

TEMASEK POLYTECHNIC
SCHOOL OF INFORMATICS & IT
AY2024/2025 OCTOBER SEMESTER
DIPLOMA IN APPLIED ARTIFICIAL INTELLIGENCE
DIPLOMA IN INFORMATION TECHNOLOGY

IOT APPLICATION DEVELOPMENT (CMC2C16)

Project Proposal

Full Name	Admin No.	Class

Name of IoT Solution

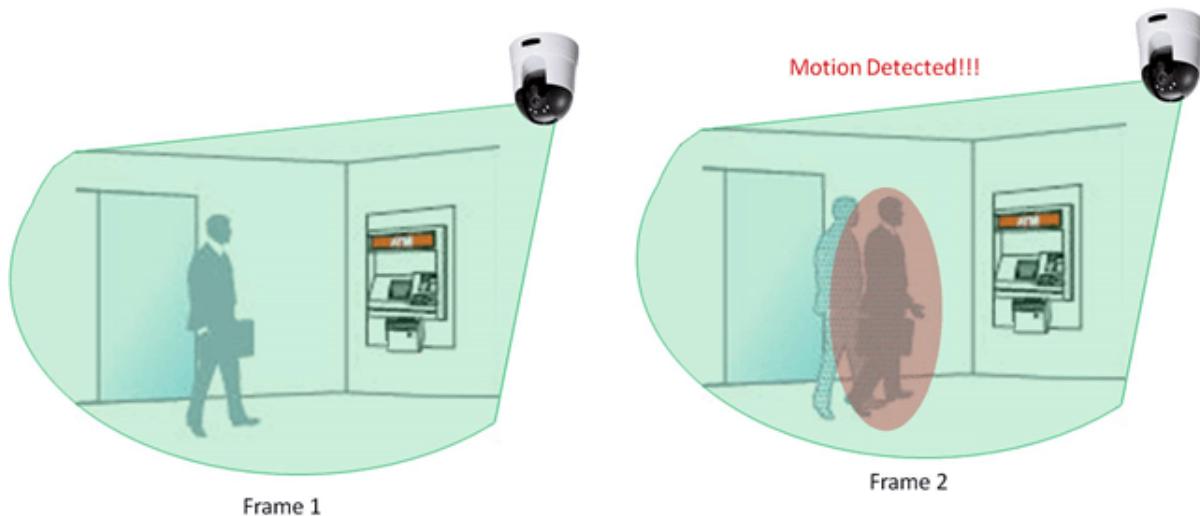
SafeShelf

Description

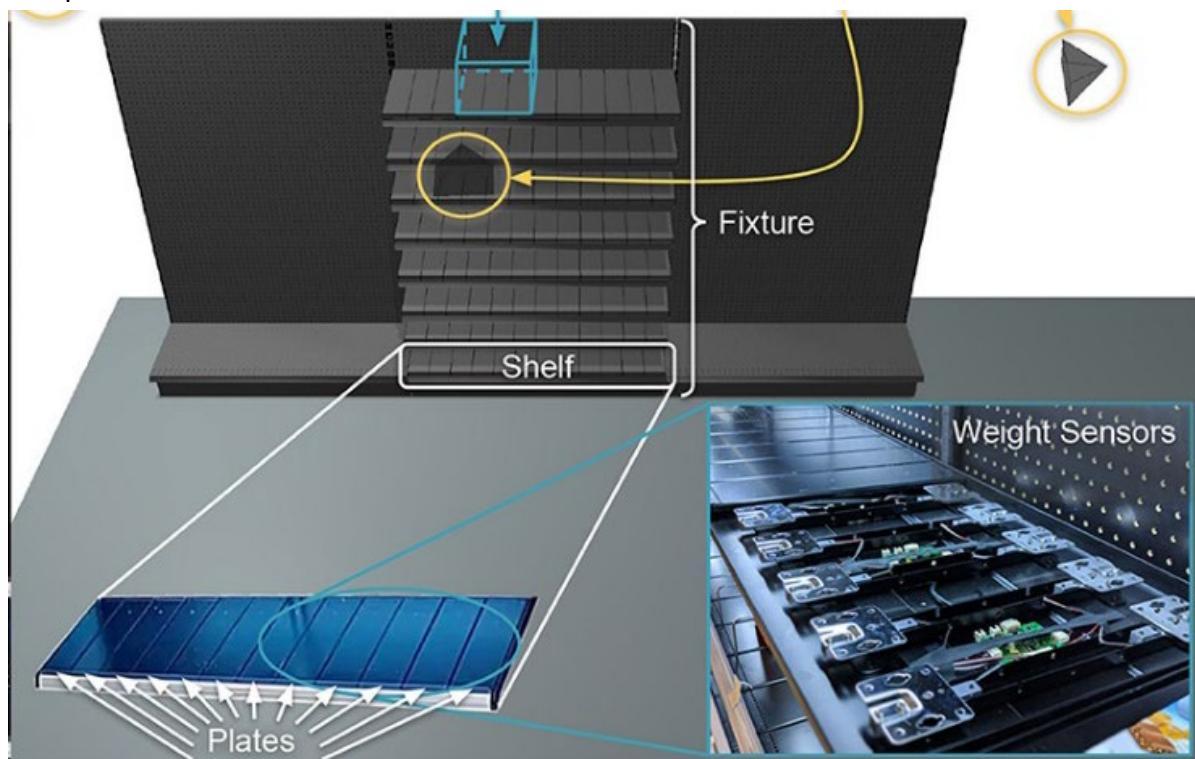
SafeShelf is a smart inventory and security system that integrates RFID, motion, and weight sensors. It provides a secure and efficient environment for retail stores. This solution automates functions like theft detection, security-monitoring during non-operating hours, and inventory management. Additionally real-time notifications are sent to user through SNS.

How it works

RFID scanners are positioned at the store's exit. Each product has an RFID tag. During the checkout process, the RFID tag has to be scanned before it can leave the shop. If an item leaves the shop without being scanned, the RFID scanner will detect the unverified tag. This will trigger an SNS notification, alerting the store manager of the incident. The RFID scanner can also sound an alarm to deter the theft.



Motion sensors are activated after the store's opening hours to monitor unauthorised movements. When motion is detected, it triggers the motion sensor. This invokes an AWS Lambda function that sends an SNS notification to the store owner or security, alerting them of a possible intruder.



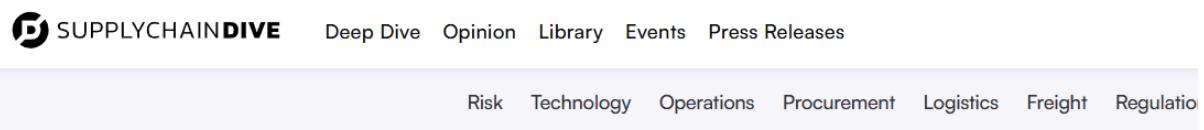
Weight sensors are placed under shelves to monitor stock level of products continuously. When an item is removed, the sensor detects a change in weight. If the weight falls below its predefined threshold, it sends an SNS notification to staff, alerting them that the shelf needs restocking. This system will also log the change in DynamoDB for inventory tracking.

Data collected by the sensors will be transmitted to AWS IoT Core, where it will be processed and stored in DynamoDB. When an event occurs – such as an unscanned RFID tag at the exit, motion detected after opening hours, or low stock detected, it routes the event to the AWS Lambda function and generates a meaningful notification message. This

message is then sent to SNS which will deliver via SMS, email to subscribed users such as store staff or security personnel. Additionally, DynamoDB stores event logs and inventory data, ensuring reliable records and insights for operational improvements.

Problems addressed

One problem SafeShelf addresses is overstocking of goods due to inaccurate forecasting. The impact of overstocking includes occupying of valuable storage space and that retail stores may need to discount items to clear them, leading to loss of profits. SafeShelf addresses this issue by using weight sensors to monitor stock levels. These sensors measure the weight of items on shelves continuously and provide precise data on inventory levels. By providing accurate and up-to-date stock insights, it encourages stores to make data-driven decisions, reducing the risk of overstocking and optimising inventory management.



OPINION

Out-of-stocks are more costly than losing a sale – but there's a fix

Published Jan. 8, 2019

By Sameer Anand and Sumit Chadha



Another problem addressed by SafeShelf is stockouts resulting in lost sales. From this article, it states about how stockouts impact a business negatively. For example, a stockout can occur because manual inventory checks failed to identify low stock levels in time. This can lead to dissatisfaction among customers and a loss of revenue. SafeShelf addresses this issue by using weight sensors to track stock levels. When the stock of a product falls below the predefined threshold, notifications via SNS to store managers ensure that the product is restocked on time.

A Singapore Government Agency Website [How to identify...](#)

A screenshot of the Singapore Police Force (SPF) website. The top navigation bar includes links for WHO WE ARE, MEDIA ROOM, COMMUNITY, JOIN SPF, ADVISORIES, EVENTS, E-SERVICES, and a search icon. Below the navigation is a banner featuring a police officer standing next to a police car. The banner text reads: "19 PERSONS TO BE CHARGED FOR SHOP THEFT". At the bottom of the page, there are links for HOME, MEDIA ROOM, NEWS, and the specific news item: "19 PERSONS TO BE CHARGED FOR SHOP THEFT". There are also emergency contact numbers: EMERGENCIES 999, EMERGENCY SMS 70999, HOTLINE 1800 255 0000, and I-Witness.

The last problem SafeShelf addresses is inventory shrinkage due to theft. This can lead financial losses. SafeShelf addresses this problem by integrating RFID sensors to trigger alerts when an unscanned item has left the store. Motion sensors also help address this issue by detecting unusual activity within the shop after opening hours, sending notifications to store managers via AWS SNS. This approach enhances security by providing alerts, enabling quick responses, reducing the likelihood of theft.

Justification

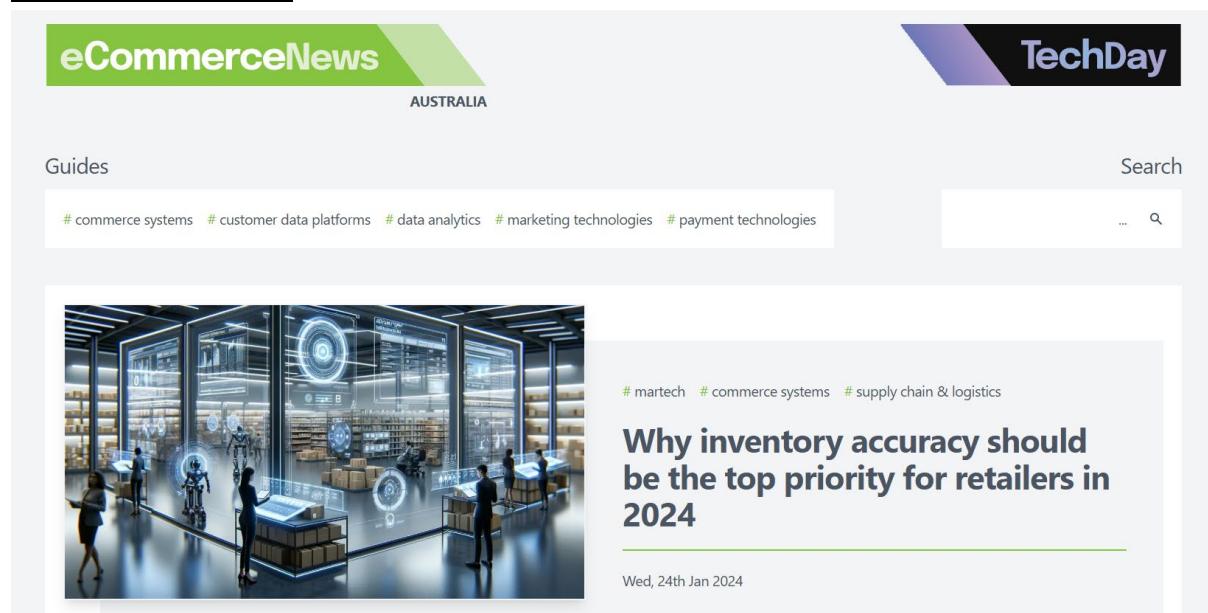
Business sector

SafeShelf falls under the retail industry. Retail stores rely heavily on accurate inventory management and robust maintain operations and maximise profitability. By using RFID, weight, and motion sensors, it provides real-time monitoring, alerts, and enhanced security. These features help retailers reduce losses, prevent inventory shrinkage, making SafeShelf an essential solution for the retail sector.

Target audience

The target audience for SafeShelf includes retail store owners, inventory managers, and security personnel. Store owners and managers are responsible for ensuring efficient operations, theft prevention, accurate inventory management. SafeShelf addresses these concerns by providing inventory updates and alerts to reduce losses and improve stock replenishment. Security personnel can also use motion and RFID sensors notifications to monitor the store and respond to threats, especially outside of working hours. Ultimately, the target audience will benefit from the enhanced security and inventory management that SafeShelf offers, which will result in improved operational efficiency and reduced financial losses.

Need for this solution



The screenshot shows the homepage of eCommerceNews AUSTRALIA. At the top, there are navigation links for 'eCommerceNews' and 'TechDay'. Below the navigation, there's a search bar and a 'Guides' section. A horizontal menu bar contains links for commerce systems, customer data platforms, data analytics, marketing technologies, and payment technologies. The main content area features a large image of a modern, high-tech warehouse or retail store with people interacting with robotic and digital interfaces. To the right of the image, a news article is displayed with the title 'Why inventory accuracy should be the top priority for retailers in 2024'. The article includes a date stamp 'Wed, 24th Jan 2024' at the bottom.

martech # commerce systems # supply chain & logistics

Why inventory accuracy should be the top priority for retailers in 2024

Wed, 24th Jan 2024

The need for the SafeShelf solution comes from the growing challenges that retail

businesses are facing such as managing inventory and preventing theft. Traditional inventory systems are often prone to inaccuracies due to human error, leading to overstocking, stockouts, or inventory shrinkage due to theft. SafeShelf offers a reliable solution which will help retailers maintain optimal stock levels, improve security, and enhance operational efficiency. Through the integration of services such as Lambda, SNS, IoT, and sensors such as RFID, motion, and weight sensors, the system provides notifications on security and inventory. This reduces the risk of overstocking, theft, and mismanagement. Ultimately this solution improves the profitability and operational effectiveness.

Benefits

Tangible Benefits

The tangible benefits of the SafeShelf solution include improved accuracy of inventory, reduced losses from theft, and enhanced stock management. By using the weight sensors, retailers can track inventory levels more accurately, reducing the risk of overstocking and stockouts. The ability to detect unauthorised movement during non-opening hours and detect not validated RFID tags exiting the store which will alert staff helps reduce theft and shrinkage, directly protecting profits. Additionally, the alerts for low stock levels allow for quick restocking, ensuring that shelves are always adequately stocked and prevent loss in sales. These functions help contribute to cost savings, increased revenue, and better resource utilisation.

Intangible Benefits

The intangible benefits of the SafeShelf solution include improved customer experience, operational efficiency, and stronger brand reputation. As security is more tightly controlled and accurate inventory levels, the customer's shopping experience will be smooth, as products will be readily available with no disruptions caused by theft and stock issues. Workload on staff is also reduced, thanks to automated inventory monitoring and automated alerts. This allows them to focus on other tasks and improve overall store operations. The enhanced security and efficiency provided by SafeShelf will help build customer trust and loyalty, impacting the retailer's brand reputation positively.

Scope

Functionality

Inventory Tracking

Weight sensor is placed on shelves to monitors the stock level of the product by weighing the shelf of that product. This ensures accurate and the latest data on available stock. When the weight detected by the weight sensor falls below the predefined threshold, This data is fed into AWS DynamoDB and a Lambda function is triggered, it will send an SNS notification to the user to inform them that the shelf needs restocking. They can detect when stock is running low it when an item is missing, helping managers maintain optimal stock levels. This

helps store managers avoid overstocking and stockouts, as well as enhancing the customer experience and satisfaction.

Theft Detection

RFID sensors are placed at the store's entrance/exit points. This sensor tracks the product movement. For example, if an item leaves the store without its RFID tag being scanned, the sensor detects it and triggers an alert, notifying staff via AWS SNS. This prevents theft as it ensures items are scanned properly before exiting.

Security Monitoring

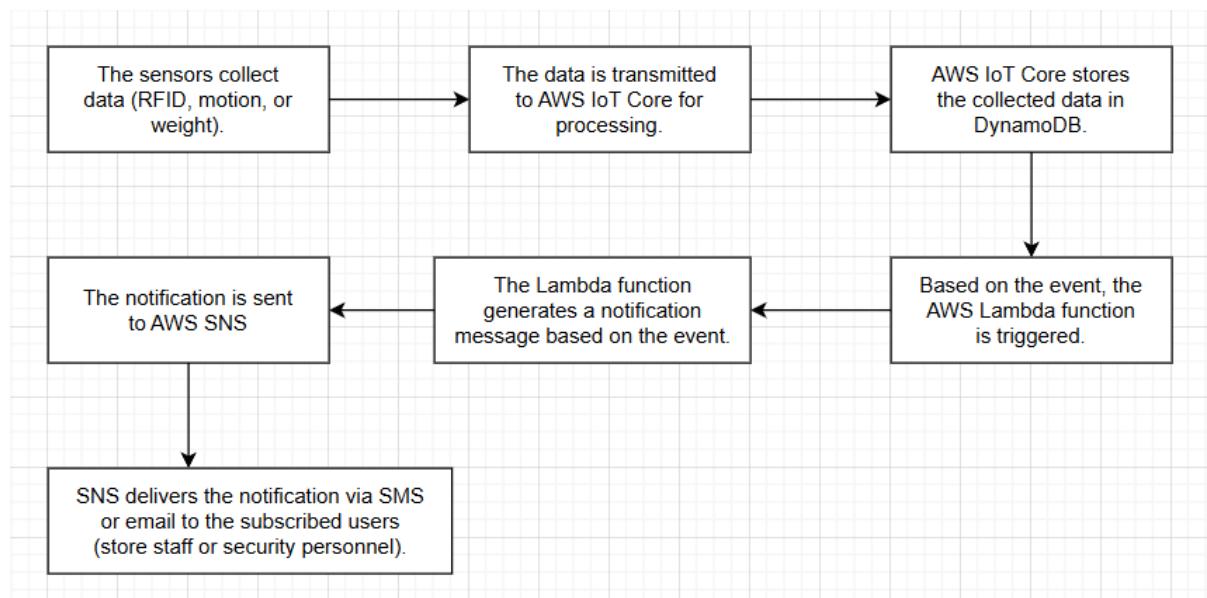
Motion sensors are placed in the store and is activated after store hours to detect unusual or unauthorised movement in the store. When movement is detected after store hours, the motion sensor detects it and triggers an alert, notifying staff via SNS. This helps enhance after-hours security.

Automated Notifications via AWS SNS

When an event, such as unauthorised item movement or low stock is detected, the event data is routed to the AWS Lambda Function by the AWS IoT. The Lambda function processes the event, generating a relevant notification. This notification is then sent via SNS to store staff, informing them of the event and allowing them to take action as soon as possible.

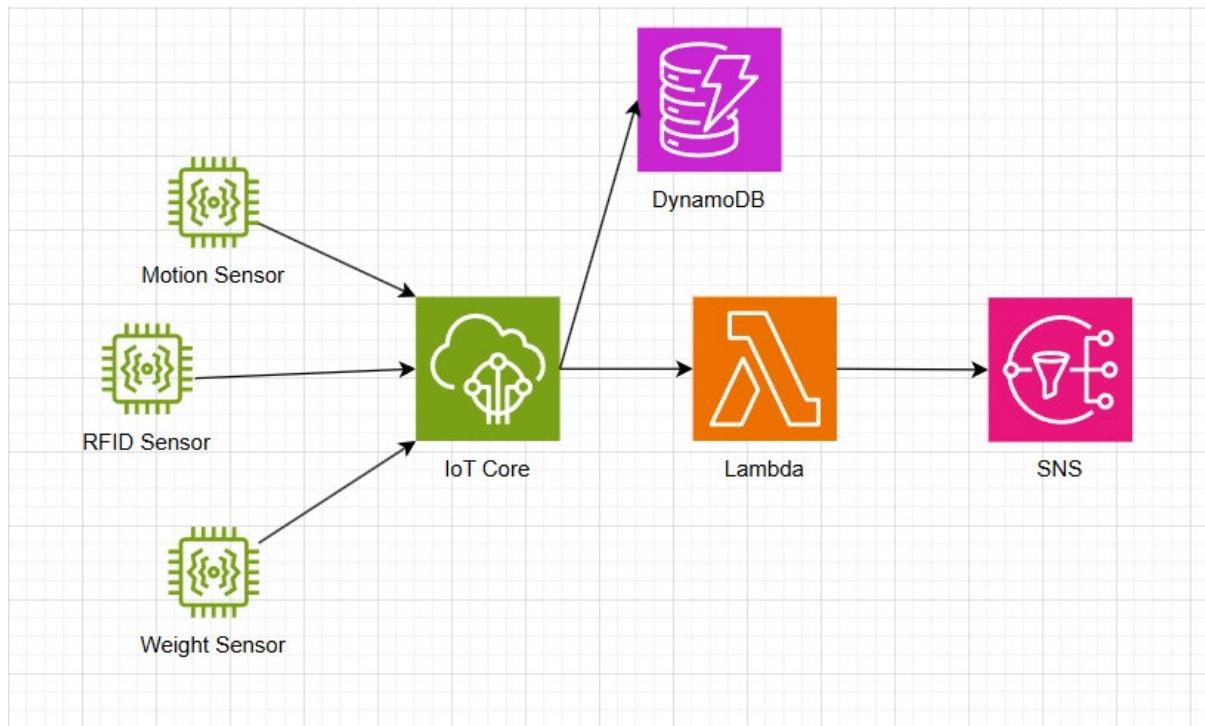
Data Logging

All data collected by the sensor, including RFID scans, weight measurements, and motion alerts will be stored in AWS DynamoDB. This database stores event logs and provides access to historical data. Store managers will be able to review trends, identify recurring issues, and make data-driven decisions to optimise store operations.



This diagram illustrates the process of how data is collected from IoT sensors is processed and used for SafeShelf. The process begins with the sensors collecting data such as RFID

tags, tracking stock levels, and detecting motion. This data is then transmitted to AWS IoT Core. The collected data is stored in DynamoDB, providing a location for event logs and inventory status. When an event such as unscanned RFID tag, low stock, or motion detected after hours, AWS Lambda is triggered to process the event and generate the notification. This notification is then sent to store staff via SNS.



This is the AWS architecture of my solution. It shows the types of sensors and services that I plan to use for this IoT solution. IoT Core will manage and process the collected data from the sensors. DynamoDB stores the processed, providing a reliable and scalable database for event logs and inventory data. Lambda generates the necessary notifications when an event such as low stock is triggered. SNS delivers the notification to subscribed users based on the events processed by Lambda.

Limitations and challenges

Initial Setup and Installation Costs

The use of RFID, weight, and motion sensors across a store can be extremely expensive. This not only includes purchasing the hardware, but also installing the sensors, and configuring the IoT network.

Sensor Limitations

There are limitations to each of the sensors. For example, RFID sensors can only detect items within a specific range, which could cause issues if the item is positioned incorrectly or obstructed. Motion sensors could be affected due to environmental factors such as temperature changes and lighting. These limitations may affect the accuracy and reliability of the system.

Reliability of Network Connectivity

SafeShelf requires an internet connection for the transmission of data collected by sensors to AWS services and the generation of real-time notifications. If internet access is limited or unreliable, the process and sending of notifications may be delayed, affecting the effectiveness of the system. For smooth operation, a stable internet connection is required.

References

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