Exploring Internet of Things (IoT) for Farming, Manufacturing, and Retail Domains

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Abstract

The Internet of Things (IoT) is a network of devices that connect the Internet to the real world through sensors and actuators. Adoption of IoT is becoming more important as organizations prioritize optimization based on data. We have explored IoT skills for farming, manufacturing, and retail domains using Microsoft materials. The lessons we covered include topics like smart farming, image classification, and object detection, each utilizing different sensors and actuators along with Microsoft Azure. This research plays an important role in enabling easy integration and adaptable IoT solutions, which are vital for advancing smart cities and industrial automation, thus influencing a

Introduction

IoT applications can be described as things (devices) that collect data, often utilizing edge services like image classifiers. The data from the devices is then sent to an IoT service, where analytics on stored data or serverless apps are used to gather insights. Insights are conclusions that are drawn based on the data. Insights prompt actions, like data visualization or sending commands to devices, to enhance a business or process.

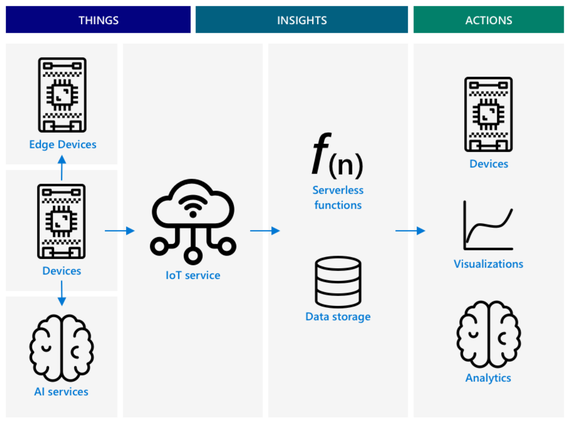

Figure 1. Internet of Things Reference Architecture [1]

Smart Farm

Using IoT devices to monitor soil moisture levels provides farmers with crucial data to optimize plant growth. By employing resistive sensors, farmers can accurately measure soil moisture to ensure it remains within the ideal range, preventing both over-watering and under-watering scenarios. This data is transmitted via MQTT, allowing for real-time monitoring and analysis. Additionally, by integrating a relay, farmers can automate the irrigation process based on the soil moisture readings, activating a water pump as needed to maintain optimal soil conditions. This comprehensive approach enables farmers to cultivate healthier crops while conserving water resources and increasing overall efficiency in agricultural practices.

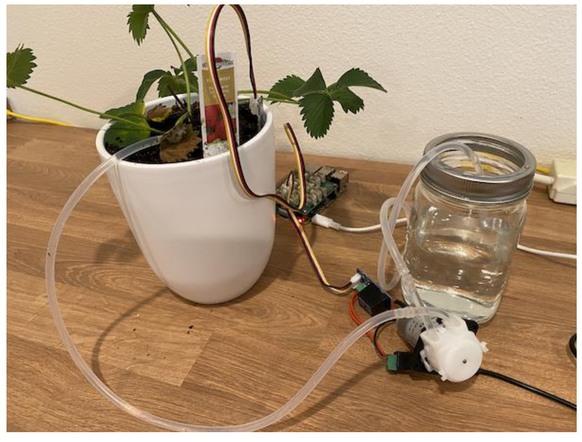

Figure 2. Automated Plant Watering System [1]

Leveraging serverless computing on Microsoft Azure can further enhance the efficiency and scalability of this solution. With Azure, data from soil moisture sensors can be processed and analyzed in real time without the need for managing servers, thanks to Azure Functions. This serverless architecture not only streamlines the deployment of computing resources as needed but also integrates seamlessly with security measures provided by Azure.

Image Classification

In food manufacturing, sorting was performed by pickers and factory workers. Initially, machines were introduced for sorting, employing optical sensors to detect the colors of tomatoes. Nowadays, modern setups use IoT technology alongside AI and optical sensors to automate food sorting, ensuring quality control and promoting early detection of crop issues. Among these IoT technologies is image classification, which uses machine learning models to distinguish between different images. For instance, by providing the model with different pictures of ripe and unripe bananas labeled accordingly, the model learns from the training data and utilizes this knowledge to predict the ripeness of a new banana based on its image.

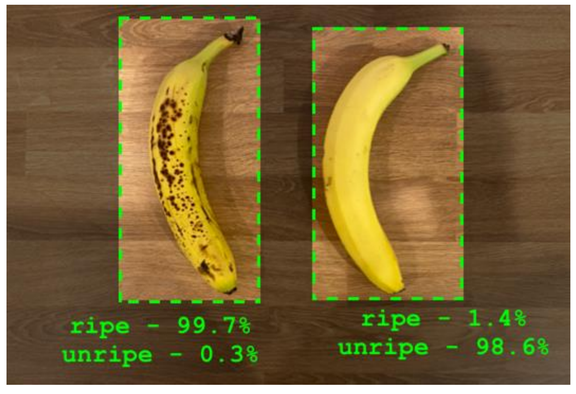

Figure 3. Custom Vision Results [1]

We used Custom Vision, a cloud-based tool, to create and deploy our image classifier. Our system combines camera and distance sensors to classify fruits in real-time. The distance sensor activates the Raspberry Pi when a fruit is ready for classification. The Raspberry Pi triggers the camera to capture an image of the fruit, which is then sent to Azure for analysis. Azure provides a probability assessment, which is sent back to the Raspberry Pi for further processing. This streamlines fruit classification, showcasing the effectiveness of cloud-based solutions in practical settings.

Object Detection

Using IoT and machine learning models optimizes stock management in grocery stores, eliminating the laborious task of individually checking shelves. Object detection technology not only identifies products but also provides bounding boxes, defining their positions within images. Bounding boxes, paired with probabilities, help in assessing detection accuracy; for example, if an object detector detects overlapping objects, the code can ignore objects with significant overlaps.

Figure 4. Object Detection [1]

Past/Future Work

Past Work: "Exploring Internet of Things (IoT) with Microsoft Materials", CoS Poster Celebration, 2023.
Future Work: Tracking a vehicle's location using a GPS sensor and adding voice recognition to IoT devices and using microphones as sensors to convert speech to text.

Acknowledgment

This research activity is funded all or in part by the Stanislaus State ASPIRE program through a U.S. Department of Education Title III Grant # P031C210159.

References

[1] Microsoft, "IoT-For-Beginners", https://github.com/microsoft/IoT-For-Beginners