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Krushi Mitra

SMART AGRICULTURE SYSTEM USING IOT AND AI/ML

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Abstract— In the expansive field of agricultural studies, the crucial contributions of farmers often go unnoticed, despite their central role in sustaining communities and global economies. This paper introduces the Krushi Mitra initiative, which aims to address practical challenges encountered by farmers. Through thorough investigation and extensive engagement with agricultural stakeholders, a team of committed computer engineering students identified various obstacles prevalent in farming practices, particularly within fruit farming, including issues related to machinery complexity and labor-intensive tasks. At the heart of Krushi Mitra lies a sophisticated ensemble comprising weather forecasting and soil testing kits, meticulously designed to serve as indispensable tools for fruit farmers. Equipped with an array of sensors and intelligent actuators, this ensemble enables autonomous monitoring and analysis of weather patterns and soil conditions, providing valuable insights for data-driven decision-making in fruit cultivation. Its intricately engineered interface and seamless functionality bolster operational efficiency and facilitate user adoption. The developmental journey of Krushi Mitra was marked by challenges, yet driven by methodical problem-solving. The team sought guidance from multidisciplinary experts, integrating insights from Embedded Systems, IoT, and Machine Learning domains. The milestones achieved through Krushi Mitra stand as commendable demonstrations of resilience and collaborative endeavor. By rigorously integrating feedback and insights from fruit farmers into the project's framework, the team has developed a solution that aligns with the industry's exigencies. This paper aims to contribute to the discourse surrounding agricultural technology by positioning Krushi Mitra as a practical tool for fruit farmers worldwide. Looking ahead, the trajectory for Krushi Mitra extends beyond its initial phase, with strategic plans to amplify its impact, augment its capabilities, and provide comprehensive training and support. Through systematic endeavors, Krushi Mitra aspires to cultivate a future where fruit farmers can harness technological advancements to optimize their operations and enhance productivity.

Keywords— Farmers, Agricultural technology, Weather forecasting, Soil testing, Krushi Mitra. Introduction (Heading 1)

In the realm of agricultural technology, where the promise of sustenance and growth hinges on every seed planted, optimizing farming practices is crucial for boosting productivity and sustainability. Despite advancements in various agricultural domains, fruit farming presents unique challenges that demand inventive solutions. The Krushi Mitra initiative emerges as a comprehensive technological endeavor tailored to meet the distinctive needs of fruit farmers.

Fruit farming, with its diverse range of crops and cultivation techniques, presents a complex tapestry of requirements and obstacles. From monitoring ever-changing weather patterns to assessing soil health, fruit farmers must navigate through numerous variables to ensure abundant yields and high quality. However, conventional methods of data collection and analysis often fall short, leaving farmers grappling with inefficiencies and subpar outcomes. In response, the Krushi Mitra initiative harnesses cutting-edge technologies such as IoT sensors, data analytics, and machine learning algorithms.

At its core, Krushi Mitra features weather forecasting and soil testing kits equipped with a network of sensors capable of real-time data collection and analysis. These kits furnish fruit farmers with actionable insights into crucial aspects like weather forecasts, soil composition, and nutrient levels. Armed with this knowledge, farmers can make informed decisions, fine-tune their practices, and maximize yields.

The development of Krushi Mitra has been marked by close collaboration with fruit farmers, ensuring that the solution is finely tuned to their specific needs and challenges. Through iterative design and rigorous testing, the Krushi Mitra team has honed the technology for seamless usability and maximum effectiveness in real-world farming scenarios. This research paper aims to illuminate the technological innovations at the core of the Krushi Mitra initiative and evaluate its impact in addressing the challenges faced by fruit farmers. By exploring its design, implementation, and real-world applications, we contribute to the broader discourse surrounding agricultural technology, unveiling its transformative potential in revolutionizing fruit farming practices and enhancing agricultural sustainability.

OBJECTIVE AND OVERVIEW

Empowering Farmers: The Krushi Mitra initiative is dedicated to empowering farmers by offering practical solutions to address challenges in agricultural practices, especially in fruit farming. This is achieved through the integration of IoT, machine learning, and solar power technologies.

Solar-Powered Farming Solution: Krushi Mitra presents a solar-powered system equipped with IoT sensors and actuators, seamlessly integrated with machine learning algorithms. This system autonomously monitors environmental conditions, optimizes resource utilization, and boosts productivity, ultimately improving the livelihoods of farmers and promoting sustainability in agriculture.

OVERVIEW OF THE PROJECT OBJECTIVES

Data Processing: Efficient data processing stands as the cornerstone of the Krushi Mitra initiative. With the integration of IoT sensors capturing extensive farm-related data, the project prioritizes robust backend systems and cloud computing infrastructure to seamlessly handle data storage, preprocessing, and analysis. This capability ensures farmers access real-time insights into environmental conditions, soil health, and crop performance, empowering informed decision-making to optimize agricultural practices.

Model Training: The development of accurate and reliable machine learning models is pivotal for Krushi Mitra's success. Leveraging historical farm data collected via IoT sensors, the project endeavors to train sophisticated machine learning algorithms. These models are tailored to predict weather patterns, forecast crop yields, and assess soil health. Through iterative training and refinement processes, the models aim to provide farmers with actionable insights to enhance productivity and mitigate risks in fruit farming.

Classification: In precision agriculture, the ability to classify and identify anomalies holds immense importance. Krushi Mitra employs advanced image recognition technology to classify images captured by farm-installed cameras. These algorithms are adept at detecting and categorizing pests, diseases, or other abnormalities in crops. Offering early detection and precise classification, farmers can proactively address potential threats, thereby minimizing crop losses and optimizing yields in fruit farming.

Deployment: The successful deployment of the integrated system marks the culmination of the Krushi Mitra project. Solar-powered IoT devices, equipped with sensors, actuators, and machine learning models, are strategically installed on farms. These devices autonomously monitor environmental conditions, optimize resource utilization, and enhance productivity in agriculture. Through seamless integration and user-friendly interfaces, the deployed system empowers farmers with practical solutions to overcome challenges in fruit farming, thereby enhancing livelihoods and fostering sustainability in agriculture.

Acknowlegdement

We express our heartfelt gratitude to the fruit farmers for their invaluable insights and contributions to the Krushi Mitra project. We also extend our appreciation to our mentors for their guidance, the collaborative efforts of our team members, and the financial support from [Insert Sponsor Name(s) Here)]. Furthermore, we are grateful for the unwavering support of our families and friends.

Technology In Project

- IoT sensors and actuators:

Usage: IoT sensors collect data on environmental parameters such as temperature, humidity, and rainfall, while actuators regulate various farm equipment based on this data.

How It's Used: Sensors gather real-time data from the farm environment, enabling farmers to make informed decisions regarding irrigation, fertilization, and pest control. Actuators automate tasks such as managing irrigation systems or adjusting greenhouse ventilation based on sensor readings.

- Machine learning algorithms:

Usage: Machine learning algorithms analyze data gathered by sensors to forecast weather patterns, assess soil health, and predict crop yields.

How It's Used: By examining historical data alongside current sensor readings, machine learning models offer insights into optimal planting times, disease identification, and yield projections, aiding farmers in strategic decision-making.

- Solar power integration:

Usage: Solar panels harness sunlight to power farm equipment and IoT devices, diminishing reliance on grid electricity.

How It's Used: Solar energy fuels the IoT system, ensuring continuous operation without external power sources, thus making it economically viable and sustainable for farmers.

- Cloud computing:

Usage: Cloud computing platforms store and process large datasets collected from IoT devices, facilitating advanced analytics and remote accessibility.

How It's Used: Data from IoT sensors is transmitted to the cloud, where it undergoes analysis using machine learning algorithms. Farmers can remotely access this data through mobile or web applications, enabling real-time monitoring and decision-making.

- Mobile application development:

Usage: Mobile applications provide farmers with an intuitive interface to access farm data, receive alerts, and remotely manage IoT devices.

How It's Used: Farmers can monitor farm conditions, obtain weather forecasts, and control irrigation or other equipment from their smartphones, thereby enhancing efficiency and productivity.

- Database management systems:

Usage: Database systems store and manage farm-related data collected from sensors and other sources.

How It's Used: Information on soil health, weather conditions, and crop growth is stored in databases, enabling farmers to track trends over time and make data-driven decisions.

- Image recognition technology:

Usage: Image recognition technology identifies pests, diseases, or anomalies in crops using images captured by cameras.

How It's Used: Field-installed cameras capture images of crops, which are analyzed using image recognition algorithms to detect signs of disease or pest infestation, facilitating timely intervention.

- Deep learning frameworks:

Usage: Deep learning frameworks like TensorFlow and PyTorch are utilized to construct and train machine learning models for tasks such as image recognition and predictive analytics.

How It's Used: Data scientists employ deep learning frameworks to develop and train models that analyze farm data, enabling applications such as crop disease detection and yield prediction.

IMPLEMENTATION OF PROJECT

Plant Village

```
[3]: dataset = tf.keras.preprocessing.image_dataset_from_directory(
         "PlantVillage",
         seed=123,
         shuffle=True,
         image_size=(IMAGE_SIZE,IMAGE_SIZE),
         batch_size=BATCH_SIZE
     )
     Found 2152 files belonging to 3 classes.
```

MODEL PREDICTION

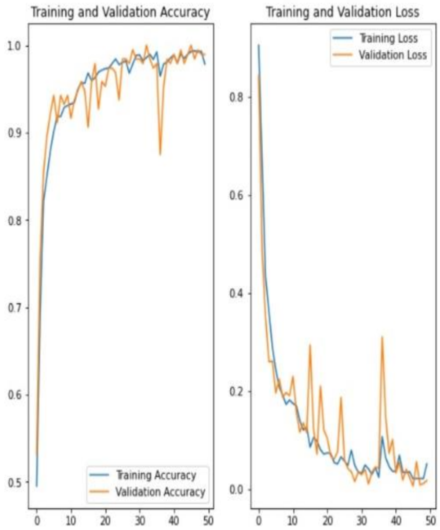
The provided code snippet facilitates the creation of a 3x3 grid displaying images along with their corresponding actual and predicted classes, alongside the confidence level of each prediction. Utilizing TensorFlow's dataset API, it fetches a batch of images and labels from a test dataset. For each image in the batch, the code predicts the class using a pre-trained model. It then presents the image with its actual and predicted class labels, along with the confidence level of the prediction. The command plt.figure(figsize=(15, 15)) is employed to adjust the size of the figure, ensuring optimal visualization. This code serves as a valuable tool for visually evaluating the performance of a machine learning model by comparing its predictions with the ground truth labels for a subset of test data.

```
[41]: plt.figure(figsize=(15, 15))
for images, labels in test_ds.take(1):
    for i in range(9):
        ax = plt.subplot(3, 3, i + 1)
        plt.imshow(images[i].numpy().astype("uint8"))

        predicted_class, confidence = predict(model, images[i].numpy())
        actual_class = class_names[labels[i]]

        plt.title(f"Actual: {actual_class},\n Predicted: {predicted_class}.\n Confidence: {confidence}%")

        plt.axis("off")
```

MODEL EVALUATION:

The provided code snippet generates a subplot featuring two plots side by side, illustrating the training and validation loss over epochs during model training. Matplotlib's subplot() function is employed to divide the figure into two sections. Subsequently, the plt.plot() function is utilized to graphically represent the training loss and validation loss against the range of epochs. Adding a legend via the plt.legend() function facilitates distinguishing between the training and validation loss curves. Lastly, the plt.title() function assigns the title "Training and Validation Loss" to the subplot, and plt.show() displays the plot. This code is instrumental in visualizing the convergence and potential overfitting of a machine learning model.

```
plt.subplot(1, 2, 2)
plt.plot(range(EPOCHS), loss, label='Training Loss')
plt.plot(range(EPOCHS), val_loss, label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')
plt.show()
```



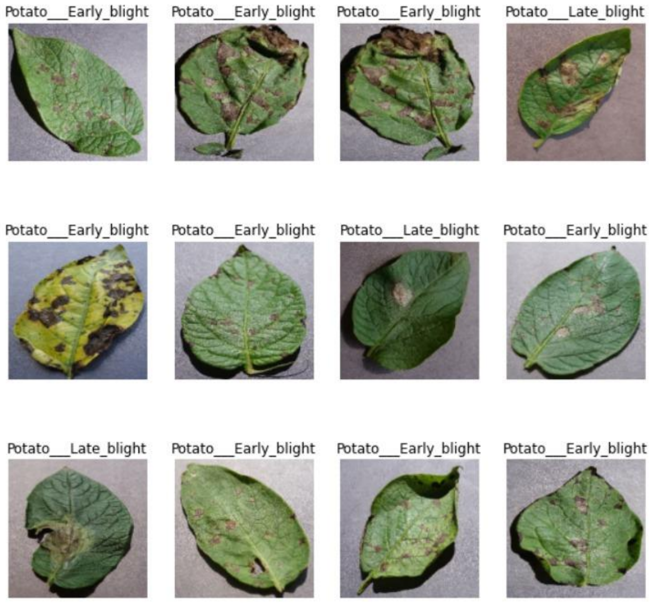
RESULTS

The following images shows the accuracy of model

```
54/54 [==============================] - 2s 29ms/step - loss: 0.0349 - accuracy: 0.9896 - val_loss: 0.0231 -
Epoch 46/50
54/54 [==============================] - 2s 29ms/step - loss: 0.0210 - accuracy: 0.9931 - val_loss: 0.0061 -
Epoch 47/50
54/54 [==============================] - 2s 28ms/step - loss: 0.0214 - accuracy: 0.9936 - val_loss: 0.0556 -
Epoch 48/50
54/54 [==============================] - 2s 28ms/step - loss: 0.0213 - accuracy: 0.9925 - val_loss: 0.0082 -
Epoch 49/50
54/54 [==============================] - 2s 29ms/step - loss: 0.0213 - accuracy: 0.9931 - val_loss: 0.0113 -
Epoch 50/50
54/54 [==============================] - 2s 29ms/step - loss: 0.0510 - accuracy: 0.9786 - val_loss: 0.0172 -

scores = model.evaluate(test_ds)

8/8 [==============================] - 1s 10ms/step - loss: 0.0086 - accuracy: 1.0000
```

You can see above that we get 98.83% accuracy for our test dataset. This is considered to be a pretty good accuracy

```
scores

[0.008594825863838196, 1.0]
```



I. CONCLUSION

In conclusion, the Krushi Mitra project emerges as a promising avenue for addressing the myriad challenges encountered by fruit farmers through technological innovation. By furnishing actionable insights into weather patterns and soil conditions, Krushi Mitra bestows upon farmers the means to optimize their practices effectively. Through extensive collaboration with farmers and iterative design processes, Krushi Mitra has been meticulously tailored for real-world application, underscoring the transformative potential of technology in enhancing agricultural productivity and sustainability. As we chart the course forward, the ongoing refinement and expansion of Krushi Mitra hold the potential for further elevating fruit farming practices and enriching agricultural communities on a global scale.

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