AGRICULTURAL TECHNOLOGIES COMPETITION PRELIMINARY EVALUATION REPORT

CATEGORY NAME: 2025 AGRICULTURAL TECHNOLOGIES

TEAM NAME: NOHUGV

APPLICATION ID: 3262258

TEAM ID: 644024

PROJECT NAME: WEED DETECTION BY UGV

CONTENTS

1. PROJECT SUMMARY (14 POINTS):

Project topic and purpose: *This project aims to detect weeds in potato fields. It will focus more on identifying the two problematic weeds in potato fields: Chenopodium album L. and Amarantus retroflexus L. The project seeks to integrate advanced AI technologies to differentiate between the potatoes and the harmful weeds using Unmanned Ground Vehicles (UGV).*

Project scope and method: *Once the weeds are detected using deep learning algorithms such as the Convolutional Neural Networks (CNN), the UGV can take appropriate actions, including: precision spraying - targeted application of herbicides directly on weeds to minimize chemical use and environmental impact, mechanical weeding - physical removal of weeds using robotic arms or automated cutting tools, and data reporting - providing real-time weed distribution maps for farmers to plan additional interventions*

2. THE PROBLEM / SOLUTIONS (16 POINTS):

Problem definitions: *UGV could have technical challenges which might limit its functionality (Agelli ve ark., 2024). In potato fields, the dense foliage and the proximity of plants can obstruct the sensors' view, leading to inaccurate weed detection (Munasinghe ve ark., 2024). This might also lead to misclassification of the weeds. Improper soil and topographic conditions would lead to malfunctionality of the UGV. Furthermore, battery life and power management of the UGV affects its effectiveness. UGVs require a reliable power source to operate effectively (Shah ve ark., 2018). The use of UGVs usually comes with operational costs. Farmers find it difficult to acquire UGVs for weed management. The initial cost and maintenance of UGVs are very high.*

Solution ideas: *Mounting sensors on adjustable arms or rotating them at different angles may improve the sensor's ability to detect crop weed by not getting tangled on foliage, also on dense areas we will slow the vehicle down so that the image processing & machine learning has more time and data to analyse. We will design a suspension system that can handle uneven terrain, and absorb the shocks of the rough conditions. Farmer training programs and user-friendly interfaces empower operators, while public-private partnerships and open-source platforms foster innovation and affordability (Gadekar ve ark., (2024). Together, these solutions make UGVs more accessible, efficient, and practical for farmers, particularly small-scale operators, enabling wider adoption and sustainable weed management in agriculture (Ritz ve ark,. (2019).*

3. LOCALISM AND AUTHENTICITY SIDE (8 POINTS):

Originality and Locality: *Unlike existing solutions, our project will offer an innovative approach that integrates UG Vehicle and IoT technology with artificial intelligence. While existing systems generally rely on manual weed control. This precision farming system will not only increase crop yields but also reduces resource wastages, thereby optimizing workflow and minimizing downtime. This system will increase* *efficiency and reduce labor costs which will translate into higher overall productivity and profitability for farmers in our country.*

4. METHOD AND TARGET AUDIENCE (24 POINTS):

Efficiency and effectiveness: *The design and development of the UGV is a critical phase of the project, as it lays the foundation for an efficient and reliable weed detection vehicle. This phase involves hardware selection, system integration, and software implementation to ensure seamless operation in agricultural fields.*

Procedure to follow: *The project involves designing a UGV with a robust chassis, all-terrain wheels, and sensors (RGB, multispectral cameras, LiDAR, GPS, IMU) for navigation and data collection. A power-efficient computing unit and battery system will be installed. Software development includes navigation algorithms, CNN-based weed detection models, and a user-friendly interface. We will use NIR cameras for the data collection for spectral analysis. AI models will be trained on preprocessed images, validated, and tested for accuracy. We will test it on Turkish potato fields to evaluate the UGV performance under varying conditions. Feedback and performance data will help refine the system, ensuring accuracy, usability, and adaptability for weed detection in diverse agricultural environments.*

Target group: *The primary target group for this project is small to medium-scale potato farmers in regions like Niğde and Nevşehir, Turkey, who face challenges in weed management. The project also targets agricultural cooperatives and agritech companies seeking innovative solutions for precision farming.*

5. INNOVATION AND COMMERCIALIZATION POTENTIAL (14 POINTS):

Technology and innovation: *Thanks to developing agricultural automation and smart agricultural applications, the applicability of weed removal systems with land vehicles in large-scale agricultural lands is increasing and it is expected to become one of the basic components of autonomous agriculture in the future. Positioning technologies such as GPS and LiDAR, RGB camera images from various angles minimize manual intervention by enabling autonomous or semi-autonomous land vehicles to move effectively in the field. While efficient routes can be created in agricultural land thanks to GPS and sensor technologies, it is also a positive feature that it provides environmental sustainability by using chemical-free methods such as laser, mechanical arms or electric current.*

Commercialization potential: *The UGV-based weed detection system has significant commercialization potential due to its ability to reduce labor costs, increase crop yields, and promote sustainable agricultural practices. Its precision and efficiency make it attractive to both small-scale and large-scale farmers, while modular and scalable designs allow for adaptability to a variety of agricultural needs. Partnerships with agricultural equipment manufacturers and government subsidies could further increase adoption, making it a viable and profitable solution for modern precision agriculture.*

6. PROJECT SCHEDULE (6 POINTS):

Work packages and schedule:

Work package name and sub-activity	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
1. Project Planning - Define project scope and objectives - Conduct literature review - Identify farmer requirements							
2. UGV Design and Development - Design chassis and mobility system - Integrate sensors (cameras, LiDAR) - Develop navigation and control system							
3. Data Collection and Preprocessing - Deploy UGV for field data collection - Annotate and preprocess data							
4. Machine Learning Model Training - Train CNN for weed detection - Validate and fine-tune model							
5. Field Testing and Validation - Test UGV in real-world fields - Collect farmer feedback							
6. Evaluation and Reporting - Analyze project outcomes - Prepare final report							

7.TEAM STRUCTURE (6 POINTS):

***Team Structure**: Team captain Abass Issaka Mohammed is a Biosystem Engineering student and has taken deep learning and image processing courses and will be responsible for the creation of the model and ensuring the UGV is optimized for field conditions, integrating agricultural needs with technology. Efe Berkay Serçe, a Digital Agricultural masters student, will be responsible for the design and the control of the UGV. Fatih Alperen Gılıç, a Plant Production student, will be responsible for the data collection and guide the best weed management strategies. Azra SAVAŞ, a Biosystem Engineering student, will be responsible for the Integrating the power supply with sensors or devices that might be used in precision farming systems. Mehmet Kürşat YALÇIN is the advisor for this project. He will provide technical guidance, ensuring the project aligns with industry standards and research objectives.*

8. PROJECT REPORT LAYOUT (12 POINTS):

***Report writing rules:** While writing the report, attention should be paid to page limits, academic writing rules, bibliography and table of contents. (6 Points)*

9. REFERENCES

- ***Agelli, M., Corona, N., Maggio, F., & Moi, P. V. (2024).** Unmanned Ground Vehicles for Continuous Crop Monitoring in Agriculture: Assessing the Readiness of Current ICT Technology. Machines, 12(11), 750.*
- ***Gadekar, A., Kataria, K., Aher, J., Deshmukh, P., Fulsundar, S., Barve, S., & Patel, V. (2024).** Recent developments in modular unmanned ground vehicles: A review. Asia-Pacific Journal of Science and Technology, 29(11).*
- ***Munasinghe, I., Perera, A., & Deo, R. C. (2024)**. A Comprehensive Review of UAV-UGV Collaboration: Advancements and Challenges. Journal of Sensor and Actuator Networks, 13(6), 81.*
- ***Ritz, S., Rizzo, D., Fourati-Jamoussi, F., Dantan, J., Combaud, A., & Dubois, M. J. (2019, February).** Training in agricultural technologies: a new prerequisite for smart farming. In 3rd Rendez-Vous Techniques AXEMA.*
- ***Shah, N., & Czarkowski, D. (2018)**. Supercapacitors in tandem with batteries to prolong the range of UGV systems. Electronics, 7(1), 6.*