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Using AI and IoT to Optimize Smart Farming: Integrating Robotics with Precision Agriculture

The Internet of Things (IoT) is a network of physical devices that are connected to the internet and are able to communicate with each other. These devices allow automation and data-driven decision-making in a variety of industries by collecting and exchanging information. IoT is important for the agricultural industry since it allows for the monitoring of environmental factors such as temperature and soil moisture. When combined with artificial intelligence (AI), IoT can further improve precision farming by allowing automated crop monitoring, early disease identification, and resource management optimization. While robotics can automate tasks that require navigation and mobility, AI-powered computer vision allows systems to monitor plant conditions in real-time. These developments make smart farming more efficient by increasing productivity through enhanced sustainability and reduced manual labor.

The goal of our research is to create a smart farming prototype that reduces human intervention in agricultural tasks, automates processes, and improves plant health monitoring through the use of IoT and AI-driven robotics. We have explored with Azure Custom Vision to use cloud-based image processing for plant health classification. We have also explored how computer vision and autonomous movement can improve smart farming using HiWonder's TurboPi, an AI-powered robot with a camera sensor.

In the previous years of our smart farm research, we utilized a Raspberry Pi, which allows us to connect to Microsoft Azure's Custom Vision service for image classification. We applied these skills to determine the percentage of banana ripeness. While we did not write the machine learning model itself, we trained it in Custom Vision using pictures of bananas with different ripeness levels. The code we developed allowed the Raspberry Pi's camera sensor to capture an image of a banana and send it to Custom Vision via Azure Cloud for processing.

Currently in our research, we have learned how computer vision can be used within smart farming by using an AI robot called TurboPi. Since TurboPi is powered by the Raspberry Pi, we did not need to write any additional code. Instead, we focused on testing its built-in navigation and mobility functions. TurboPi uses a servo-mounted camera sensor to capture visual data, allowing it to analyze the plants in its surroundings. It uses OpenCV for computer vision, allowing for functions such as color recognition and line tracking. The color recognition feature helps the robot identify different colors, which is useful for monitoring plant health based on the color of its leaves. The line tracking feature allows TurboPi to follow specific paths autonomously, enhancing its navigation in a farm setting.

In our prototype phase, we tested the functions of TurboPi. It successfully navigated in a circle using its line tracking feature, demonstrating its ability to follow a set path. When TurboPi reached its designated point, it stopped and used its servo-mounted camera to focus on different flags with a red or green ball on it. After identifying the flag, the robot moved on, continuing its journey. These tests show TurboPi's potential for smart farming applications, and we are excited to keep improving its capabilities as we move forward in our project.

For future work, we plan to integrate TurboPi with a Python code that will perform image classification through Custom Vision on Microsoft Azure. This integration will allow TurboPi to analyze visual data in real-time, enhancing its functions in AI-powered smart farming. By using machine learning techniques within the image classification model in Custom Vision, TurboPi will be able to identify specific features of plants, such as signs of disease or nutrient deficiencies, allowing for more precise monitoring of crop health.