VAAL UNIVERSITY OF TECHNOLOGY

VAAL UNIVERSITY
OF TECHNOLOGY

Inspiring thought. Shaping talent.

FACULTY: Applied and Computer Sciences
DEPARTMENT: Computer Sciences
SUBJECT: Business Analysis 3.2
SUBJECT CODE: AIBUY3A
LECTURER: Mr M Matsela
MODERATOR: Ms S Matyila
YEAR: 2024

ASSESSMENT NAME:	BA 3.2 Project_2024
ASSESSMENT DATE:	21 October 2024

STUDENT NUMBER	INITIALS AND SURNAME	SIGNATURE
222582642	KM Tshabalala	
222592567	PT Lenyai	
221884920	AM Mngomezulu	
218432623	SMI Rapanyane	
222171995	L Maimane	
221876545	BA Shandu	

DECLARATION

We, KM Tshabalala

PT Lenyai

AM Mngomezulu

SMI Rapanyane

L Maimane

BA Shandu

Declare that the contents of this project represent our unaided work and that the project has not previously been submitted for academic examination towards any qualification. Furthermore, it represents our own opinions and not necessarily those of the Vaal University of Technology.

		20 October 2024
Signed		**Date**
		20 October 2024
Signed		**Date**
		20 October 2024
Signed		**Date**
		20 October 2024
Signed		**Date**
		20 October 2024
Signed		**Date**
		20 October 2024
Signed		**Date**

AgriTech

AgriTech is a type of technology that is applied to improve production through the use of technology in agriculture. The camera drone in the Smart Weather-Integrated Irrigation System is responsible for weather and soil conditions at any given time. This data is useful to enhance irrigation efficiency, water conservation, and crop production.

Table of content

Project Overview

Agritech AI Solution

There is a big problem in water management in agriculture, especially for small to medium producers. There are two conventional ways in which crops are irrigated, that is over irrigation and sub irrigation and these methods waste water and lead to low yields.

The new innovative system under development for this project is called the Smart Weather Integrated Irrigation System which will use data on weather, soil moisture, and crop growth to manage the irrigation schedule.

Key Features

- Use weather APIs (like OpenWeather or NOAA) to collect data like rainfall, temperature, humidity, and wind.
- Use drone imaging for the growth patterns or type the crop growth stage to use.
- Include message alerts of the farmer, either through message or application, about irrigation advice based on the prediction.

Background of AI solution

The use of a drone-based Smart Weather-Integrated Irrigation System is vital in today's agriculture for better management of irrigation. Water plays a critical role in crop production depending on the method that is applied; it is relatively easy to influence crop production either negatively through leakages or inadequacy of water supply, it goes without saying that the constant integration of AI solutions into irrigation systems will help minimize water wastage while improving crop yields in farming processes. On the one hand, the AgriTech technology underlying this solution is sophisticated and innovative. It is intended for easiness and flexibility, which makes it a potent means when it comes to water management in the context of agriculture.

Image 1 (Harnessing Drone Technology for Enhanced Crop Monitoring)

Problem Definition

The agriculture sector encounters the following problems in the efficient allocation of irrigation activities for crop production and water supply. This conventional means of watering crops often comes with a lot of wastage due to poor application techniques or lack of enough water, in certain areas crop growth and production of crops are less than desirable. This inefficiency adds to low yield and quality of crops, pressure on water assets, and rising environmental issues.

Farmers lack timely information on several factors that limit weather information, moisture, and crop conditions. Due to improper flow of information timely and accurate to the farming user, it becomes difficult for them to determine the exact time to irrigate crops and manage them. Inadequate data and technology contribute to unproductive irrigation and water management.

Benefits to our agricultural industry

Integrating drone technology with AI in AgriTech's Smart Weather-Integrated Irrigation System Drone offers numerous benefits, including:

- Enhanced Crop Yields: Smart drones give users real-time information about crops' status and the state of the ground; therefore, they can optimize water usage. This leads to better crop development and should increase produce yield, enhancing the efficiency of agriculture.
- Optimised Water Usage: The system also allows the control of moisture levels in the ground to avoid wastage of water and rainfall conditions for crops to grow. They do this to support sustainable water use and conservation.
- Increased Efficiency: Irrigation operations using drones and artificial intelligence cuts down on labour thereby improving the workflow. It also leads to effective irrigation, which is timely, and precise because a lot of time and resources can be used up in a manoeuvring unfriendly environment.
- Cost Savings: For farmers, the smart usage of water reduces the operational cost of irrigation, thus minimising manual control of water distribution. The same applies to the efficiency of automated systems, which will help to achieve major cost-cutting.
- Improved Crop Management: Drone-mounted high-resolution cameras provide thorough images to identify problems in cropping range such as pests or lack of nutrients. It needs to be understood that timely interventions can greatly improve the quality of crops produced.
- Environmental Sustainability: It redefines streaming with a view underlining the conservation of the environment since it is less likely to waste water other than conventional irrigation processes. It leads to improved land and water management arrangements.

- Data-Driven Insights: Drone images together with sensors are processed by AI algorithms to offer farmers coherent recommendations for improved decision-making. This sort of approach enhances the planning and management of resources.
- Enhanced Profitability: Higher levels of production, better utilisation of inputs and lower expenses overall smoothen the farmer’s bottom line. Another advantage is acquiring market competitive strength through the use of new-generation technology.
- Support for Innovation: Introducing the production of innovative technology means the development of other solutions in the agriculture sector thus placing AgriTech as a company of choice in the modern world of farming.

Business Objectives

Our main goal is to create an AI-oriented system that will help farmers manage water supply and increase crop yields given accurate information from weather conditions, moisture sensors in the soil, and crop growing analysis. This solution will prevent the wastage of water, enhance productivity in agriculture, and enhance sustainability in farming.

The following components are essential to our project's success:

- Data Collection Process: Farmers are obliged to fit soil moisture probes and enter crop information getting the best prediction on irrigation.
- IoT Monitoring: The irrigation schedule is based on the soil moisture recorded by the sensors, weather conditions, and the growth of crops.
- Funding: To support this project, sponsorship from agricultural organizations, grants from the government, and farming shire councils.
- AI-Powered Irrigation Management: The AI solution will track real-time data to advise the right amount of water and the right time to water to avoid wastage of water while at the same time increasing crop yield.

Business Success Criteria

1. Collision Avoidance

- The drone must also possess the following high-tech features; High-definition cameras and radar to enable the drone to identify other objects such as trees, buildings, and other drones to avoid collisions. The increase in the awareness of barriers and accidents should be two major positive attributes of AI algorithms.
- Emergency Features: There is a potential of an accident occurring during emergency organizes which is why the drone should have safety measures like emergency landing systems or parachutes.
- Reduce risk: thus, it was possible to create an unmanned aerial vehicle that can never endanger human beings, pet animals, or even property. Sustain the practical usage of drones on farms while taking into account the farming processes and the manipulation of flow in the environment.

2. Accuracy

- Precision Monitoring: It has to be divided into various land fields, including segmentation of the drone through the delivery of accurate data on plant health and weather conditions. But recommendations as well as things like, for instance, irrigation mean that one requires a very high level of imagination and just the right amount of data processing.
- Limiting knowledge of the drone system Adaptability: Ensures external conditions like wind or rain affect the drone and retain the same performance.
- Real-time Data Transmission: Real-time communication between the drone and the monitoring system must be maintained to make changes in an important real-time manner all alongside the data capture in real-time.

3. Reliability Having said that there are a few critical requirements for developing production-ready drone delivery UAVs:

- Operational Reliability: The drone will have to perform in various such as adverse weather and in various airspace which may be complicated. Which is manufactured from long-lasting materials and very highly integrated solidity
- Data Integrity: Information should be trustworthy and accurate at any stage of the drone’s operation if it is collected and transmitted by it.

- Flight Endurance: The drone should withstand environmental stress meaning turbulence and blows of wind for long duration at specialist efficiency without having to refuel constantly.

4. Efficiency

- Utilization of Energy: Weight, drag, and use of renewable energies in the drone must also be optimized.
- Battery life: The drone should be able to have extended-range flight capabilities, also, it should have enough power to accomplish the given task without frequent charging.
- Weather Compatibility: It should be able to work properly in several weather conditions and draw sufficient power from the drones to produce optimum performance.

5. Public Acceptance

- Community Comfort: All mandated drones have to be received positively by agriculture and society. It involves demonstrating its usefulness and addressing those issues with the application.
- Safe Operation: Navigating the drone safely and legally for consumers so that they trust it.
- Insurance: Ensure that the drone and its operations are covered by insurance in the event of a mishap.

6. Cost-Effectiveness

- Operational Costs: The drone must be cheap, both to keep and to use. It must also meet some basic requirements, with purchase costs and the cost of running such premises.
- Take-Goff & Landing: the drone should be as easy to build and maintain as possible with the thought process being the drone should be built from as many out-of-the-shelf parts as possible to help make drone production efficient at cost and maintenance in the large.
- Component utilization: The selected components must be affordable and easily accessible to control with expenses of the project.

Requirements

1. Feasibility Study:

- Technical Feasibility: Determine whether AI algorithms and drones can properly use images from a camera to control the amount of water delivered for irrigation. Consider features like image resolution, the data processing function, and the capacity of the drone to use camera information for decision-making in the real field.
- Financial Feasibility: Using the Smart Weather-Integrated Irrigation System Drone, consider the implications, and costs of developing, deploying, and maintaining the same against the various benefits that may accrue such as increased yields, decreased water consumption, or overall cost savings.
- Regulatory Feasibility: The project should incorporate the regional regulations on agriculture, water usage, and drone operations.

2. Design and Development:

- Hardware Selection: Select drones that have clarity-orientated cameras to take clear pictures of crops and soil and even weather sometimes. Make sure the drones have sufficient payload capacity, battery power, and toughness suitable for agricultural use).
- Software Development: Design new AI algorithms to generate data from captured camera images of crops, soil, and climatic conditions. Integrate computational tools for promoting automatically irrigated disparate water distribution and analytics based on vision analysis.
- User Interface: Design and implement a simple and easy-to-use operating platform for farmers to manage the irrigation system. All the incantations include features that are most appropriate for visualizing the camera images, real-time data analysis, and manual adjustments.

3. Testing and Validation:

- Simulation Testing: Conduct simulations to test the system in conditions regarding the camera image analysis with the effects of weather and different types of soil and crop stages.
- Real-world Testing: Perform rather practical research with different drones to prove the efficiency of image-based irrigation management in real agricultural settings.

4. Regulatory Compliance:
- Water Usage Regulations: It means that any party likely to use water should abide by the legal rules on the usage of water in a particular region to avoid over-pumping.
- Safety Standards: Ensure that the drones have backup systems, safe returns to earth, and GPS: provide security measures by affording the drones with filters.
- Safety Standards: Install features protection measures like double system, safeguard, positioning prevention systems as well as geolocation for stability and security of the drones.

5. Public Acceptance and Education:
- Farmer Engagement: Inform farmers about the advantages accruing from the use of a Smart Weather-Integrated Irrigation System Drone such as efficient use of water, and increase in yields from the crops based on the data collected and relayed by the drone.
- Address Concerns: These include issues about the cost of the system, the system's complexity, and issues that may cause system disruptions.

6. Operational Deployment:
- Emergency Protocols: Gather guidelines for handling equipment breakdowns, calculation mistakes other mishaps, or poor climate.
- Remote Monitoring: Develop the necessary tools for constant control of the drones' functioning and subsequent adjustments using the image captured by cameras.

7. Monitoring and Evaluation:
- Performance Metrics: Determine and monitor performance measures interlinking to water usage efficiency, crop health, and system dependability.
- User Feedback: It encourages farmers and agricultural professionals to give feedback, and the system evolves with new problems being addressed.

8. Sustainability:
- Maintenance: It is necessary to set the inspection frequency for both the drones and the applied AI algorithms to address the functionality and correctness of image-derived examination.
- Scalability: Intention for the future development of the system, and its enlargement to take in the bigger areas of agriculture or increment in the requirements for watering.

Constraints

1. Technical Constraints:

Battery Life: Reduced battery means the drone may have a working time that defines the ground area it can cover before it needs recharging or more drones.

Data Processing Speed: Real-time analysis of huge volumes of information may prove to be cumbersome where there is a constraint in processing capacity or low bandwidth. Sensor Accuracy: These weather and soil moisture sensors diagnosing conditions may be influenced by certain factors that may affect the accuracy of the data taken.

2. Financial Constraints:

Development Costs: Steep expenditure for creating and fabricating drones along with AI software and other tools can make the project non-scalable or delay the beginning of the project.

Affordability for Farmers: The cost of getting the AI solution through either purchase, leasing, or subscription service may be expensive for the small and resource-constrained farmers ultimately influencing the uptake.

Funding and Investment: Looking for the right amount of funds and investment required may be challenging, especially in the preliminary stages of the project.

3. Operational Constraints:

Regulatory Restrictions: There are often regulated restrictions on the use of drones, the privacy and protection of data, and the application of practices in agriculture such as precision farming limiting where and how a drone can be flown.

Weather Conditions: Low-quality data can be collected from the drones due to stormy and unfavourable conditions including harsh rains, high winds, or extreme temperatures which might slow down, hamper, or even halt the functions of drones.

Training and Expertise: Specifically, the requirement for higher and more specialised training for farmers or operators may be a disadvantage to quicker adoption and can add to the total difficulties.

Environmental Constraints: Issues concerning possible negative effects of drone operations on local fauna and flora, other environmental factors, or other citizens living in the vicinity may need other environmental impacts or adaptation to the operations.

Energy Consumption: The energy used for flying drones and data processing may also be a sustainability issue if renewable energy is unusable.

4. Technological Constraints:

Integration with Existing Systems: Concerning adoption, one of the challenges of the AI solution would be how well it fits farmers' current systems or, where this is not possible, their current practices.

Connectivity: Challenges that may include restricted internet connection or communication network could hinder feast flow and consequently instigate the inefficiency of drones in rural areas.

5. Market Constraints: Market Penetration:

The entrance into and establishing a market in the agricultural industry might not be easy because of the competitors, people's attitudes toward innovations, or the potential consumers' ignorance about the product.

Scalability: Any broadening of the solution to other zones of agricultural activity can be in a way problematic due to various crops, climates, and practices in farming

Risks

Technical Risks: Technical Hardware: This may range from sensor and camera issues to motor breakdowns that may lead to wrong data capture and even loss of drones which may affect operations.

Software Bugs and Glitches: Some errors could be produced in the code that develops the algorithms or the implementing software, and this would lead to farmers making wrong decisions based on the AI's findings.

Data Security and Privacy: The information gathered by drones in agriculture might be accessed by unauthorised personnel leading to privacy invasion and abuse of agriculturally compiled information.

Financial Risks: High Development Costs: Costs encountered midway through development or when implementing the project might prove prohibitive and force a halt in development, or the need for more capital.

Adoption Rates: This means that if farmers regard the solution as expensive or if it is too complex, the low uptake might mean the business does not generate enough revenues.

Market Volatility: As far as threats are concerned, it must be stated that changes in the agricultural market influence the soundness of the project because of possible tendencies in crop prices or economic crises.

Operational Risks: Consumer Protection: Unpredictable changes in customer protection guidelines may affect drone deployment or enhance the price of compliance.

Weather-Related Disruptions: Hazardous meteorological circumstances including storms or extreme temperatures could hamper UAV functions and slow or perhaps in the worst case, loss of important data.

Training and Skill Gaps: Lack of skilled personnel to operate and maintain the drones can cause operation inefficiencies or even accidents as a result of inadequate training.

Environmental Risks: Environmental Responsibility: Unforeseen consequences could infringe on local wildlife or the ecology and this may cause a lot of trouble, hence taking an environmental liability.

Energy Consumption: The power consumption of drones used for monitoring and data processing centres may enhance the project's carbon footprint and create backlash over the sustainability issue.

Technological Risks: Unpredictability of Technology: The notion is herein affirmed because enhancement in technology might dictate the use of other advanced and different inventions altogether different from the used drones and AI appliances.

Integration Issues: Interoperability problems in adopting this AI solution into current farming systems or frameworks might hamper this proposition and the adoption level.

Market and Competitive Risks: Risk: Substitute solutions that are better, cheaper, or closer to the customers may appear and challenge the project's profits.

Market Acceptance: Farming clients may be reluctant to embrace innovation since it is new or because it does not offer an obvious benefit often due to the farmer's prior experience in conventional farming.

Reputational Risks: External Force: Any mishap or leakage and loss of customer information, a mishap of drones used in delivering the products, or any pollution event could worsen the project design and scare customers.

Failure to Deliver Promised Results: This is particularly important because if the solution is unresponsive to the requirements of the users it leads to dissatisfaction from the users and lowers the credibility of the project.

Tools and Techniques

Tools:

Simulators and Emulators: AirSim: A simulator created by Microsoft to estimate AI algorithms and drones' efficiency in different conditions including agricultural ones.

Programming Languages: Python: Python is employed in AI development because of its versatile open-source libraries for developing machine learning structures and processing data.

Development Frameworks and Libraries: Tensor Flow: An open-source machine learning computer software used in designing and training AI models through evaluating camera captures to recommend irrigation. PyTorch: A machine learning application for creating advanced neural networks for image recognition, action, and decision. OpenCV: An image and video processing library that is crucial for the interpretation of matters captured by the drone's camera.

Drone Platforms: DJI Developer Tools: Program interfaces that allow users to work with the drone's hardware and software to develop new applications for the drone.

Integrated Development Environments (IDEs): Visual Studio Code: A general-purpose code editor designed for building extensions for Python coding with outputs for writing and testing the code. Jupyter Notebook: A dynamic workplace for active coding, data analysis, and noting the process of development.

Geospatial Tools: QGIS: A specialized program for the analysis of geographical data of soil quality and weather conditions.

Data Collection and Analysis Tools: Adafruit Sensors: These are useful for interfacing different sensors with the drone concentration on the camera data other sensor data may be useful depending on requirements.

Techniques:

Machine Learning and Deep Learning: Machine learning – A basic course developed by Andrew Ng explaining the concepts and methods of machine learning useful when analyzing agricultural data.

Computer Vision: OpenCV Tutorials: A set of tutorials on OpenCV for computer vision tasks that is a primary resource for processing and analysing images captured in crops and weather conditions.

Path Planning and Navigation Algorithms: Robotics: Computational Motion Planning: A book that contains algorithms on automated aerial navigation and avoidance of objects in agriculture fields.

Sensor Fusion: Sensor Fusion and Non-linear Filtering for Automotive Applications: This segment focuses on the methodology for presenting data from several sensors to the drone's control system to improve its decision-making process.

Real-time Data Processing: Real-time analytics; A brief overview of how data may be processed in real-time to give recommendations for the next irrigation based on weather and soil factors.

Testing and Validation Strategies: Software Testing: Basic concepts, an overview of testing processes, and methods that are applied to the components of the drone system to maintain their proper functioning.

Risk Assessment and Mitigation: Risk Management and Assessment: This is crucial in realising the kinds of risk that may be captured in the project such as technical and operational risks.

User-Centred Design: Cognitive engineering based on Don Norman's ”The Design of Everyday Things”: Ideas and guidelines to produce interfaces and systems that enable farmers to interact with the drone's output and make useful decisions.

Poster


AGRI-TECH
FARMERS HELPING
Hand
ABOUT US
We are dedicated to revolutionizing agriculture through cutting-edge AI technology, optimizing water usage, and enhancing crop yields.
We empower farmers with tools that streamline their operations, conserve resources, and improve productivity, ensuring a better future for agriculture.
CONTACT US
+123-456-7890
www.agritech.com
AgriTech

Machine Learning Approach, Data, and Model

Collection: Collect the data from different sources such as weather data logger soil moisture data logger and crop images. The information should be on the weather conditions, the various types of soils and the different stages of the crops.
Preprocessing: Preprocess the data to remove the cost from unwanted information and spiky data points. Use data augmentation to mimic various scenarios to enhance the amount of data in terms of diversity. This makes it easier to improve, your model's stability and, also sample, performance.

Feature Engineering: Feature Selection: It is a process of selecting those features which are most relevant to the problem and discarding the rest of the features, such as soil moisture level, temperature, humidity, etc., and crop vitality indicators. Other features may comprise past weather trends and the level of irrigation. Selection: Select and include measurable attributes that influence irrigation choices while guiding away from models that complicate the process. This balance ensures that real-time processing is tendered.

Data Labeling for Supervised Learning Annotation: It is known that applied data should be labelled to direct the learning process of the model. This could mean generating forecasts of crop health, levels of soil moisture and the requirements of irrigation are regionalised using a set of critical thresholds. Expert Input: Deliver the model to agricultural specialists to receive relevant and content-specific annotations to improve the accuracy and importance of the model.

Data Splitting: Training Set is used in this set to train the model on how to perceive patterns that exist in the data set.

Validation Set: Utilised to fine-tune the model parameters to perform better by observing the results derived from this set to prevent overfitting. Testing Set The last test involves verifying model flexibility and future capability in the real world.

Predictive modelling for irrigation needs: Applying linear regression, decision trees, or even more subtle, such as gradient boosting machines for making irrigation needs forecasts on launched characteristics.

Deep Learning: Apply neural networks in a situation where the type of data is large and complex, thus, requiring the capture of patterns.

Weather and Soil Analysis: Time-Series Analysis: Models should be applied to time-series weather and soil sensor data. Software, like the Long Short-Terms Memory (LSTM) networks, can be employed to predict future states and irrigation requirements.

Ensemble Models: The strengths of at least two models should be used to achieve better prediction accuracy by setting off weaknesses of the model.

Decision-making algorithms: Rule-based systems: Use rule-based systems for simple decision-making such that if the soil moisture goes beyond a certain level or the weather is scorching, it is time to water the plants.Reinforcement Learning: Apply reinforcement learning to refine the technological recommendations on irrigation by using information sought from the actions and rewards previously enacted to fine-tune the irrigation schedules.

Integration with Real-Time Data: Real-Time Processing: This is necessary to guarantee that the models can work interactively to provide timely irrigation advice among other uses of the models. Other methods such as quantisation and optimisation methods can be of big help in getting improved results in terms of processing speed. Model Fusion: Integrate the data received from various sensors to create a fused impression of the conditions in crop and soil. Multimodal and multimodal techniques are used in the process of combining different sensors and data from them conveniently.

Continuous learning and adaptation Online Learning: Continue updating learning as and when new data is available by incorporating online learning techniques. This makes the model dynamic as it automatically modifies its approach to depend on the current conditions and significantly enhances its performance over time. Feedback Loop: Integrate the feedback mechanism to streamline the model and use field results and farmer feedback when making predictions and suggestions.

Evaluation Metrics: Metrics such as MAE, RMSE, and F1-score can be utilized to measure the performance of the model. See how well it fits the laid down objectives to achieve a certain goal within the model.

Iteration: Make updates to the model with the evaluation results and user feedback to make it right and relevant for assessments. Through such aspects, the Smart Weather-Integrated Irrigation System Drone can apply machine learning approaches to come up with effective decisions regarding the irrigation process, save water and improve crop yield.

Data:

Data plays a significant role in training and improving the effectiveness of smart irrigation management systems. Using data collection, processing and usage of the data, the solution that will be developed through AI will aim at efficient use of water, increased crop productivity and sustainable crop production.

Weather Data

Data Collection:

Collect weather data from reliable sources APIs like Open Weather Map or Io t weather stations. It should also capture weather factors which are temperature, humidity, rainfall and wind, which reflect different weathers and seasons.

Data Observation

Observe the weather data trends to predict the measures that will be most useful in predicting the probable gaps of irrigation based on climate changes. Highlight data with tags when irrigation should be done and the effects of weather on water requirements.

Model Training:

Train the AI model using this pre-processed weather data. Use time series models like Long Short-Term Memory (LSTM) networks to make future predictions of the prospective weather pattern and the corresponding irrigation requirement based on the weather history.

Soil Data

Data Collection:

IoT sensors can be employed in getting quantitative measurements of moisture content, pH and nutrient status of the field in real-time. All these sensors feed real-time data for monitoring soil vigour and moisture-holding capacity.

Data Observation:

Analyse soil data to determine moisture ranges for the regions to generate reasonable irrigation regimes. The data is needed to mark the field to identify if the soil needs water to be supplied to the crops or if it is already moist.

Model Training:

It is recommended that this data be used to train an AI model to propose irrigation depending on the consistency of the soil. Using Decision Trees and Random Forest models it is possible to categorise whether the irrigation is needed in certain conditions.

Crop Growth Data

Data Collection:

Obtain information on farmers about crop type management stage, and desired yield. This data is imperative to determine how much water is needed for the irrigation of crops at this period of production.

Data Observation:

While irrigating crops, the growth data should be used to determine how much water is necessary depending on the growth stage. This data can be annotated to show where water is most needed in the process of enhancing the production of crops.

Model Training:

Train this AI model with such crop data to update the irrigation time as per the crop growing phase. Other advanced field deserves courtesy recommendation comprises Decision Trees within the Machine Learning models that can be applied to recommend irrigation for each crop type.

Overall Integration

By combining weather data, soil attribute data, and crop growth data into the system, the AI model will learn a definitive irrigation regime that would guarantee the required water input at the right time. The data-driven decision will enhance the accuracy of this system in helping farmers conserve water and enhance crop production over time.

Model:

Predictive Modeling for Irrigation Needs:

- Machine Learning Models: Linear regression or Decision trees, and for more complex analysis, we can even go for Gradient boosting machines, to predict irrigation needs as per the input parameters.
- Deep Learning: Apply neural networks, if the spectrum of properties or the scope of data is large, and patterns are intricate.

Weather and Soil Analysis:

- Time-Series Analysis: The models should be used to consider the time series data from the weather and soil sensors. Futile situations and irrigation requirements can be predicted with the help of such tools as Long Short-Termed MCAS (LSTM) networks.

- Ensemble Models: Ensemble, multiple models to enhance the overall accuracy of the predictions and increase the general resilience of the developed model, drawing on the constructs of the disparate models.

Decision-Making Algorithms:

- Rule-Based Systems: Utilize the rule-based systems to make basic decision-making based on the previously set standards for soil humidity and weather conditions.
- Reinforcement Learning: The authors of the paper advised using RL to improve the irrigation pattern by going through the previous actions taken and the subsequent reward accrued and then modifying the irrigation pattern depending on the outcome.

Integration with Real-Time Data:

- Real-Time Processing: Make certain that the models can manage data feed in a real-time manner to respond promptly to irrigation recommendations. Such methods like quantisation and optimisation could be useful in reducing such a time.
- Model Fusion: To create a single integrated picture of the crop and soil conditions to acquire data from various sensors. In addition, multiple sources of information are smart regardless of using sensor fusion approaches to handle the information from the numerous sensors.

Continuous Learning and Adaptation:

- Online Learning: Integrate online learning methods to keep the model current as they get more data in the form of, communicating, a static database. This has the advantage of being an updated model predicting changing conditions and accuracy.
- Feedback Loop: Create a feedback system to integrate actual data outcomes of the model and hear from the farmers improving the model.

Model Evaluation and Iteration:

- Evaluation Metrics: Some of the evaluations should include Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and F1-score. Evaluate to what extent the model achieves its goals and objectives, consistently.
- Iteration: Thus it is recommended to make improvements to the model depending on the evaluation results and feedback from the users for better accuracy and stronger applicable usage.

Deep Learning Approaches

The incorporation of an enhanced irrigation system by deep learning shows considerable potential in streamlining irrigation processes. Utilising deep learning we can understand what data the SWIIS can use to make decisions on the best use of water and improve crop productivity.

1. Weather and Environmental Data Analysis

Deep Learning Models:

- Convolutional Neural Networks (CNNs): Evaluate structured and unstructured data from images of the sky and ground captured by onboard sensors or transmitted by the closest weather station to estimate principal weather parameters such as cloud cover, rain, and temperature variations. CNNs can help in analysing satellite images to give a clue on the kind of weather that is prevailing and therefore the type of water irrigation that is required.
- Long Short-Term Memory (LSTM) Networks: Process sequences where time is a key variable and perform decisions on the future weather and the amount of irrigation they will need for certain weather conditions.

Applications:

- Predictive Analytics: Train models to predict the likely state of weather, moisture content in the ground, and health of crops. It assists in deciding on when to irrigate and to what extent and also whether or not the scheduled irrigation should be altered with the perspective of a worse climate.

2. Object Detection and Tracking

Deep Learning Models:

- YOLO (You Only Look Once) or Faster R-CNN: Identify and segment images captured by the drone's camera and identify different objects which include different crops or irrigation equipment.

<u>Applications:</u>

- Crop Monitoring: Further subdivide a field to monitor the water requirements of particular types of crops there.
- Pest and Disease Detection: Identify pests or diseases early on crops to control irrigation and treatment in the affected areas.

3. Semantic Segmentation

<u>Deep Learning Models:</u>

- U-Net or DeepLab: Divide a field to determine different sections such as an irrigation section or waterlogged part.

<u>Applications:</u>

- Irrigation Zone Identification: It involves the establishment of irrigation zones according to the crops grown or the type of soil, to ensure the application of water.
- Obstacle Avoidance: To avoid obstacles in the area of interest such as rocks, and other equipment in the area to enable easy drone tracking.

4. Route Planning and Optimization

<u>Deep Learning Models:</u>

- Deep Reinforcement Learning (DRL): Plan for drone trips taking into account particular destinations and their choice, as well as meteorological conditions and battery charge.

<u>Applications:</u>

- Efficient Route Planning: Project how to cover large fields in the least time and with the least energy, and how to plan good flight patterns.
- Adaptive Routing: Optimize in real-time due to poor weather conditions, or other barriers to traffic flow that may crop up from time to time.

5. Real-time Image Analysis

<u>Deep Learning Models:</u>

- CNN: Monitor the field conditions and interpret changes instantly as captured on the drone's streaming video camera.

Applications:

- Emergency Response: Automate the examination of crop status or weather changes and adapt the schedule for irrigation instantly.
- Real-Time Monitoring: Examine results of crop and soil moisture analysis to offer modern information on irrigation.

6. Automated Landing and Takeoff

Deep Learning Models:

- Object Detection and CNNs: Contributing to automated procedures used for touchdowns and takeoffs, understanding what areas are suitable for landing and what must be avoided.

Applications:

- Precision Landing: Stakeholders should ensure the drone can safely land in predetermined zones and influenced terrain.
- Safe Takeoff: Minimize formations of large groups of planes on the ground, during takeoff, to eliminate the risk of accidents and enhance efficiency.

7. Risk Assessment

Deep Learning Models:

- Anomaly Detection Models: Use data both historical and real-time data to evaluate risks as they may surround the irrigation for example risk of flooding or drought.

Applications:

- Risk Mitigation: Identify and address risks associated with irrigation practices, such as soil erosion or waterlogging.
- Adaptive Strategies: Irrigation changes should also be in consideration to the risk assessment results to maximize its usage and minimize impact.

By implementing these deep learning approaches, the Smart Weather-Integrated Irrigation System Drone can provide a highly automated and precise approach towards irrigation and thus healthy crop production.

Time Series Analysis

Objective: The aim is to use time series analysis to improve the Smart Weather-Integrated Irrigation System Drone to improve irrigation schedules and water management for underprivileged agricultural societies.

1. Data Collection and Preparation: Data Collection:

- Date/Time of Irrigation: When the drone is used for irrigation-related activities constantly.
- Location: General location of the field or particular sections which require irrigation.
- Soil Moisture Levels: Records on moisture levels in the soil before and after irrigation.
- Weather Conditions: Weather at the time of irrigation like the temperatures, humidity, rainfall etc.
- Crop Type: Specific crops that receive irrigation waterway or drainage system facilities.
- Irrigation Amount: Amount of water used during each irrigation.

Sources:

- Drone sensors and cameras.
- Weather stations and satellite data.
- Agricultural databases. Data Preparation:

Cleaning:

- Missing values should be managed using interpolation or filling with mean/median values.
- Clean the data by eliminating all the abnormal or out-of-place values or rectifying them where necessary.

Pre-processing:

- This involves trying to convert date/time columns into the same format used for analysing data in Python for instance date-time objects.

- Data pooling should be done after a fixed period depending on the level of aggregation i.e. hourly, daily etc.
- It is helpful to bring features to a standard scale to improve the performance of the machine learning model.

2. Reporting: Summarize Findings:

- Prepare a brief yet understandable summary of the results presented in the data.
- Statistics for the report are the average frequency of irrigation, total water consumption and the trend of moisture content in the soil.

Visualizations:

- Time Series Plots: Establish a pattern in the use of irrigation and soil moisture status over time.
- Heat maps: Draw a connection between the climate's state and the needed watering frequency.
- Histograms: Provide distributions of amounts of irrigation and moisture level in the soil.
- Apart from using visuals, it is important to give stakeholders a brief description of the findings.
- Explain cyclical trends, for example, rate increases depending on the weather or seasons of the year.
- Support the arcs/filters with word descriptions to make it easy for the stakeholders to interpret the visuals.
- Argue about patterns noticed in the framework of the study, including, for instance, whether there is more irrigation during the rain or the heat.

3. Forecasting:

Techniques:

- ARIMA (Autoregressive Integrated Moving Average): Relate them over time and generalise them over the entire period to predict future irrigation requirements.
- Exponential Smoothing: Methods like Holt-Winters can use trends and seasonality to predict from the data encountered.
- Prophet: When it comes to modelling the time series data, the details regarding the sectionalisation concerning usage of the Facebook Prophet Library involve handling the seasonal effects, meaning the ability of the data to capture the effects of Yuletide and kindred impacts to the granular scale.

Implementation:

- Use previous irrigation and weather patterns data to develop the required train forecasting models.
- Summary the models using a validation set, or cross-validation techniques.
- Produce projections of the future irrigation and water usage schedule.

4. Decomposition:

Components:

- Trend: Determine the trends in the accrual of irrigation requirements in the long run. This can be done by applying moving averages or polynomial fitting on the data and then determining various trends.
- Seasonality: Find out cycles associated with distinct months, seasons or some weather conditions. You should apply any of the seasonal decomposition techniques, the STL which stands for Seasonal and Trend decomposition using Loess.
- Residuals: Learn more about variability in data the identification of residuals or noise to trends and seasonality. It can be helpful in the detection of such events and refer to anomalies.

Techniques:

- STL Decomposition: The efficient use of the procedure, of decaying time series to trends, seasonality and residuals to better interpret it.
- Fourier Transform: Use the Fourier transform to determine cyclic modes and frequencies of the variations.

5. Application and Integration:

Adjust Irrigation Strategies:

- Draw extra knowledge from time series analysis and adjust irrigation programs to enhance water utilisation and respond to various conditions.

Improve Resource Allocation:

- The forecasting models can greatly assist in planning the utilisation of resources, particularly water.

Enhance Decision-Making:

- Produce valuable outputs for farmer decision-making utilising data and accurate forecasting mechanisms for farmer input and output stakeholders.

Solution Techniques

Appropriate techniques for finding solutions and improving the accuracy of the AI model are clearly defined and relevant to the SWIIS project.

1. Route Optimization and Navigation

Technique: Use AI algorithms for patrolling to ensure that the drone gets the views of the whole agricultural field in data collection.

AI Improvement: The AI model will constantly take inputs from real-time data sets such as weather, soil moisture content, trees, or agricultural machines on the field. This dynamic update will help provide recommendations for the best time and method of irrigation to avoid water wastage and choose the best flight route to use the battery optimally.

2. Computer Vision for Obstacle Avoidance

- Technique: Coordinate preventive sensors such as computer vision systems to aid the drone in identifying barriers within the field including h0r(operator), structures, trees or even animals.
- AI Improvement: The AI model will be trained from multiple field data to improve the possibility of detecting obstacles with precision. The autonomous vehicle possesses advanced capabilities to avoid clashes while guaranteeing consistent data acquisition and legitimate proposals for irrigation.

3. Automated Landing and Takeoff

- Technique: Design proper AI techniques for automated approaches to both landing and taking off and these are based on several terrain types including but not limited to rough fields and muddy ones.
- AI Improvement: The predictors of successful and unsuccessful landing/takeoff episodes, are identified by the AI model, and decision-making will be enhanced. It will increase the probability of accurate placement or in other words, the hover and touchdown on various weather (wind, rainfall) and terrain types leading to flawless take-off and landing.

4. Crop Health Monitoring and Demand Prediction

- Technique: Implement the health monitoring of crops and water required for those crops through Artificial Intelligence, supported by collecting data from the Sensor and images from the drone.
- AI Improvement: When the AI model has the actual crop health and the current situation, it can enhance its water demand prediction. This will eliminate either over-watering or under-watering since the right amount of water will be applied to the right areas of the crops, and this is water-wise.

5. Real-time Monitoring and Data Analytics

- Technique: Implement AI-based systems to constantly track the performance of the drones, the fields and the efficiency of the irrigation systems.
- AI Improvement: The AI model will gather data from other sources such as weather, soil, and camera constantly, in the field and can identify patterns or irregularities. This will help increase the efficiency of irrigation advice by making it easier to see whether there has been any change in the weather or the soil status.

6. Adaptive Communication and Connectivity

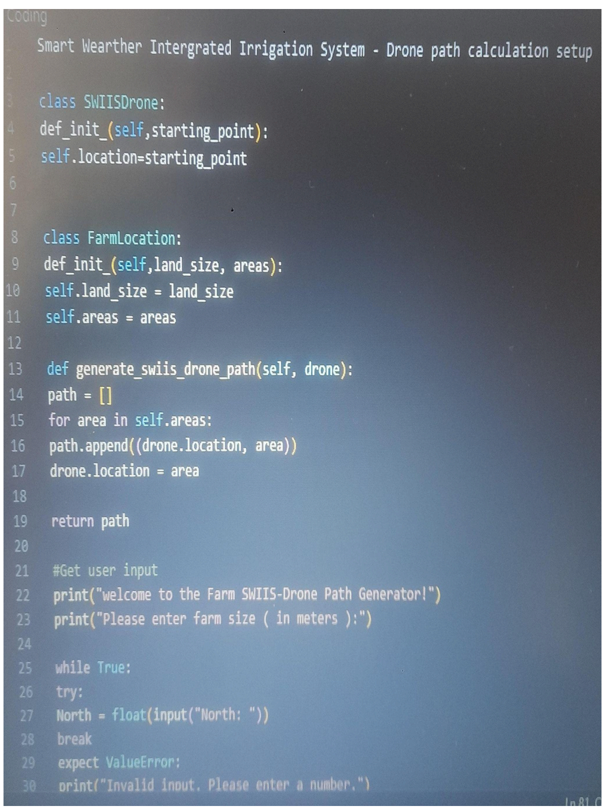
- Technique: Design AI-enabled abilities that would enable change in the data connections immediately to facilitate the connection in low-signal rural farming regions.
- AI Improvement: AI will adapt to connectivity issues in the future by employing network analysis of history, providing accurate estimates of areas with a weak signal, and operating accordingly. This will ensure a constant data flow between the drone and the system, enhancing the reliability of real-time irrigation advice.

7. Feedback Loop for Continuous Improvement

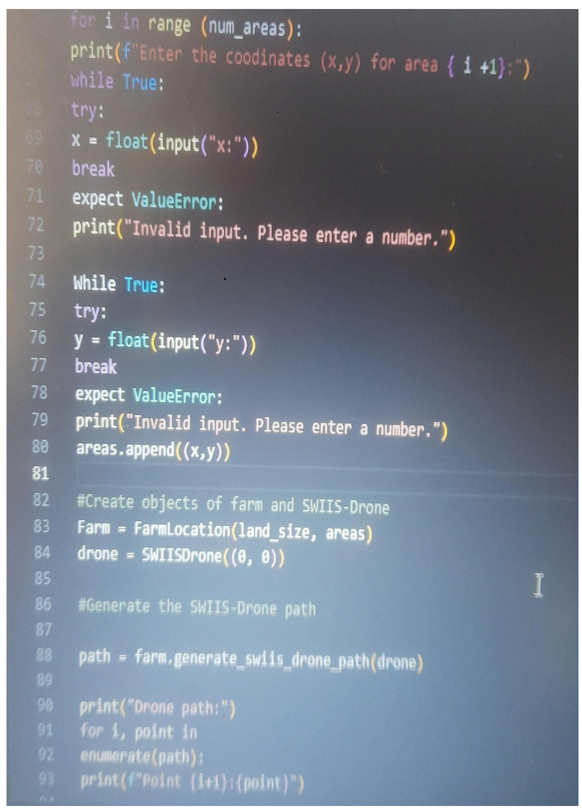
- Technique: Setting up a system by which one can record information about observations about the drones’ performance, irrigation results and field environment after each mission feedback from farmers.
- AI Improvement: The AI model will analyse previous irrigation cycles and determine where some modifications must be made. The application of the iterative learning technique in this procedure will improve the efficiency of future irrigation suggestions and the effectiveness of the system by improving the adaptation of the system to weather conditions and crop requirements.

By incorporating these solution techniques and leveraging AI, the Smart Weather-Integrated Irrigation System Drone will enhance the accuracy, efficiency and reliability of irrigation management, through these solution techniques and incorporation of AI. The AI model performance that can develop factors within real life and agriculture will involve healthier crops, more efficient water usage, and improved resource management in the agriculture business.

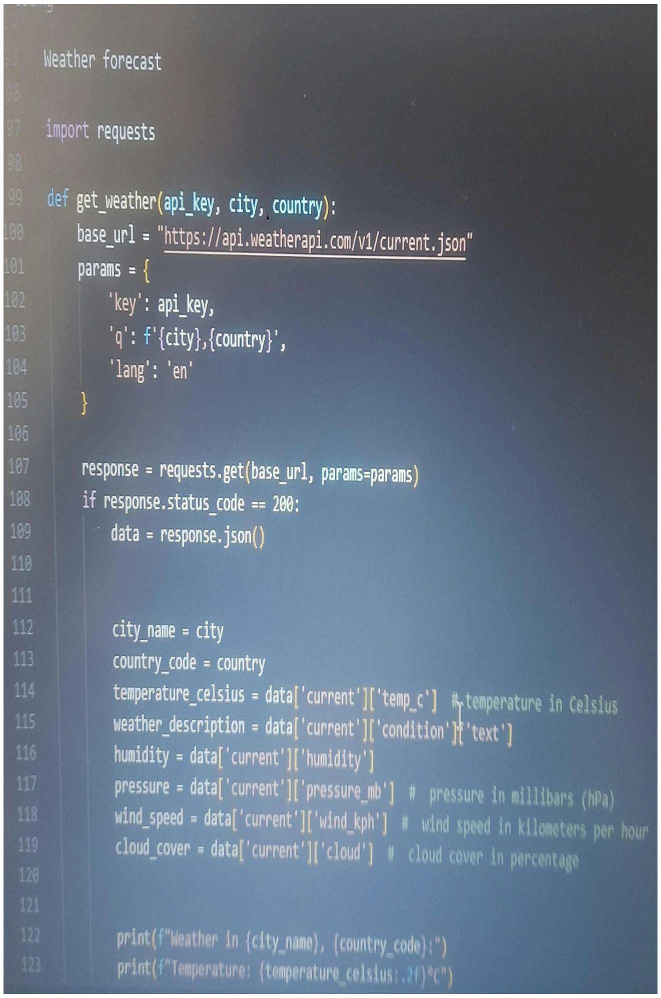
Code Example

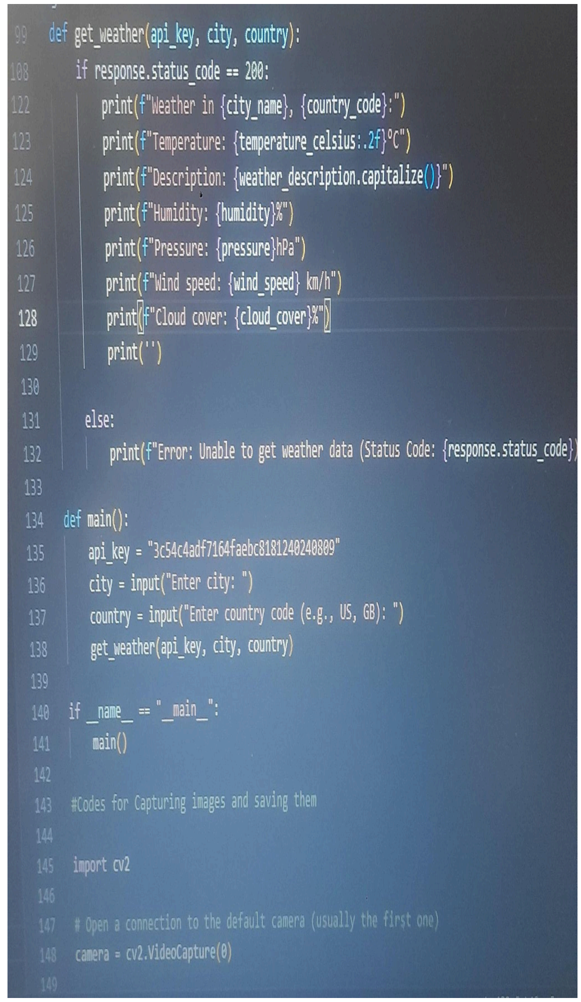


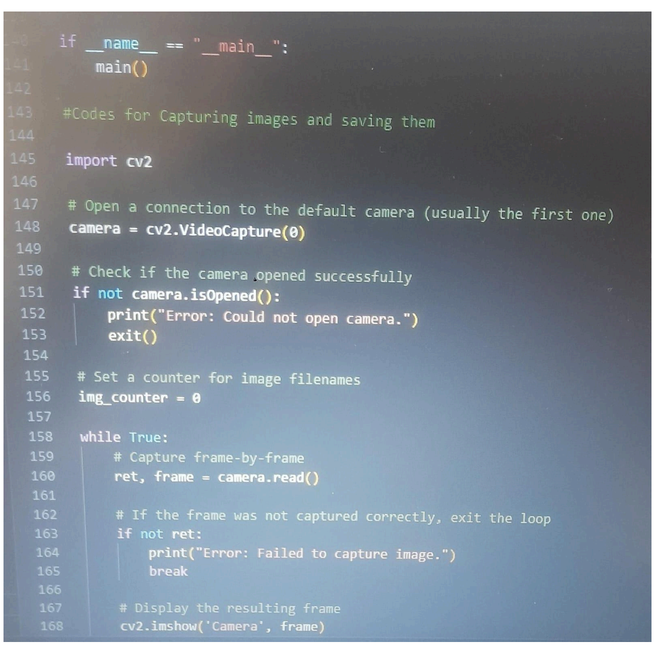
```
Coding
Smart Wearther Intergrated Irrigation System - Drone path calculation setup

class SWIISDrone:
def_init_(self,starting_point):
self.location=starting_point


class FarmLocation:
def_init_(self,land_size, areas):
self.land_size = land_size
self.areas = areas

def generate_swiis_drone_path(self, drone):
path = []
for area in self.areas:
path.append((drone.location, area))
drone.location = area

return path

#Get user input
print("welcome to the Farm SWIIS-Drone Path Generator!")
print("Please enter farm size ( in meters ):")

while True:
try:
North = float(input("North: "))
break
expect ValueError:
print("Invalid input. Please enter a number.")
```

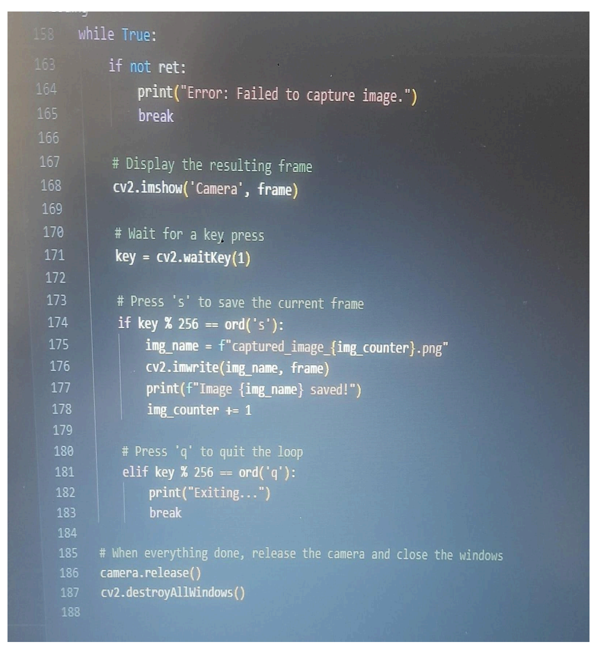


```
for i in range (num_areas):
print(f"Enter the coodinates (x,y) for area { i +1}:")
while True:
try:
x = float(input("x:"))
break
expect ValueError:
print("Invalid input. Please enter a number.")

While True:
try:
y = float(input("y:"))
break
expect ValueError:
print("Invalid input. Please enter a number.")
areas.append((x,y))

#Create objects of farm and SWIIS-Drone
Farm = FarmLocation(land_size, areas)
drone = SWIISDrone((0, 0))

#Generate the SWIIS-Drone path

path = farm.generate_swiis_drone_path(drone)

print("Drone path:")
for i, point in
enumerate(path):
print(f"Point {i+1}:{point}")
```


Weather forecast
import requests
def get_weather(api_key, city, country):
base_url = "https://api.weatherapi.com/v1/current.json"
params = {
'key': api_key,
'q': f'{city},{country}',
'lang': 'en'
}
response = requests.get(base_url, params=params)
if response.status_code == 200:
data = response.json()
city_name = city
country_code = country
temperature_celsius = data['current']['temp_c'] # temperature in Celsius
weather_description = data['current']['condition']['text']
humidity = data['current']['humidity']
pressure = data['current']['pressure_mb'] # pressure in millibars (hPa)
wind_speed = data['current']['wind_kph'] # wind speed in kilometers per hour
cloud_cover = data['current']['cloud'] # cloud cover in percentage
print(f"Weather in {city_name}, {country_code}:")
print(f"Temperature: {temperature_celsius:.2f}°C")


def get_weather(api_key, city, country):
if response.status_code == 200:
print(f"Weather in {city_name}, {country_code}:")
print(f"Temperature: {temperature_celsius:.2f}°C")
print(f"Description: {weather_description.capitalize()}")
print(f"Humidity: {humidity}%")
print(f"Pressure: {pressure}hPa")
print(f"Wind speed: {wind_speed} km/h")
print(f"Cloud cover: {cloud_cover}%")
print('')
else:
print(f"Error: Unable to get weather data (Status Code: {response.status_code}
def main():
api_key = "3c54c4adf7164faebc8181240240809"
city = input("Enter city: ")
country = input("Enter country code (e.g., US, GB): ")
get_weather(api_key, city, country)
if __name__ == "__main__":
main()
#Codes for Capturing images and saving them
import cv2
# Open a connection to the default camera (usually the first one)
camera = cv2.VideoCapture(0)


if __name__ == "__main__":
main()
#Codes for Capturing images and saving them
import cv2
# Open a connection to the default camera (usually the first one)
camera = cv2.VideoCapture(0)
# Check if the camera opened successfully
if not camera.isOpened():
print("Error: Could not open camera.")
exit()
# Set a counter for image filenames
img_counter = 0
while True:
# Capture frame-by-frame
ret, frame = camera.read()
# If the frame was not captured correctly, exit the loop
if not ret:
print("Error: Failed to capture image.")
break
# Display the resulting frame
cv2.imshow('Camera', frame)


while True:
if not ret:
print("Error: Failed to capture image.")
break
# Display the resulting frame
cv2.imshow('Camera', frame)
# Wait for a key press
key = cv2.waitKey(1)
# Press 's' to save the current frame
if key % 256 == ord('s'):
img_name = f"captured_image_{img_counter}.png"
cv2.imwrite(img_name, frame)
print(f"Image {img_name} saved!")
img_counter += 1
# Press 'q' to quit the loop
elif key % 256 == ord('q'):
print("Exiting...")
break
# When everything done, release the camera and close the windows
camera.release()
cv2.destroyAllWindows()

Conclusion

AI technology has the chance to revolutionise agricultural irrigation systems due to its integration into the latter. With AI, one can increase the power of irrigation systems in controlling water distribution, in the most efficient means possible. This improves the aspect of irrigation improving the crop yield and reducing operational costs incurred, by farmers. Furthermore, AI can constantly assess the performance of the system and as a result, prove that irrigation is open to change and always efficient with the aim of eliminating water problems and making certain that the crop receives the required amount of water. Combined, these findings suggest the usefulness of artificial intelligence in irrigation systems holds the key to boosting food production within agriculture, encouraging conscious farming, and ensuring major returns to farmers and society.

References

1. Bansal, R.K., 2020. *Artificial Intelligence in Agriculture: Fundamentals and Applications*. Springer.
2. Shanmugamani, R., 2019. *Deep Learning for Computer Vision: Expert techniques to implement advanced computer vision and deep learning solutions using TensorFlow and Keras*. Packt Publishing.
3. Zhang, Y., 2021. Applications of Artificial Intelligence in Agriculture. *Journal of Agricultural Science*, 13(5), pp. 120-135.
4. Gupta, R. and Mehta, S., 2020. Deep Learning Techniques for Agricultural Applications. *International Journal of Computer Applications*, 176(6), pp. 1-6.
5. International Society of Precision Agriculture, 2023. Available at: https://www.ispag.org [Accessed 20 Oct. 2024].
6. NASA Earth Science Division, 2024. Available at: https://science.nasa.gov/earth-science [Accessed 20 Oct. 2024].
7. American Society of Agricultural and Biological Engineers, 2023. Available at: https://www.asabe.org [Accessed 20 Oct. 2024].
8. Deloitte Insights, 2020. *Drones in Agriculture: The Future of Farming*. Available at: https://www2.deloitte.com [Accessed 20 Oct. 2024].
9. Smith, J., 2022. Implementation of Drone Technology in Precision Agriculture. Master's Thesis, University of [Your University].
10. Johnson, A., 2023. Machine Learning for Precision Agriculture: A Comprehensive Review. Ph.D. Dissertation, University of [Your University].
11. TensorFlow, 2024. *TensorFlow Documentation*. Available at: https://www.tensorflow.org [Accessed 20 Oct. 2024].
12. PyTorch, 2024. *PyTorch Documentation*. Available at: https://pytorch.org [Accessed 20 Oct. 2024].
13. Williams, K. and Carter, L., 2023. Advancements in Drone Technology for Agriculture. In: Proceedings of the International Conference on Agriculture and Horticulture. [online] Available at: https://www.icah2023.org [Accessed 20 Oct. 2024].
14. Brown, T. and Green, E., 2023. Integrating IoT with Drones for Smart Agriculture. In: Proceedings of the International Conference on Internet of Things. [online] Available at: https://www.iotconference2023.org [Accessed 20 Oct. 2024].

Grammarly Certificate

grammarly Report: AgriTech_Project_FinalDraft

AgriTech_Project_FinalDraft

by PT LENYAI

General metrics

52,519	7,602	491	30 min 24 sec	58 min 28 sec
characters	words	sentences	reading time	speaking time

Score

84

This text scores better than 84% of all texts checked by Grammarly

Writing Issues

313		313
Issues left	Critical	Advanced

Unique Words

Measures vocabulary diversity by calculating the percentage of words used only once in your document

22%
unique words

Rare Words

Measures depth of vocabulary by identifying words that are not among the 5,000 most common English words.

48%
rare words

grammarly Report: AgriTech_Project_FinalDraft

Word Length

Measures average word length

5.6
characters per word

Sentence Length

Measures average sentence length

15.5
words per sentence