Embedded Insights

AUGUST 2023 EDITION

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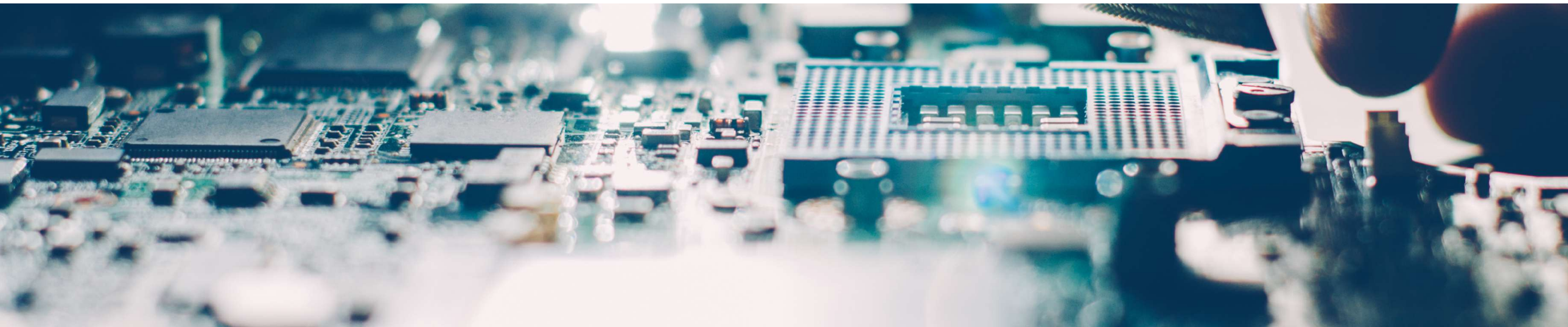

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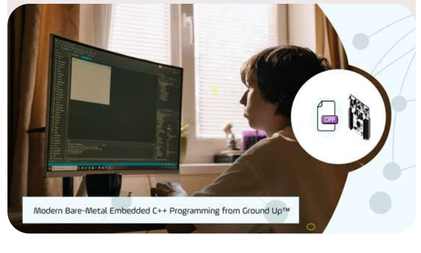

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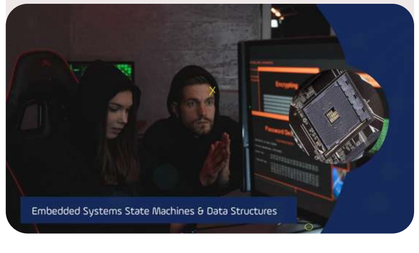

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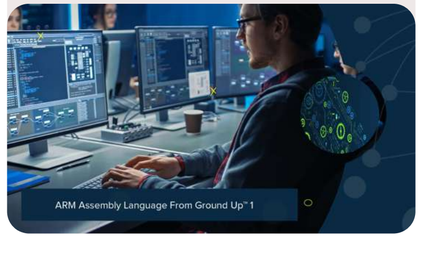

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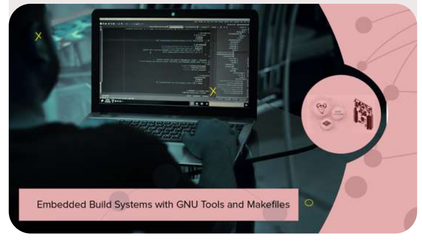

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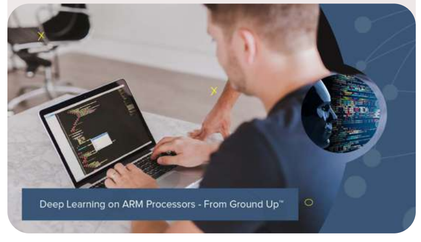

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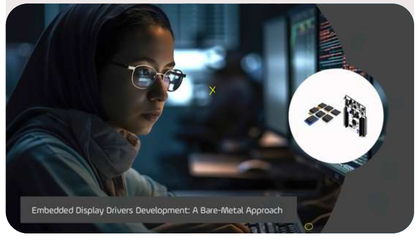

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Case Study: Implementing Real-Time Object Detection In Industrial Automation Using STM32 And Deep Learning.

Introduction

Industrial Automation Is An Area Where Real-Time Object Detection Can Significantly Enhance Efficiency And Safety. This Case Study Focuses On The Development And Implementation Of A Real-Time Object Detection System Using STM32 Microcontrollers And Deep Learning Models. The System Is Designed To Identify And Sort Objects On A Conveyor Belt In Real-Time, A Common Requirement In Various Industries Like Manufacturing And Logistics.

Objectives

- To Implement A Low-Latency Object Detection Algorithm Suitable For Real-Time Applications.
- To Develop A Cost-Effective And Scalable Embedded System Using STM32 Microcontrollers.
- To Integrate A Camera Sensor To Capture Video Feeds For Real-Time Analysis.

Project Requirements

- STM32H7 Series Microcontroller (STM32H743ZI).
- OV5640 Camera Module.
- External RAM For Buffer Storage.
- Conveyor Belt Setup.

Project Requirements (Software)

- STM32CubeIDE For Firmware Development
- TensorFlow Lite For Microcontrollers For The Deep Learning Model
- MQTT Protocol For IoT Communication

System Architecture:

The System Consists Of:

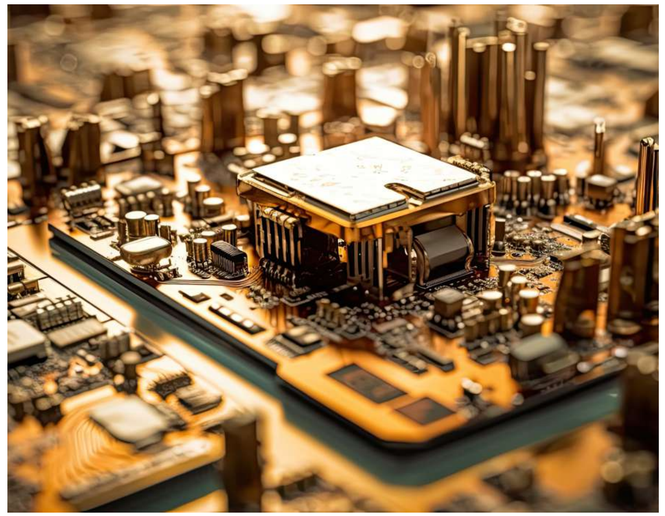
- A Camera Sensor Capturing Video Feeds Of The Conveyor Belt.
- An STM32H7 Series Microcontroller For Image Processing And Running The Object Detection Algorithm.
- An External RAM Module For Temporary Storage Of Image Frames And Model Inferences.
- A Cloud-Based Server For Advanced Analytics And Monitoring.

Implementation: Deep Learning Model

- A Convolutional Neural Network (CNN) Model Is Trained On A Labeled Dataset.
- The Model Is Then Quantized And Converted To The TensorFlow Lite Format.

STM32 Integration:

- STM32CubeIDE Is Used To Develop The Firmware.
- The TensorFlow Lite For Microcontrollers Library Was Cross-Compiled For The STM32H743ZI.
- Camera Sensor Interface
- OV5640 Camera Module Was Interfaced With The STM32 Via DCMI (Digital Camera Interface).



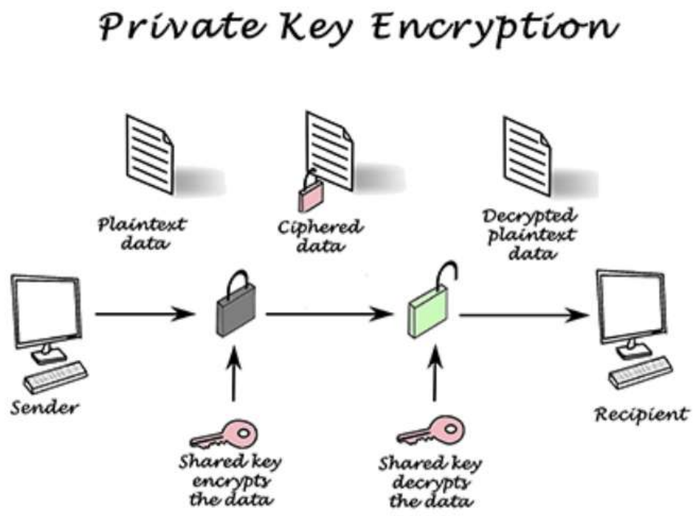
Expected Results & Evaluation

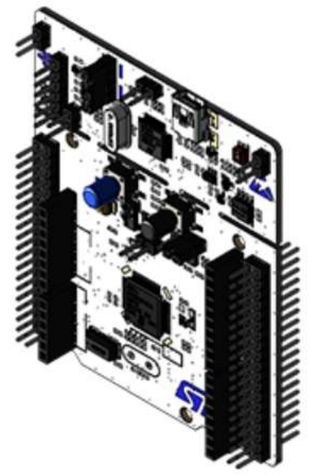
- The System Should Achieve A Latency Of Less Than 200 Ms For Each Detection Cycle.
- Accuracy Levels For Object Detection Measured Should Be At Least95%.

Conclusion

The Project Demonstrates The Capability Of STM32 Microcontrollers In Handling Real-Time Object Detection Tasks Effectively. By Leveraging Deep Learning Models, The System Can Achieve High Levels Of Accuracy, Thereby Making It A Viable Solution For Industrial Automation Applications.

The Scalability Of The Solution Is Evident From The Modular Architecture, Which Allows For Adding More Sensors And Computing Resources Without Significant Changes In The System Design. Future Enhancements Could Include Integrating Additional Sensor Modalities And Optimizing The Deep Learning Model Further For Faster Inference.





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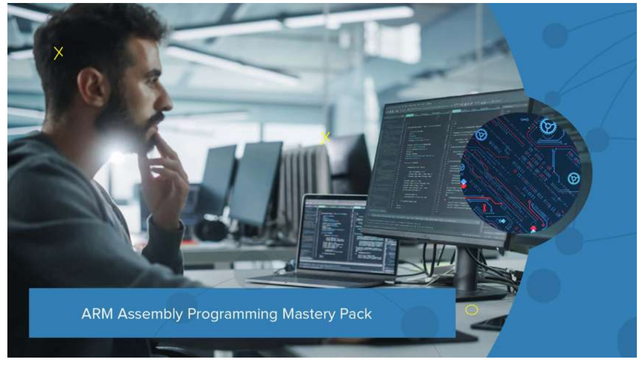

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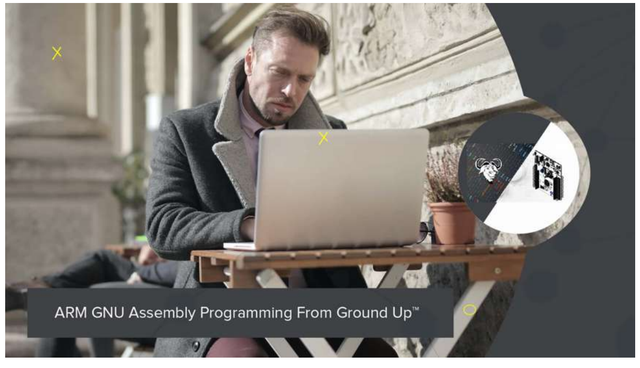

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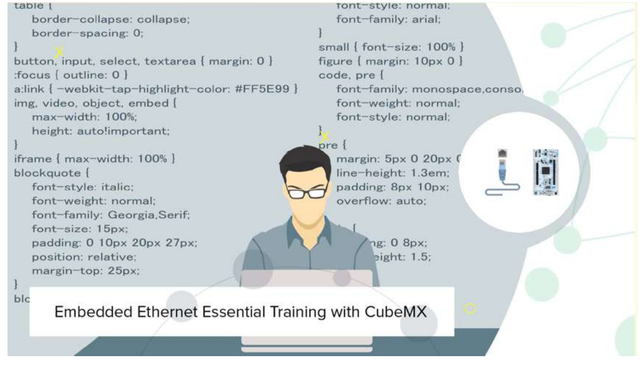

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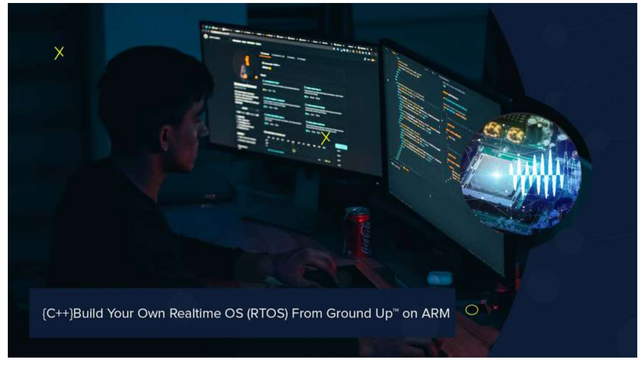

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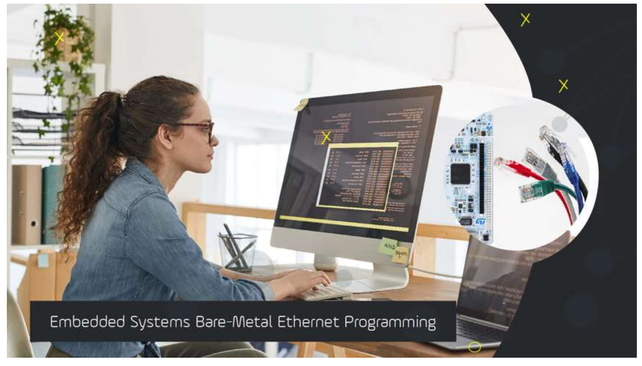

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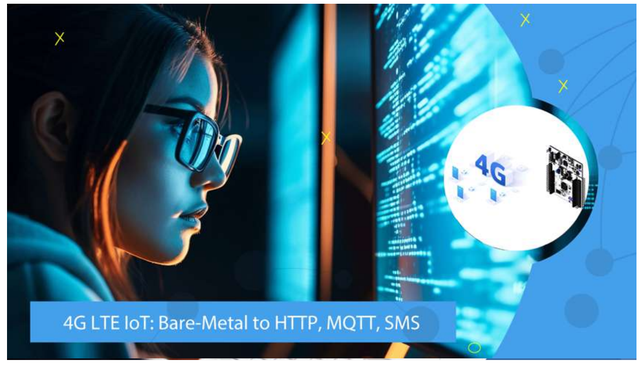

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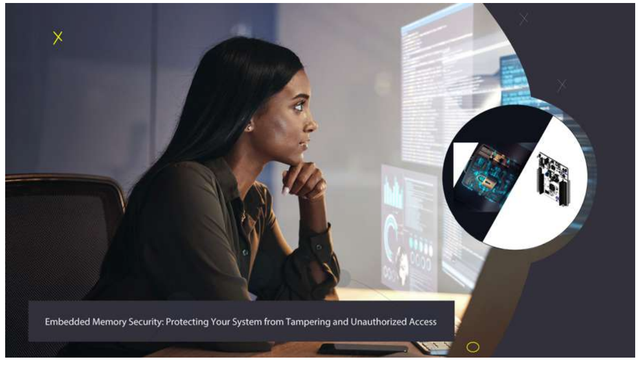

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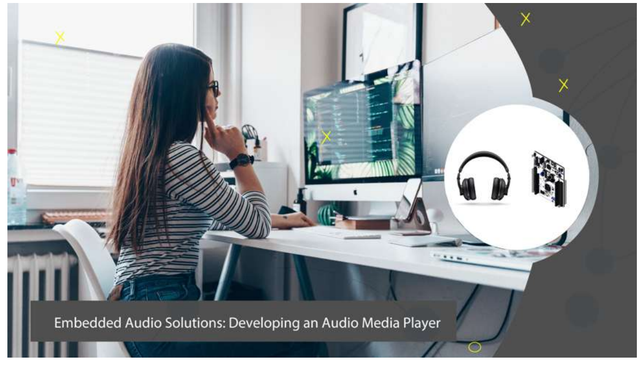

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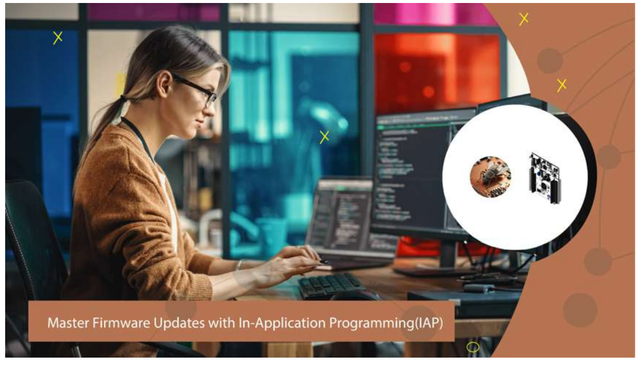

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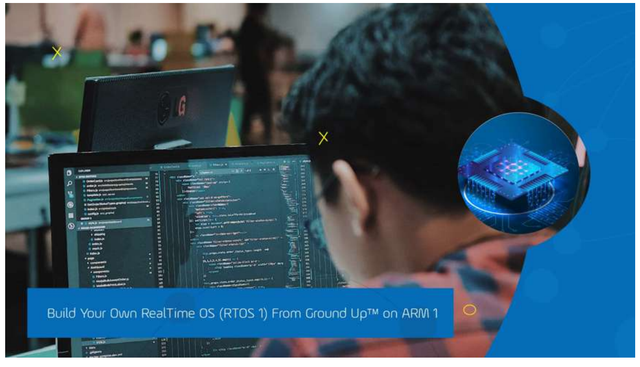

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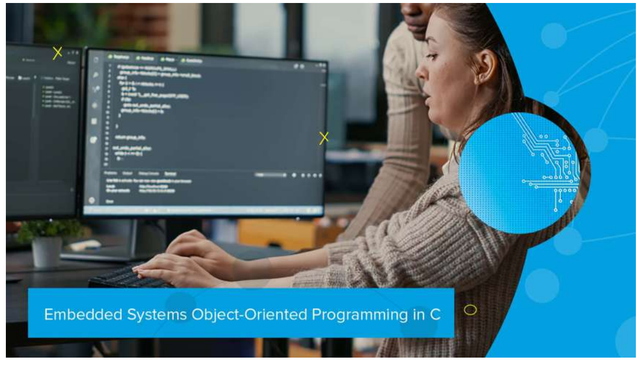

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