is a biotechnological process and is undoubtedly one of the most important steps in winemaking. The alcoholic fermentation in the winemaking industry is a complex process that must account for characteristics, including the following: batch fermentation on natural complex media, anaerobic conditions due to $CO2$ production, the composition of the raw material, the low media pH, levels of sulphur dioxide, inoculation with selected yeasts, and interactions with other microorganisms.

Controlling the alcoholic fermentation process is a delicate task in winemaking for several reasons: the process’s complexity, nonlinearity, and non-stationarity, which make modeling and parameter estimation particularly difficult, and the scarcity of on-line measurements of the component concentrations (essential substrates, biomass, and products of interest). One of the core issues in industrial winemaking involves developing soft sensors with outstanding performance and robustness to replace the hardware/physical sensors in bioreactors. This would reduce the disadvantages of real-time measurements, nonlinearity constraints, and other complex mechanisms in the fermentation process.

An alternative to overcome the difficulties mentioned above is to use neural networks (NNs), one of the fastest growing areas of artificial intelligence. With their massive learning capabilities, NNs are able to approximate any continuous functions and can be applied to nonlinear process modeling. If properly trained and validated, these models can be used to accurately predict steady-state and dynamic process behavior and thus improve process control performance.

A NN model can offer information regarding the values of the state variables (as inputs: biomass and temperature from the bioreactor; as outputs: alcohol and the substrate) useful for a control system in the fermentation process. This is due to the ability of a NN to "learn" the shape of a relationship between variables from the data observed in the training regime and generalize that relationship to the data zone requested in the test regime. Such information is important especially in the exponential phase of biomass production.

III. Models, Methods, Tools, and Data Sets

For the development of the application data obtained in a bioreactor were used. The bioreactor has been equipped with sensors and analyzers to monitor pH, temperature, level and stirred speed control, dissolved O2, and the released CO2 and O2.

Therefore the neural network was trained using experimental data obtained from the bioreactor where fermentation occurred. The data were collected either by samples acquisition and analysis or from the transductors. Different datasets were used in the training and testing steps, which contain some or all of the following process variables:

- Temperature;
- Biomass concentration;
- Time;
- Initial substrate concentration (glucose);
- Substrate concentration at time;
- CO2 concentration;
- Evolved oxygen concentration;
- pH.

All those data were used to create the following application:
http://193.226.29.27/WineFermentation/NeuralNetworkConfig

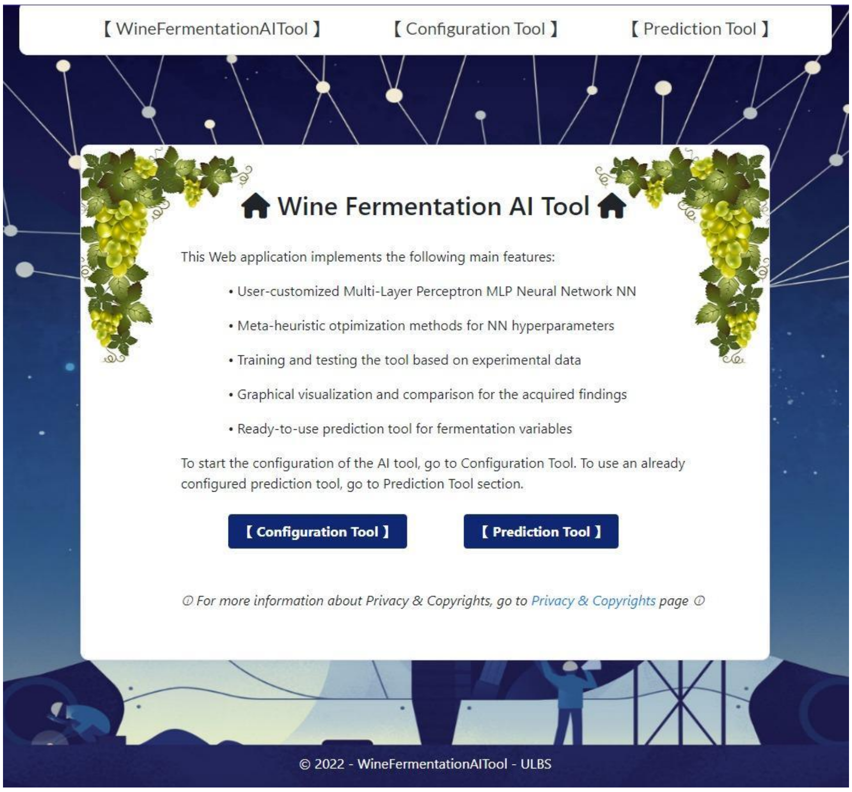


Fig. 1. Tool interface

As it can be seen in the picture above, the tool contains a variety of inputs and so we can configure the application based on what we need.

The purpose of predicting these process features is to obtain information about status variables so that the process can be automatically driven.

In the following table can be seen the phases of yeast growing.

Phase	Caracterisation	Observations
I. Latent (adaptation)	It takes place the regeneration processes of the hyphes or the germination of the spores, the function of the inoculums type.	Generally, this phase has a reduce practical importance. For this reason, in order to be eliminate this phase, more generation of cells are cultivated on the respectively medium aiming to accustom the cells with it.
II. Begining of growing	The volume of the cells is growing fast.	
III. Exponential growing	The specific growth rate μ is constant and the biomass growing is exponential.	This phase presents a practical importance when we have in view the obtaining of biomass. The metabolically activity from the exponential phase is in fact the primary metabolite; it corresponds with trot phase.
IV. Decelaration growing	The specific growth rate μ comes down.	It appears when the feed with an essential nutrient becomes insufficient or an element necessary for growing has been run out or in the medium has been accumulated intermediary substances.
V. Stationary	The microbial cells reach a maximum concentration, the proportion between alive and death cells number remains constant. The quantity of limiting nutrient influences this quantity of biomass, named total production.	The secondary metabolism is typical for the stationary phase; it corresponds to idiophase.
VI. Decay	The cells die, it takes place the autolysis, the quantity of biomass comes down.	At one point it is possible that an easy growth of biomass to take place, due to the alive cells' consumption of the nutrients. The nutrients have been delivered by the lysated cells. For a valorous culture, the decline phase must be eliminated.

Table 1. The microbial population growing phases

This application works on fuzzy rules so it works on conditional statement. The form of fuzzy rules is given by IF THEN statements. So for example: IF ((CO 2 =const.) AND (CO 2 <=0.5)) AND ((pH =const.) OR (pH decrease)) AND (substrate concentration=const.) AND (last_phase=latent_phase) THEN (new_phase= latent _ phase). DESCRIPTION: identify the latent phase in biomass developing.

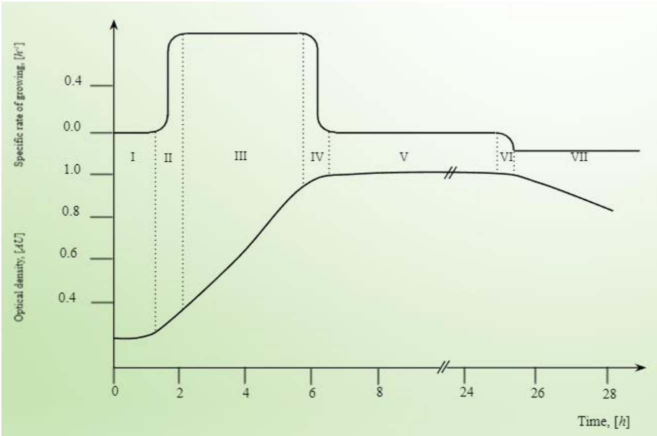


Fig. 2. The microorganisms number evolution vs. time

We tested the application for a series of initial data, inputs like temperature, time, substrate concentration, and biomass and also, we can configure the pH and CO_2 concentration released. For the application to "learn" and predict we also uploaded a data set sheet. As outputs we receive the alcohol concentration and substrate concentration.

Fermentation process parameters

Data sets used for training and testing the NN (in and out parameters).

	DATASET 1	DATASET 2	SIGNIFICANCE
INPUT	*T*	*T*	*Temperature (°C)*
	t	*t*	*time (h)*
	S_0	S_0	*Initial substrate concentration (g/L)*
	X	*X*	*Biomass concentration (g/L)*
		pH	*pH*
		CO_2	*CO_2 concentration released (percentage volume)*
OUTPUT	*P*	*P*	*Alcohol concentration (g/L)*
	S	*S*	*Substrate concentration (g/L)*

Dataset organization spreadsheet for a fermentation temperature of 24 °C.

INPUT				OUTPUT	
Time **[h]**	***X*** **[g/L]**	***T*** **[°C]**	S_0 **[g/L]**	***P*** **[g/L]**	***S*** **[g/L]**
0	0.1	24	210	0.2	210
5	0.1	24	210	0.2	210
...	...	...	...	...	...
127	2.4259	24	210	19.1123	158.7665
...	...	...	...	...	...
197	1.107	24	210	52.0241	24.135

Fig. 3. Fermentation process parameters

In the following image is presented an example of how the wine fermentation tool works.

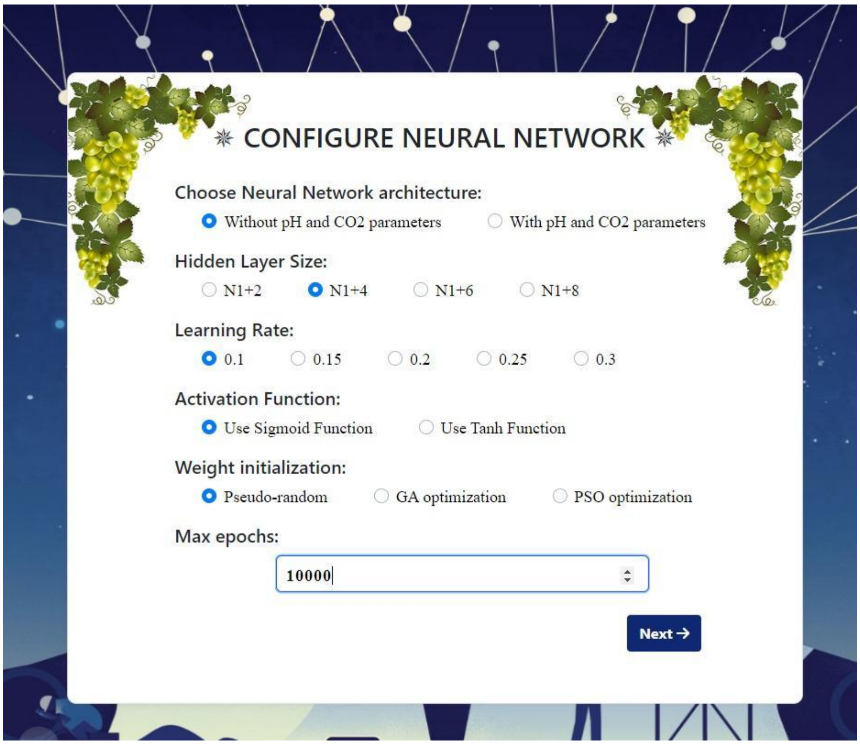


Fig. 4. Application home

As it can be seen in Figure 4, the tool has a configuration interface from which we can select the options that we want. In Figure 5, are represented the selectable temperatures at which the alcoholic fermentation process starts.

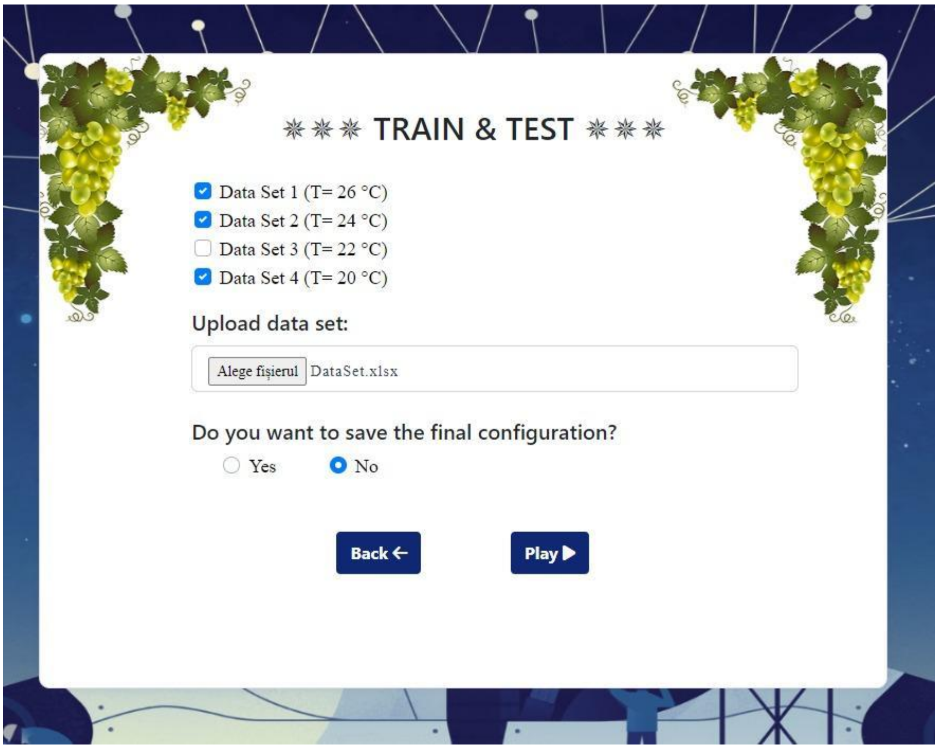


Fig. 5. Train and test

The chart from Figure 6 shows the consumption of the amount of substrate.

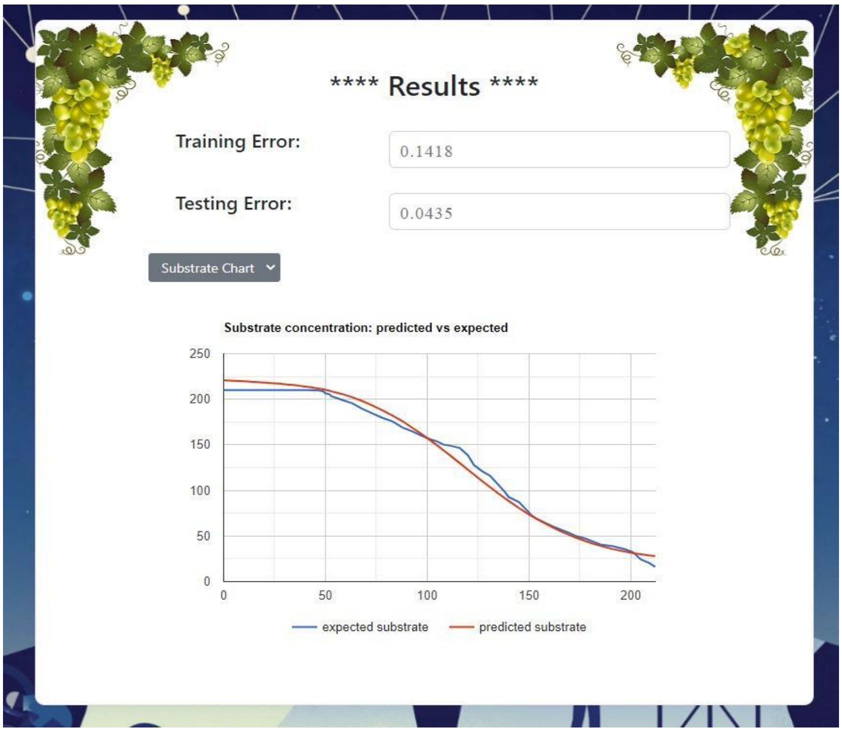


Fig 6. Substrate representation chart

The chart in image 7 shows the formation of the amount of alcohol.

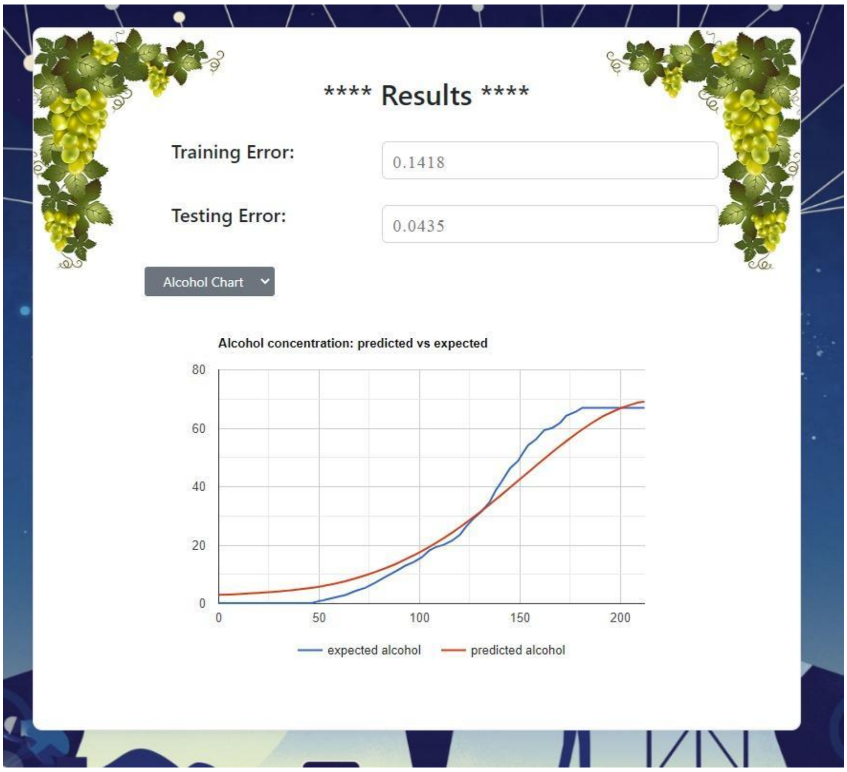
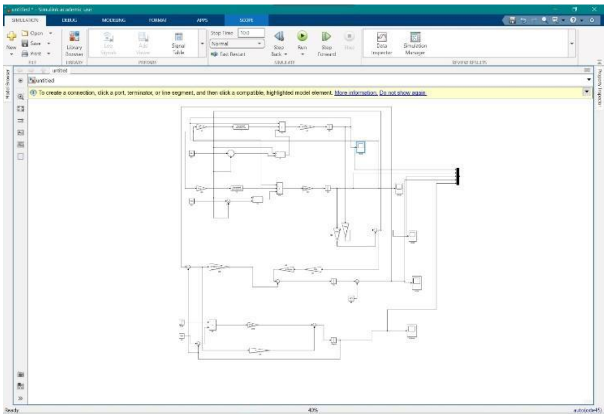


Fig. 7. Alcohol representation chart

Beside the developed application we used MATLAB as well. By using different blocks from the library we managed to start a Simulink system. We also added some initial data, known values. After linking every block in the right order and in the right place we could see the final results. Each scope block represented a graphic for: yeast, alcohol and substrate concentration.



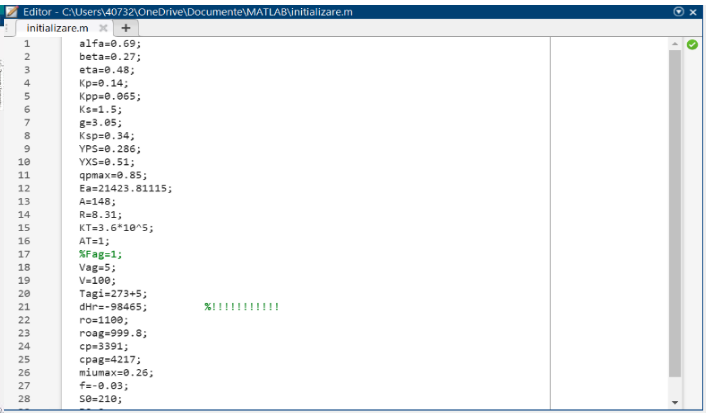


Fig 8. Simulink system   Fig 9. Initial data

IV. Conclusions and Further Work

This paper proves the possibility of integrating the field of artificial intelligence and machine learning into fermentation bioprocesses. This is a hybrid work combining two different fields, computer engineering and food engineering, showing the usefulness and necessity of digitalization in the development of processes in today's industrial climate.

Wine fermentation is a complex bioprocess in which monitoring the variables is crucial for obtaining the right products. One simple mistake and the end results will be compromised. So, in order to avoid that, neural networks and artificial intelligence can be implemented, thereby the process will be monitored and controlled.

Although the artificial intelligence is doing its job and works properly, minor errors can appear and so in the further work we want to eliminate them as well.

V. References:

[1] Florea, A.; Sipos, A.; Stoisor, M.-C. Applying AI Tools for Modeling, Predicting and Managing the White Wine Fermentation Process.

[2] Sipos, A.; Florea, A.; Arsin, M.; Fiore, U. Using Neural Networks to Obtain Indirect Information about the State Variables in an Alcoholic Fermentation Process.

6.3. The Team 3 report

Controlling Robots & Automation

Team Members

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Adel Hedjar

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Motto: "Science is the magic that works"

Table of Contents

I. Abstract

The present paper represents an introduction into the robotics world. The theme of the project encapsulates two important concepts which targets the robots: Controlling robots and Automation.

Using our robots, the DoBot and mBot, along with some technologies such as Bee-Up, we can model and test the functionalities of the robots in different scenarios. These steps are important when developing complex applications with robots because in this way we can establish the right behavior and the possible unexpected events that can be avoided.

II. Introduction

With the advancement of technology, more ICT applications have been integrated into organizations to facilitate the execution of tasks, save money, time, and increase efficiency. Robotics is one of many applications that have been widely used in several industries. What constitutes a robot is debatable depending on the use case.Robotics has reached the apex in manufacturing, for example. In our case, and during the summer school, we were introduced to dummy robots that execute a set of fixed and simple commands. Usually, these commands are repetitive tasks. Thus, a robot is a machine that executes a repetitive, mathematical form of action that could mimic human action to achieve an objective.

Any activity that is handled by a machine is considered a form of automated process. That is because human actions were substituted by machine actions. Organizations tend to automate processes to save money and time.

Many fields other than manufacturing are in an increased need for more applications of robotics such as education, agriculture, and medicine. Robotics can facilitate the management of crops, monitor the performance of farms, and efficient use of resources.

Modeling is an essential step before developing any automated process as it explains the problem domain and how it can be solved in logical and abstracted order. Conceptual modeling is easy to understand and execute for those who are non-IT practitioners.

Fig 1. Harvesting robot for tomatoes

III. Hardware and software components

DoBot (Robotic arm) is a single arm robot that can pick, pass, and move small objects from **X** point to **Y** point. It has a fixed part, so that it can stay on a flat surface. All the actions are done by its arm. This arm is given instructions and commands by the programmers. This arm is capable of moving on 3 axes - Ox, Oy, Oz. It can have different extensions: a 3D printer, a plier or a pen. For our implementation we have used a suction pad.

Fig 2. Robotic arm to be programmed

The mBot is a code based small robot with four wheels. It contains an Arduino and a RaspberryPi board, which are open sourced programmable boards that can execute a variety of commands.

The mBot has the possibility to recognize different modifications on the track and it can also detect obstacles. This feature is included in the standard version. Nevertheless, the features of the robot can be extended by adding some extra equipment.

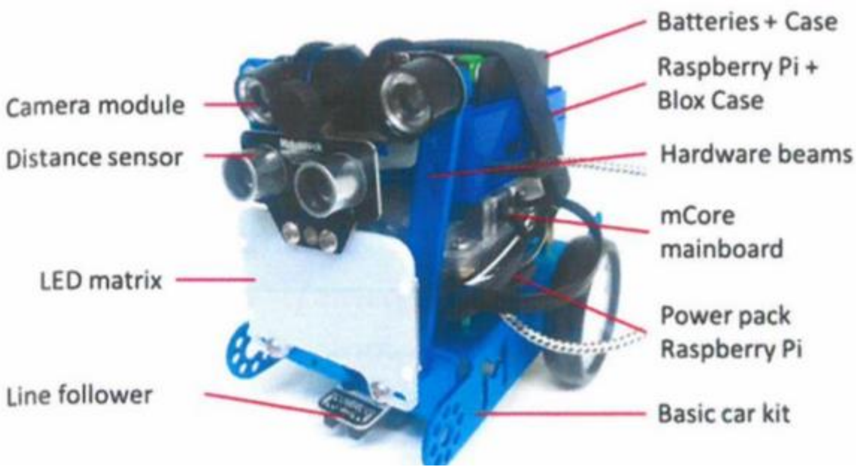

Fig 3. Mobile robot to be programmed

IV. Tools used for representing/testing the functionality of the robots

We used the Bee-Up tool in order to control the two robots. This tool has been created based on the ADOxx development environment, by the OmiLab team. One big advantage of it, is that we can use different alternatives to model a real problem. As presented in the picture below, we used a flowchart based solution to describe the behaviour of the two robots.

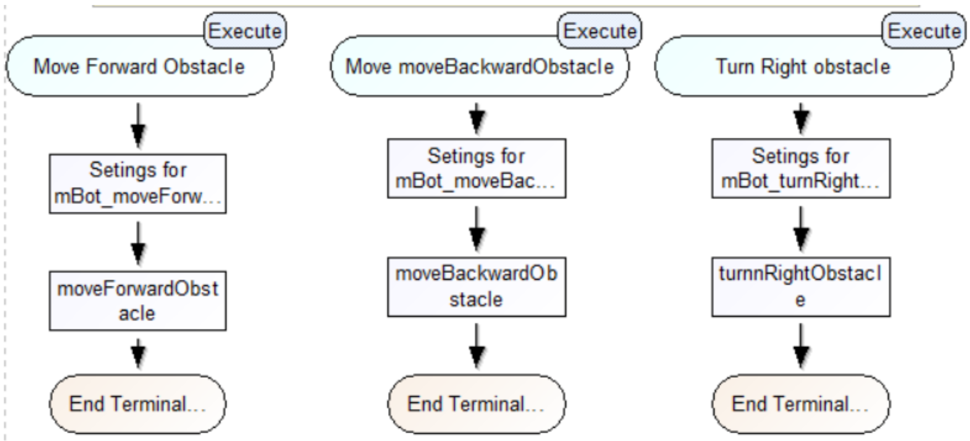

Fig 4. Mobile robot to be programmed

The Bee-Up tool is installed on a PC. The commands are sent via WiFi, from BeeUp to a specific IP address, of a RaspberryPi situated inside the robots. The RasberryPi receives the commands and it launches the execution for each robot.

V. Models, Methods / Methodologies, Tools

- **Possible scenario**

As an applicability for real life we thought of the following scenario:

Supposing in a store there is a need for some products to be moved from one place to another. This thing can be done in an automatic way by using the two robots.

The DoBot can be responsible for picking up products from a specific position, load the mBot with them and then the mBot can carry away the products to another place where they are needed. Additionally, in this place another DoBot can be placed and use it for emptying the mBot.

- **Implementation**

In order to reproduce this scenario we used the mBot, DoBot, some cards which represent the products and some white papers marked with a black line which is the route of the mBot.

For simulating the process we used Bee-Up (Flowchart) which gives us the possibility to set up some successive commands to fulfil the task.

At the beginning the mBot follows the black route until the gap located in front of the DoBot is detected – here it stops. For picking up the products we established the coordinates where the DoBot should move the arm. After arriving in the correct spot the card can be picked-up using the pump attached to the robot arm. Then with the card in the DoRobot pump, the arm of the robot is moving to a place where the mBot is located based on some new coordinates. Here the card is dropped directly on the mBot. Now that the mBot has something to transport it can continue its route.

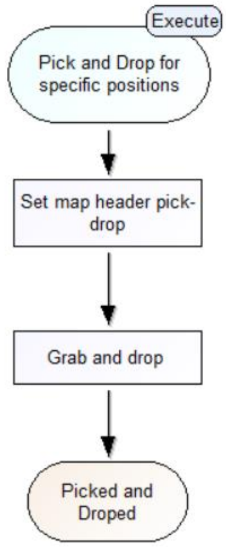

Fig 5. Flowchart for picking and dropping the card

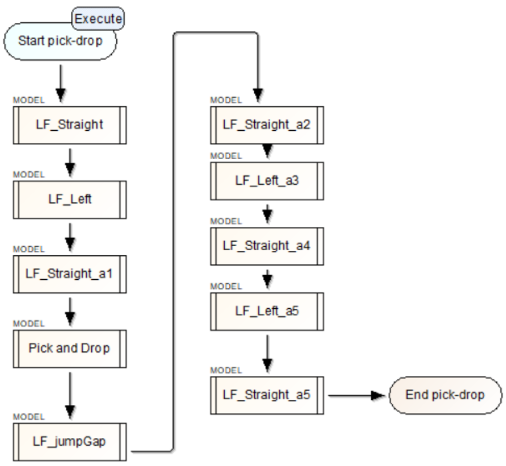

Fig 6. Flowchart for cooperation of the two robots

VI. Challenges

The main challenges that were faced by our group during this summer project are in regards to the position of the dobot arm geometric coordinates. There were two available robots to use, but one of the machines was in Romania, and the controls were done virtually. As a result, the coordinates used to control the robot were not the same as those used to control the other robot. This made the task of creating a use case time consuming. Besides, the Bee-Up tool was also new for us so we had to understand it in a quick way.

VII. Discussions

Regarding the agriculture field a lot of more utilities can be found by using the two of the robots due to the flexibility of each. As an example, attaching a camera to the mBot so it can walk through the culture and detect if the plants are damaged. The DoBot along with the mBot can be used for harvesting.

For future applications, it is possible to use tinyML with the doBot and mBot. TinyML will enable the integration of machine learning and IoT bringing the beauty of two worlds. One simple application that can be used is making the mBot analyse the track points for example point (A & B) and find obstacles, then learn how to create the optimal root by avoiding the objects.

VIII. Conclusions

In this course we learned about what it means to control a robot and the importance of how precisely the movements and the moments of executing a task should be. Also, we were introduced to the Bee-Up tool which allows us to model processes that should be done by robots.

We managed to realize what we proposed in the first place: a minimalist presentation of an autonomous way of carrying products in a store.

6.4. The Team 4 report

Drone - a possibility of aerial monitoring of crops in modern agriculture

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Motto: "We see more, we know more, we solve the problem faster."

Table of Contents

I. Abstract

The growth of population and the demand for food is one of the main reasons for finding new ways to replace traditional farming activities with modern agriculture. Farmers, specialists in agriculture but at the same time specialists in IoT and computing systems are trying to improve the process of farming. Nowadays, agriculture has to face global changes and the impact of farming practices over decades. Drones, known as UAV, could be seen as a solution for the agriculture system because of theirs

benefits. Drones are used in agriculture to collect precise data about the crop, the vegetation condition, seeing in real time changes of crop and its vulnerability but the drones could also be helpful with sprinkling chemicals over the crops. In this application we tried to collect data with a drone from a freshly harvested field and a bean crop. We have used a drone model DJI MAVIC 3 provided with a camera, so we had the possibility to take quality pictures and videos. After collecting data, we had processed the image to see better the crop condition, in the case of freshly harvested fields we had the possibility of interpreting the photos to say if the harvest was made correctly on the entire field. As regards the bean crop, we directly interpreted the photos without a post processing.
Keywords: drones, agriculture, dji mavic 3

II. Introduction

The 2020 World Population Data Sheets indicates that the world population is projected to increase from 7.8 billion to 9.9 billion by 2050. The main source of food is agriculture, so if the demand for food is higher, agriculture has to face a new challenge of being able to provide a higher quantity of food.. Applying new technologies in the agriculture domain has many benefits like streamlining the process of planting, growing or harvesting.

The drones, also known as Unnamed Aerial Vehicles, are aircrafts without any human pilot or passengers operated under remote control by an operator or with various degrees of autonomy (autopilot). The drone is the carrier for the monitoring system. In modern agriculture, drones are used to collect information about the yield or the crop. Drones are used because they are easy to use, have a high mobility and cover a large area. Using drones in agriculture can provide real-time data (image/videos) even if there are parts which cannot be easily accessed. Drones have many applications in agriculture which could short reaction time from management to factors that affect the crops. Drones can be used in planning crop irrigation, detecting plant disease, monitoring crop maturation, illegal activities and even forest fires. Also, drones can be used as a sprinkler of chemicals like insecticides, pesticides or water for irrigation.

III. Methods, tools and methodology

In this paper we collected data from a drone DJI MAVIC 3. This drone weighs 895 g, it is provided with a camera with a 20 MP CMOS sensor and a tele camera. The temperature resistance is between -10 grades C and 40 grade C, the max wind speed resistance is 12 m/s and the max flight time is 46 minutes without wind. Moreover, it is provided with an omnidirectional binocular vision system.

The high resolution camera gives us the opportunity to get real photos that we can zoom in to get as many details as possible. And using the drone helps us to have a wide view so we can easily notice if some part of the farm has some abnormal colour or texture. In this case using zoom in, we could see the flower of the bean plant that help the farmer to see the stage of plants growing and to calculate the possible date of harvesting.

Fig 1. Potential problems in crop

IV. Data collecting – views of crops from drone

Fig 2. Vertical view of the beans crop

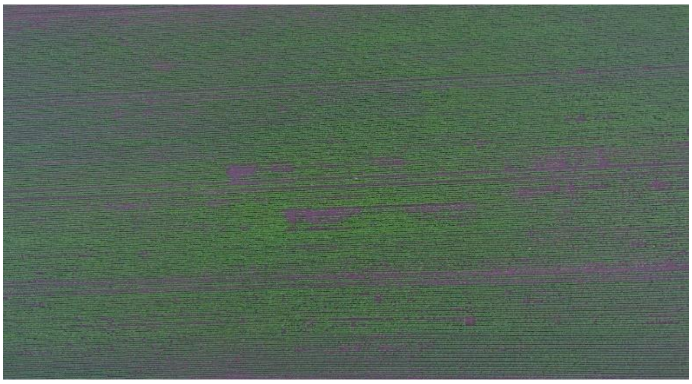

Fig 3. Landscape view of the beans crop

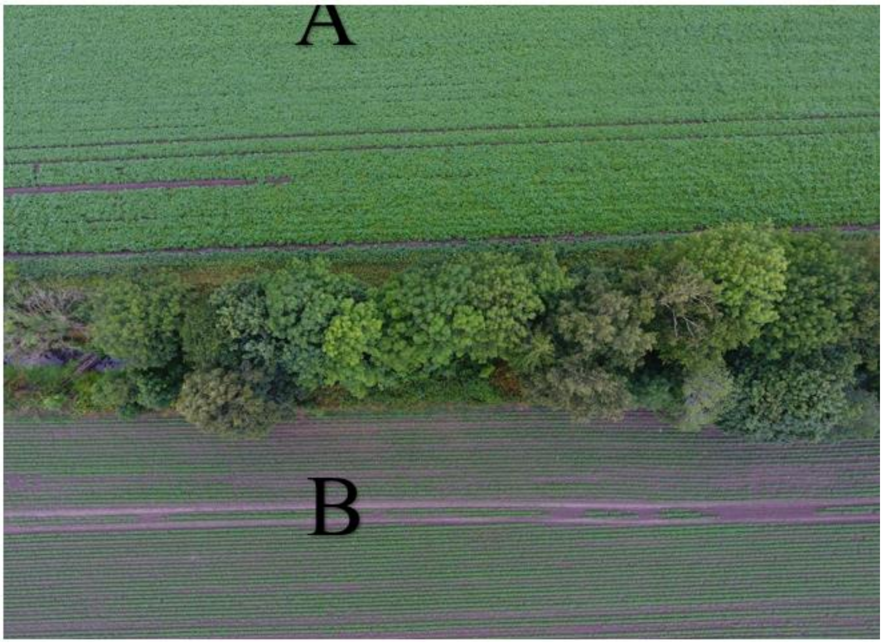

Fig 4. View of the trees barrier (**A**- potatoes crop, **B**- beans crop

Fig 5. Grains crop

Fig 6. Freshly harvested field

V. Post-processing of image step by step

After collecting the footage from the drone, we need to select frames from the video. It is not necessary to process all the frames in the video because the drone doesn't move that fast. We use image processing to try to extract the region of interest (ROI) from the frame, meaning only the terrain used for agriculture purposes. And for this we apply a set of operations on the original image to build a mask that will be applied to the image and extract only the region of interest. All the intermediate steps between the original steps and the final result are illustrated below, from left to right.

Fig 7. Original photo

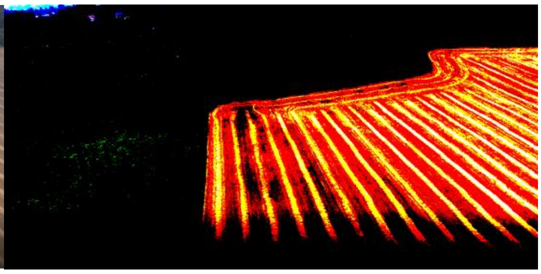

Fig 8. Thresholded photo RGB

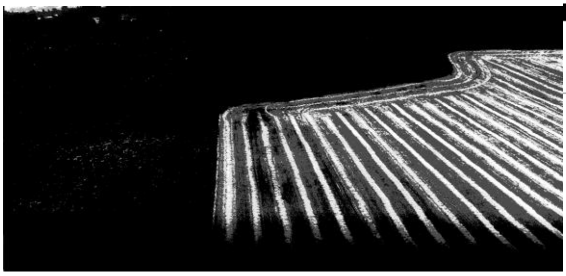

Fig 9. RGB to Grayscale

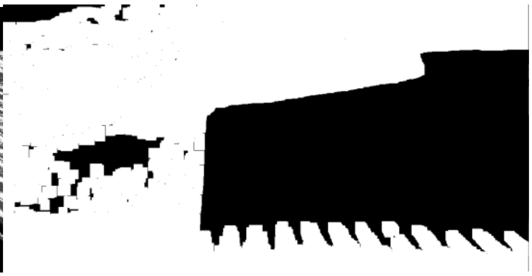

Fig. 10 Binarized photo

Fig 11. Smoothened photo

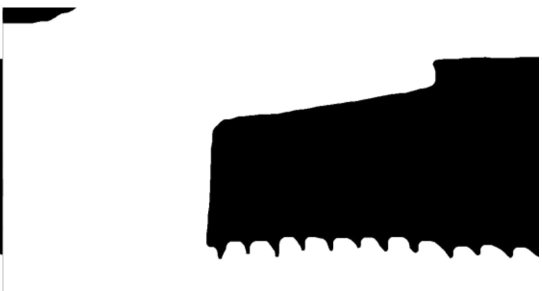

Fig. 12 Chosen mask

Fig 13. Result by applying the mask

We can see the result is not perfect because of the lighting, that's why this approach works better for highly contrasted frames.

VI. Discussions

As positive features regarding the drone, we can say something about its weight, it is easy to carry, easy to handle, and modern design and we received videos and images with high quality. As regards the limitation or the bad points of using drones we can put the accent on the necessity of changing batteries. Moreover, bad weather like rainy and windy days influenced our activity.

In addition, there are many ways of post processing the image, here we describe one of delimiting the interest area from the entire image. Also, this processing is just the first step in this problem of analysing the terrain. After we extract the ROI we should apply another algorithms on top of it to obtain useful information about the soil, for example artificial intelligence algorithms.

VII. Conclusions

Drones could be a solution for farmers to be more efficient in monitoring the crop, to shorten the time between detecting the problem and the action, especially to prevent disasters. Despite their limitations, drones could be adapted for agriculture uses but at the same time the price will be higher. This could be a good investment for developing modern agricultural practices.

7. Testimonials

SV: Thank You for providing access to Melsom High School - MAPIoT project Extern Mesaje primite ×

Linda Isolde Hiis 16:57 (acum 4 ore)
către eu, Lasse

engleză > română Tradu mesajul Dezactivează pentru: engleză ×

Dear Adrian and Lasse

Thank you very much for the nice email.

We are so happy that Melsom could be the venue for this year's summer school. The topic of modernizing agricultural practice using is an important approach for modern research and development of agriculture.

It was inspiring to meet you. See and listen to their motivated students, their commitment and interest. It creates faith and hope for future agriculture.

Thank you for allowing me to be with you today.

I wish you all the best.

SV: Thank You for supporting the project and sharing your views - MAPIoT project

Vegard Steinstø prin 7sense.onmicrosoft.com
către eu, Lasse

engleză > română Tradu mesajul

Hi Adrian,

Thanks for having me over. Keep up the good work, and keep on inspire your students with relevant and important tasks.

Best Regards,
Vegard Steinstø

Mobile: +47 980 20 806

7Sense Agritech AS
Moloveien 14
3187 Horten
Norway

Tel: +47 33 08 44 00
7sense.no

SV: Thank You for participation at Multiplier Event - MAPIoT project Extern Mesaje primite ×

Camilla Nereid joi, 11 aug.,
către eu, Lasse

engleză > română Tradu mesajul

Thank YOU Adrian
I was very impressed by the motivation and skills demonstrated by your students here. I am looking forward to continuing the collaboration

All the best

Camilla

SV: Thank You for welcoming us to your company - MAPIoT project Extern

Bjørn Erik Rui <bjornerik.rui@vesar.no>
către eu, Lasse

engleză > română Tradu mesajul

Thank you for the visit, the letter and pictures!

Med vennlig hilsen
Bjørn Erik Rui
Ass. daglig leder/
Drifts- og utviklingssjef
Tlf.: (+47) 91 16 90 74
E-post.: ber@vesar.no

vesar
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E-post: post@vesar.no
www.vesar.no

SV: Thank You for supporting the project and sharing your views - MAPIoT project Extern

Larsen Erlend 12:37
către eu, Lasse

engleză > română Tradu mesajul

Dear Florea and Berntzen

Thank you so much for your kind and warming words.
It was my pleasure to be your guest and to see the projects that was presented.
I believe in cooperation between countries, and appreciate your efforts to do so.

Best regards!

Hilsen Erlend Larsen
Stortingsrepresentant, Vestfold og Telemark Høyre
Medlem av Transport- og kommunikasjonskomiteen

Tlf: 92237217
Følg min hverdag på Stortinget: https://www.facebook.com/erlend.larsen.31

STORTINGET

The two weeks at MAPIoT summerschool in Norway exceeded my expectations by approaching a broad subject such as modern agriculture and taking it step by step, explaining the basics and allowing us to experiment with building our own monitoring systems. We spend the week in groups following professor's Lasse Berntzen presentation of Internet of Things and applying our gained knowledge to the microcontrollers and sensors. Between the practical sessions, Professor Adrian Florea held a presentation about the in depth software of IoT, showing us several algorithms used in IoT related apps programmed by some of his own students. Moreover, what pleasantly surprised me was the fact that the lecture filled days were balanced out by enough free time to explore the beautiful cities near us. Overall, I would highly recommend MAPIoT summerschool to other students if they are interested in these subjects and see this as an opportunity for their future. I would gladly attend the next session of this summerschool and similar projects.

My time spent in the MATIoT summerschool in Norway has been a truly unique experience both in terms of the approached subject that was taught, Internet of Things devices, and the domain we were applying it in, smart agriculture. Professor Lasse Berntzen's lectures about IoT were an excellent introduction but at the same time advanced enough so that everyone had something new to learn. Between the IoT courses Professor Adrian Florea held a presentation about the intricacies of neural networks in machine learning and different methods of training such simulated networks of neurons in order to beat predict various scenarios related to agriculture and wine fermentation. Along with all the knowledge that we gained during the summerschool, we also had plenty of time to enjoy the beauty of Norway. I would gladly join again and highly recommend other students to do so as well.