Application Brief

AM62A SoC Improves Barcode Readers with Hardware Accelerated Vision Processing

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Introduction

Barcodes are crucial in machine vision applications such as inventory management, asset tracking, information sharing, ticketing, and more. 1-D and 2-D barcodes condense information into a visually coded form that can be printed or displayed on screens and monitors. Printed 1-D codes can be scanned with a laser-based design. However, 2-D codes, which can encode much more information and include error-correction information, require imaging with cameras. Codes displayed on screens also require cameras for scanning because lasers does not reflect properly. These camera-based readers can be referred to as “imagers”.

Imagery contains dense information, and resolution requirements for barcode scanning is typically 0.5-2 Megapixels (MP). Applications like asset tracking for packages on a moving conveyor require a high framerate, and as a result, fast processors or FPGAs.

The dataflow of a barcode imager end-equipment is shown in Figure 1. The code must first be localized within the entire image before being decoded. Rotating or computing a transformation on the barcode to reorient the code to be upright and free of effects from the camera angle or non-flat surfaces is beneficial. As proof of concept for this use case, a demonstrative application has been developed. This application uses deep learning and open source decoder software to detect, decode, and display encoded information to a monitor.

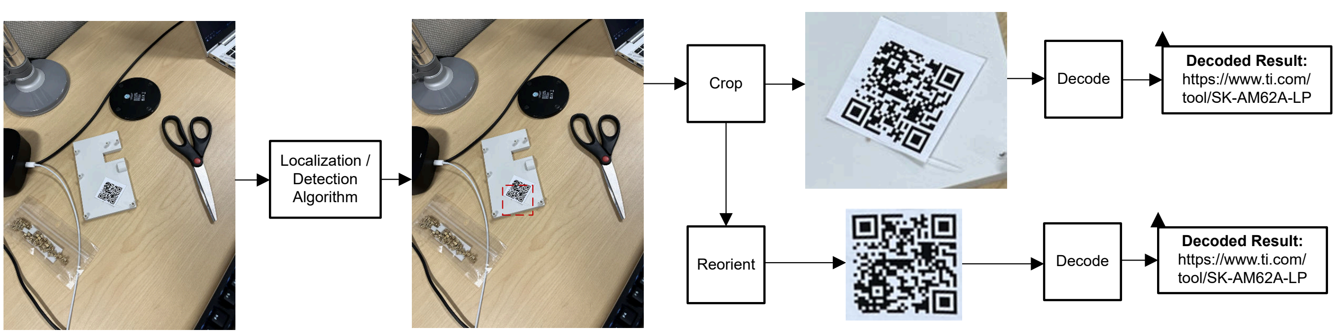

Figure 1. Application Dataflow for Barcode Reader

Deep Learning in Barcode Imagers

The most challenging and compute-intensive task for barcode imagers is to find or localize the code within an image [1]. Conventional algorithms have been extensively used for this task, but require custom implementations and optimization, as well as tuning to match new environments.

To locate a barcode, deep neural networks models (also known as deep learning, are an alternative. Object detection and semantic segmentation models excel at finding loosely defined patterns in imagery. The model does not need to extract the encoded information from the barcode; the model only needs to find where the code is within the image. Deep learning requires only a data set of images with barcodes and associated ground-truth labels, whereas conventional algorithms require domain specific knowledge and conventional computer vision expertise. The deep learning approach has a lower barrier to entry.

Furthermore, deep learning (DL) is easier to accelerate than conventional algorithms, which requires custom implementations on high-performance DSPs or FPGAs to give comparable performance. DL models consist of many matrix multiplications that are straightforward to parallelize for rapid computation. While DL is higher computational complexity than some conventional algorithms can be, the basic set of operations are consistent across most types of DL models. This allows developers to rely on existing, optimized implementations on DL accelerators.

TI's AM6xA advanced vision microprocessors are built with accelerators fit to this exact task by combining a DSP and a matrix-multiply accelerator, called the C7xMMA. The AM6xA portfolio has scalable performance in terms of deep learning performance and the number of camera streams that can be captured and processed concurrently.

AM62A SoC for Barcode Imagers

The AM62A is designed for barcode imagers and machine vision cameras, such as fixed retail scanners, stationary factory scanners, defect detection cameras and inspection cameras.

The C7xMMA in the AM62A offers up to 2 TOPS of performance, with which object detection models can run at more than 120 frames-per-second (fps), which allows for rapid scanning and image analysis. The integrated image signal processor (ISP) allows raw camera feeds via MIPI-CSI2, enabling 2 Megapixel (MP) RGB cameras at 150 fps, 1 MP at 300 fps, or any other permutation of 300 MP/s (within a maximum 8 MP resolution). Monochrome cameras allow faster capture through the 1.5 Gbps per lane, 4-lane CSI interface. The lens distortion correction (LDC) accelerator allows a wide-angle or fisheye lens to be used in applications requiring a large field-of-view, like stationary scanners, while mitigating the impact of the lens on image quality.

The AM62A SoC consumes less than < 3 W at 85°C, simplifying thermal escape and enabling passive cooling. For usage in factories and industrial applications requiring safety certification, AM62A is SIL-2 capable regarding hardware integrity and has SIL-3 systematic capability. Secure boot and hardware security capabilities protect sensitive customer or intellectual property information on the device.

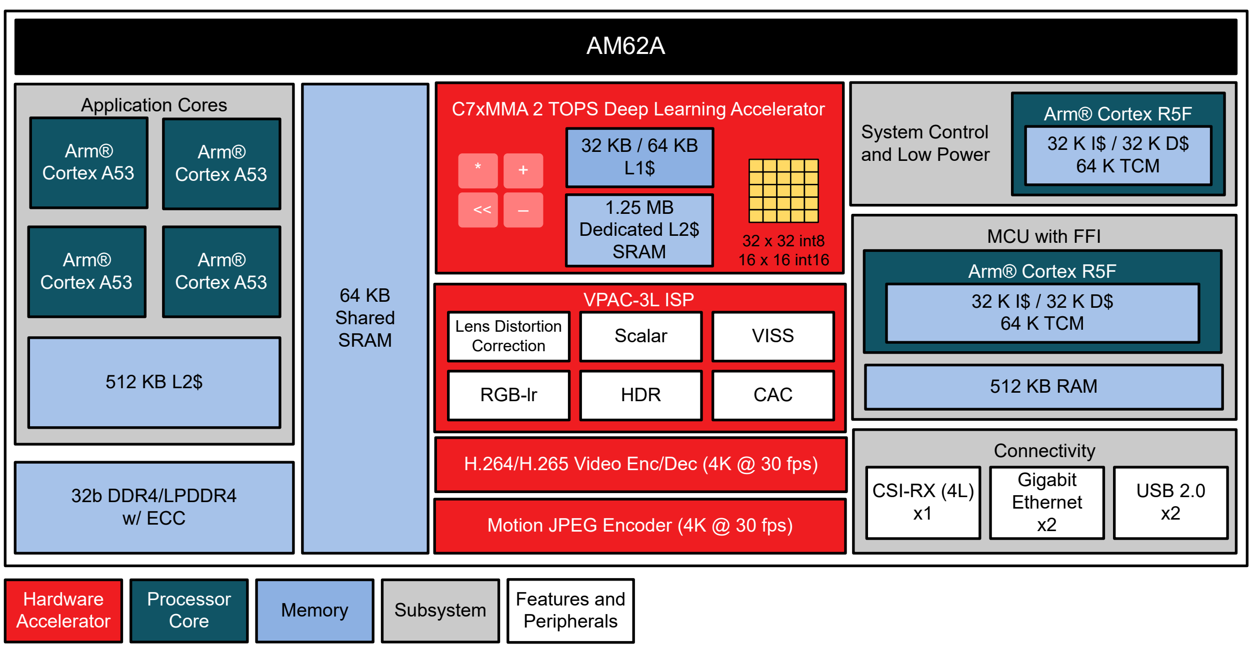

Figure 2. AM62A SoC Simplified Block Diagram

Please see the AM62A data sheet for full details on the SoC capabilities.

Barcode Imager Demo Application

As a demonstrative application of barcode imaging on an AM62A, please find our application on GitHub. This application utilizes a custom-trained deep learning model[1] and open-source 1-D and 2-D decoder software. Barcodes are localized with the deep learning model at up to 120 fps and decoded with text shown on the screen.[2]

https://github.com/TexasInstruments/edgeai-gst-apps-barcode-reader

Supporting documentation within this repository describes how the model and application were built. Further, the documentation instructs on how first-cut applications like this can be developed quickly and with minimal effort to ease evaluation before focusing on application-specific performance optimization for the SoC.

Resources

Table 1 lists resources for Edge AI and AM62A to start an application featuring barcode imaging.

Purpose	Link
AM62A product page (superset)	AM62A7
AM62A Starter Kit EVM	SK-AM62A-LP
EVM User Guide	AM62A Starter Kit EVM (SK-AM62A-LP)
Home Edge AI page on GitHub	Edge AI
Edge AI Cloud	Edge AI Studio
Edge AI Academy for new developers	Edge AI Academy (01.00.00.00)
AM62A Processor SDK	PROCESSOR-SDK-AM62A
Edge AI Linux SDK Documentation	Processor SDK Linux Software Developer's Guide
AM62A Academy for Linux	Academy for AM62Ax
AM62A Design Gallery	AM62A Design Gallery
Support Forums (e2e)	https://e2e.ti.com

References

1. R. Wudhikarn, "Deep learning in barcode recognition: A systematic literature review," *IEEE Access,* vol. 10, pp. 8049-8072, 2022.

1 The deep-learning barcode-reader model is intended for evaluation only. TI provides no claims or guarantees about the accuracy of this model or the usage in commercial applications.
2 The deep learning model with acceleration runs at up to 120 fps, but the application is generally CPU limited by the unoptimized, open-source barcode decoder library. The application generally runs at 15-30 fps based on the number of codes to decode.

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