BUSINESS PROPOSAL

ONYVA

OCTOBER 2024

AstrOnion

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ABOUT ASTRONION

We are a team of six passionate individuals who met during the **Artificial Intelligence Bootcamp at Factoría F5 in Madrid**. Our shared enthusiasm for technology and problem-solving quickly brought us together, and now we're ready to take on a new challenge — the **2024 NASA Space Apps Challenge**.

Participating in this hackathon represents a new frontier for us, where we will further develop our skills in AI, teamwork, and creative thinking. This global challenge encourages us to push our boundaries, applying the knowledge we've gained to tackle real-world problems related to space and Earth sciences.

Together, we aim to not only learn but also to inspire others by showing how a diverse group of individuals can collaborate, innovate, and make a meaningful impact on the future.

THE ASTRONION TECH TEAM

Alberto Carrillo
IA Developer

Vittoria de Novellis
IA Developer

Freddy Materano
IA Developer

Esther Tapias
IA Developer

Isabel Teruel
IA Developer

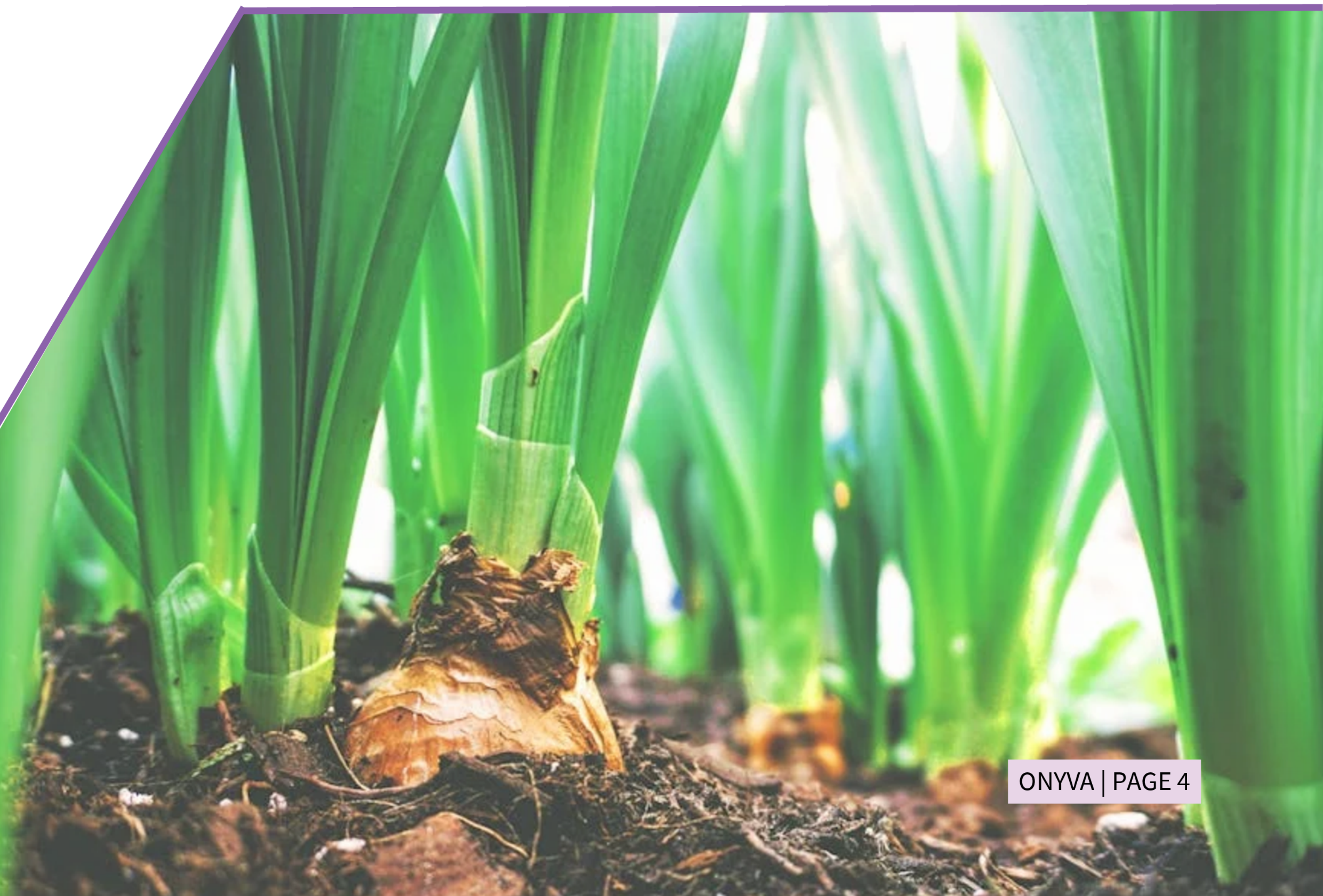
Jaanh Yajuri Bernal
IA Developer

Description

Our project focuses on developing a technological solution to improve agricultural management through an app and an IoT device shaped like an onion. This device collects data from the soil and environment, such as humidity, NPK, electrical conductivity, pH, CO_2, and solar radiation. By combining this data with satellite information from NASA, including temperature, heat index, CO_2, humidity, UV, and evapotranspiration, a machine learning (ML) model is used to provide predictions and recommendations to farmers.

The goal is to help optimize resource use, particularly water, in contexts where scarcity is a recurring issue. The mobile app integrates all this data, presenting real-time information, alerts, and recommendations in an intuitive way, allowing farmers to make informed decisions and improve the efficiency of their crops, reducing costs and maximizing sustainability.

The project is also designed for scalability, as it can be adapted from small farms to large-scale global agricultural systems. Over time, as more data is collected, the predictive models will become more accurate, expanding the positive impact on sustainable farming.



Problem

Onyva addresses the growing need for efficient and sustainable agricultural management. Farmers face challenges related to resource optimization, particularly water, which is often scarce. In addition, they need reliable data to make informed decisions about irrigation, crop health, and weather risks.

Solution

Onyva is an intelligent agricultural platform that combines a mobile application with a custom IoT device shaped like an onion. The IoT device collects real-time data from the soil and environment, which is then combined with satellite data from NASA. This integration allows farmers to receive personalized recommendations that optimize irrigation and crop management. The goal is to improve resource efficiency, especially water, while maximizing sustainability in agricultural production.

How It Works

The IoT device gathers key environmental data, including humidity, NPK (nitrogen, phosphorus, potassium), pH, electrical conductivity, solar radiation, and CO2. It features a black box to secure data in case of accidents or disasters, a solar panel for autonomous energy, and a camera that captures images to enhance the models with additional terrain information. This local data is then merged with NASA satellite data, such as temperature, heat index, humidity, CO2, UV radiation, and evapotranspiration. Machine learning (ML) models process this combined data to generate predictions related to crop conditions, irrigation needs, and potential climate risks. The Onyva app displays all this information in a user-friendly interface, where farmers can monitor real-time conditions, receive alerts, and make informed decisions. The home screen is divided into quadrants for each device, offering an overview or detailed data for each section.

Benefits

Onyva helps farmers optimize the use of key resources such as water, reducing operational costs and increasing efficiency in crop production. Additionally, it enhances their ability to anticipate extreme weather conditions, droughts, or floods, enabling them to take preventive measures. By integrating local IoT data with global satellite information, Onyva provides a complete, accurate view of crop conditions, supporting more sustainable decision-making and contributing to environmentally friendly farming practices.

Goals

Onyva aims to revolutionize agriculture by harnessing advanced data and technology to increase efficiency and sustainability. The platform seeks to help farmers better manage water and other resources, increase crop productivity, and improve land management practices. Long-term, Onyva aspires to reduce the environmental impact of farming while assisting farmers in addressing the growing challenges of climate change.

Technologies and Tools Used

- Hardware: Custom IoT devices shaped like onions, equipped with sensors for humidity, NPK, electrical conductivity, pH, CO2, solar radiation, and more.
- Software: A mobile application for real-time monitoring, connected to a cloud database that collects and processes data from both IoT devices and NASA satellite sources.
- Programming languages: Python for implementing machine learning models and integrating data. Java or Kotlin is used for mobile app development.
- APIs and services: APIs are employed to access tools like AppEEARS (for extracting geospatial data) and Giovanni (for satellite data visualization).
- Machine learning: Predictive models analyze and process environmental and satellite data to generate recommendations for farmers.
- Data platforms: Cloud storage is used to handle and process large volumes of data.
- Device design: The device includes a black box for data backup, a solar panel for autonomous energy, and a camera for capturing images to improve terrain analysis.

Device design-ONIVA

Project Overview

ONYVA is an innovative AI-powered platform designed to help farmers make informed decisions about their agricultural practices by leveraging NASA's Earth science data, Meteomatics API (as part of the NASA Space Apps Challenge), and local IoT sensor information. This project aims to enhance crop yield, optimize resource usage, and promote sustainable farming practices through advanced climate prediction and analysis.

Features

- Integration of NASA Earth science data and Meteomatics API data with local IoT sensor data
- Advanced climate condition prediction using machine learning
- Real-time monitoring of soil moisture, temperature, and other critical parameters
- User-friendly mobile application for farmers to access insights and recommendations

Technical Architecture

Data Sources

1. **NASA Earth Science Data:**

- **Agriculture and Water Management Pathfinder**
- **Floods Data Pathfinder**
- **Extreme Heat Data Pathfinder**

2. **Meteomatics API (NASA Space Apps Challenge resource):**

- **Provides high-resolution weather and climate data**

3. **Local IoT Sensor Data:**

- **Soil moisture**
- **Temperature**
- **Salinity**

Data Sources

- **AppEEARS (Application for Extracting and Exploring Analysis Ready Samples)**
- **NASA Earthdata Search**
- **Giovanni for data visualization and analysis**
- **Meteomatics API for retrieving weather and climate data**

AI Model

Our AI model is built using Python and leverages the following libraries:

- pandas for data manipulation
- scikit-learn for machine learning algorithms
- XGBoost for gradient boosting
- matplotlib and seaborn for data visualization

The core components of our AI model include:

1. Data Preprocessing (preprocess_climate_data.py):
   - Handles missing values
   - Normalizes features
   - Creates a 'Favorable_Condition' label based on climate parameters
   -
2. Feature Engineering (build_climate_features.py):
   - Creates rolling averages for key climate variables
   - Generates lag features to capture temporal patterns
   - Constructs interaction features to model complex relationships

3. Model Training (train_xgboost_model.py):
   - Utilizes XGBoost for its high performance and ability to handle complex datasets
   - Performs feature importance analysis to understand key predictors

4. Prediction (predict_climate_conditions.py):
   - Makes predictions on new data using the trained model
   - Provides interpretable results for farmers

5. Visualization (visualize_climate_data.py):
   - Generates correlation heatmaps to understand relationships between variables
   - Creates feature importance plots to identify key predictors
   - Produces time series plots to visualize trends in climate data

Data Parameters

The model is trained on the following parameters obtained from the Meteomatics API:

- lat: Latitude
- lon: Longitude
- validdate: Date and time of the data point
- t_2m:C: Temperature at 2 meters above ground in Celsius
- absolute_humidity_2m:gm3: Absolute humidity at 2 meters in g/m^3
- heat_index:C: Heat index in Celsius
- prob_precip_1h:p: Probability of precipitation in the next hour (percentage)
- uv:idx: UV index
- evapotranspiration_1h:mm: Evapotranspiration in the last hour in millimeters
- drought_index:idx: Drought index
- frost_days:d: Number of frost days

These parameters provide a comprehensive view of the climate conditions relevant to agricultural decision-making.

Data Parameters

1.Data Collection: The system continuously collects data from NASA's Earth science datasets, Meteomatics API, and local IoT sensors.

2. Data Preprocessing: Raw data is cleaned, normalized, and prepared for analysis.

3. Feature Engineering: The system creates advanced features to capture complex patterns in the data.

4. Model Training: An XGBoost model is trained on historical data to predict favorable farming conditions.

5. Prediction: The trained model makes predictions on current and forecasted climate conditions.

6. Visualization: Results are visualized through various plots and charts for easy interpretation.

7. User Interface: Farmers access insights and recommendations through a user-friendly mobile application.

Future Developments

- Integration with more NASA datasets for enhanced prediction accuracy
- Implementation of deep learning models for complex pattern recognition
- Development of crop-specific prediction models
- Integration with automated farming systems for direct action based on predictions

Contribution to Sustainable Agriculture

ONYVA contributes to sustainable agriculture by:

- Optimizing water usage through precise irrigation recommendations
- Reducing the use of fertilizers and pesticides by predicting optimal application times
- Improving crop yields through data-driven decision making
- Enhancing farmers' resilience to extreme weather events through early warnings

By combining NASA's global Earth science data, Meteomatics API data, and local sensor information, ONYVA provides a powerful tool for farmers to adapt to changing climate conditions and promote sustainable agricultural practices.

CONTACT US FOR FURTHER INQUIRIES

Alberto Carrillo | alb.carrillop@gmail.com
Vittoria de Novellis | vittoriadenovellis@gmail.com
Freddy Materano | jmc.freddy1@gmail.com
Esther Tapias | esthertpc93@gamil.com
Isabel Teruel | isabel.teruel@hotmail.com
Jaanh Yajuri Bernal | Jyajuber@gmail.com