MACHINE
LEARNING UB

QR Code Detection

Bilegsaikhan

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About Me

MACHINE LEARNING UB

- **Machine Learning UB**
  - Founder, May 25 2019
- **AI Startup**
  - Co-Founder, CTO

- **Deep Learning UB summer school**
  - Assistant teacher
- **ANDSystems Tech**
  - Lead ML Engineer, Machine Learning Team
- **FreeBit Co., Ltd**
  - Software Engineer
- **Osaka University**
  - Intelligent Systems Science Course

Agenda

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QR Code Detection

- QR Code History
- Traditional Methods
- Modern Methods
- Simple Implementation

https://github.com/x-hw/amazing-qr

QR Code History

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1D BarCode

NCR 255 scanning system for supermarkets extends computer's power to checkstand. First system installed in U.S. is in Marsh Super Market, Troy, Ohio. Checker passes purchased items over scanning window. Universal Product Code, which appears on package, is read by laser scanner linked to computer. The latter records items and flashes prices on display panel. In supermarket control room, NCR 726 minicomputer controls system and provides detailed operating information for store manager.

QR Code History

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1D BarCode

- The barcode was invented by **Norman Joseph Woodland** and **Bernard Silver** and patented in the US in **1951**.
- The invention was based on **Morse code** that was extended to thin and thick bars.

QR Code History

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1D BarCode

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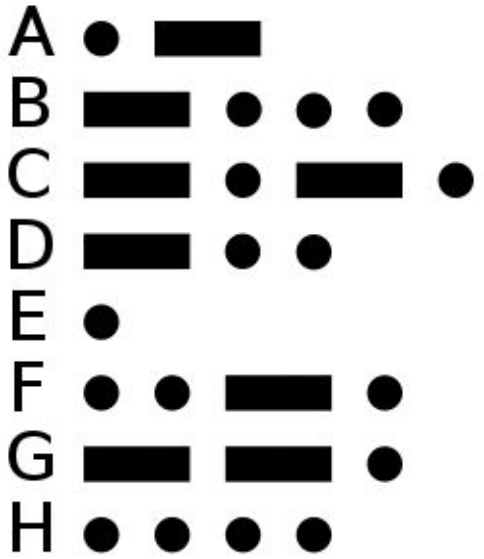

QR Code History

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1D BarCode

Advantages:

- It allows data to be collected accurately and rapidly with the help of barcode readers.

- It is less expensive.

QR Code History

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1D BarCode

Disadvantages:

- Barcode readers are able to scan only limited number of informations.

- Barcode readers are easily vulnerable to physical damages.

QR Code History

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QR Code

- QR (Quick Response) code is a type of matrix barcode invented in **1994** by **Masahiro Hara** from the Japanese company Denso Wave.

- Hara recognized game **Go**'s black and white pattern could be used to encode information.

QR Code History

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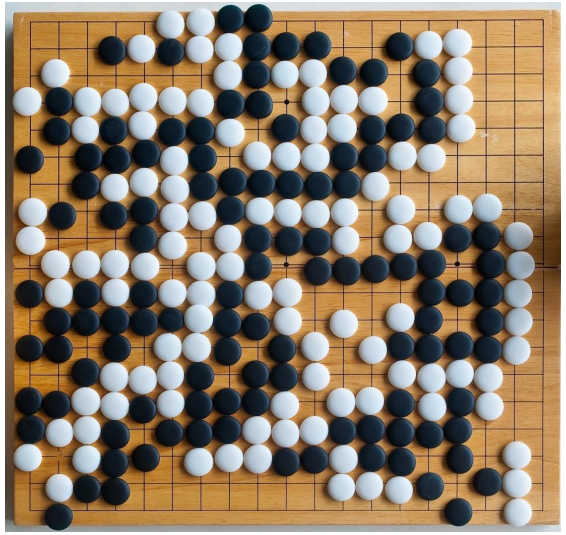

QR Code History

QR Code

- Capable of storing approximately 7,000 figures with the additional capability to code Kanji characters

- Scannable more than 10 times the speed of other codes.

QR Code History

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QR Code Structure: https://www.iso.org/standard/62021.html

Finder pattern

Indicate the direction in which the Code is printed.

Alignment pattern

If the QR Code is large, this additional element helps with orientation.

QR Code History

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QR Code Structure: https://www.iso.org/standard/62021.html

Timing pattern

Using these lines, the scanner determines how large the data matrix is.

Version information

These specify the QR Code version that is being used. There are currently 40 different QR Code versions.

QR Code History

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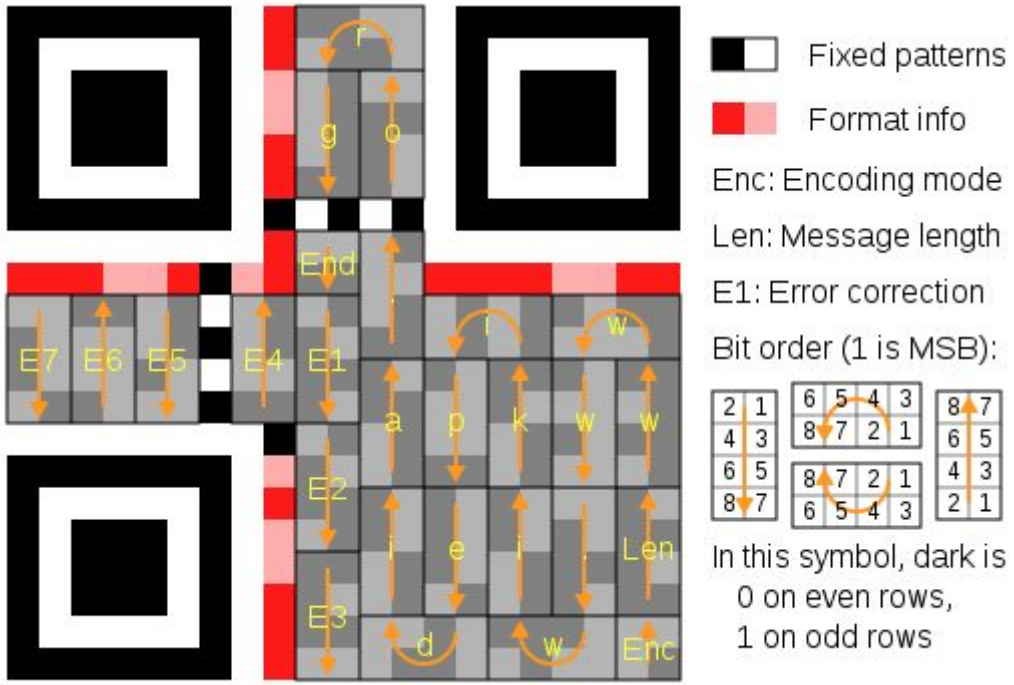
QR Code Structure: https://www.iso.org/standard/62021.html



https://www.the-qrcode-generator.com/

Data and error correction keys

These patterns hold the actual data.

Reed-Solomon code:

Correction is applied to restore the data when a part of QR code is missing.

QR Code History

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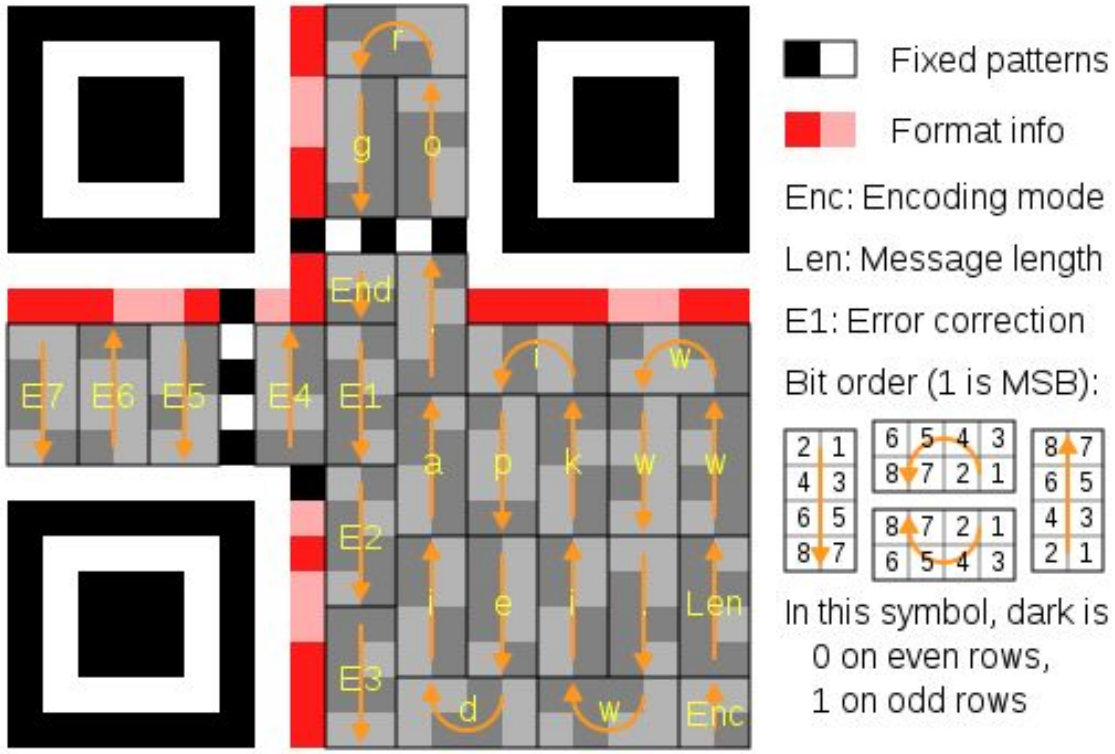

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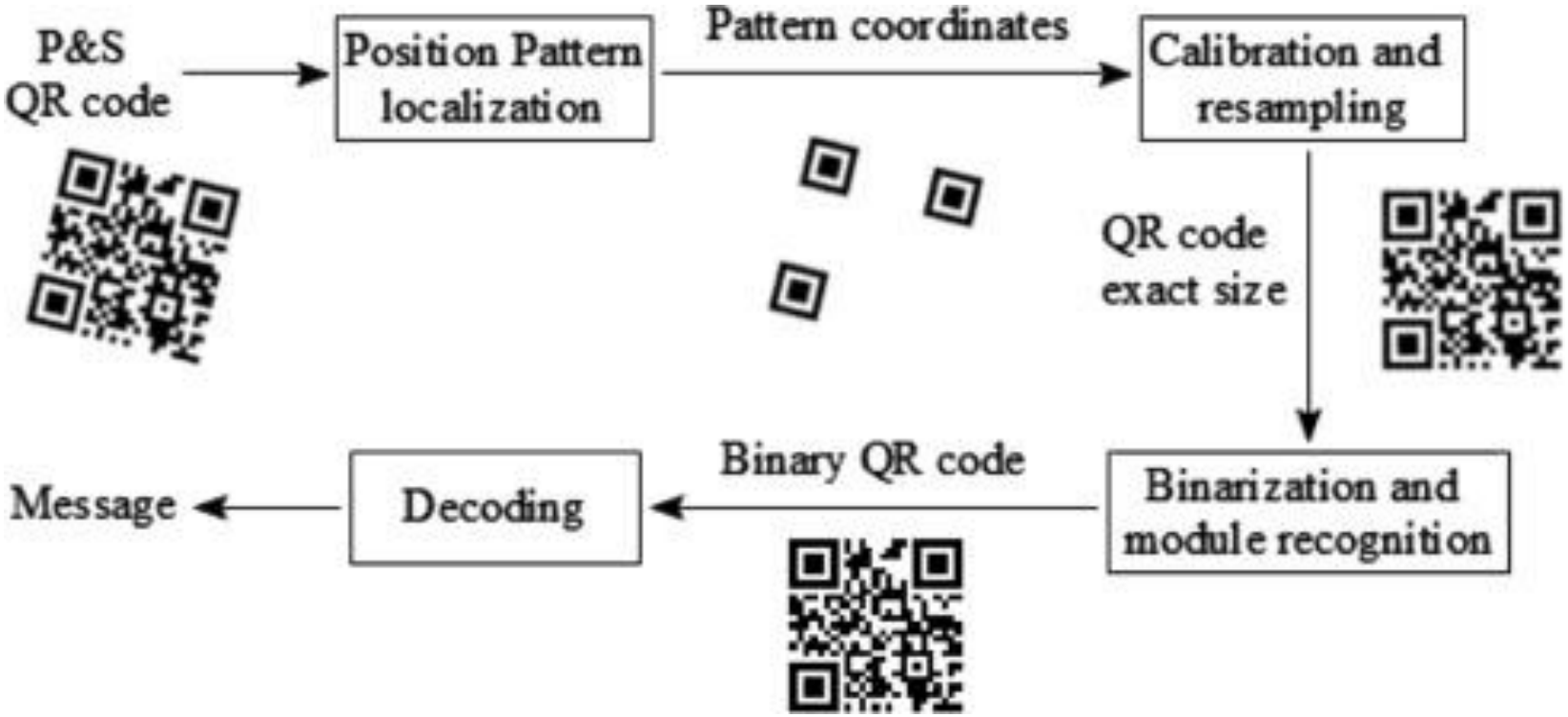
Error Correction

- Level L 7% of codewords can be restored.
- Level M 15% of codewords can be restored.
- Level Q 25% of codewords can be restored.
- Level H 30% of codewords can be restored.
-

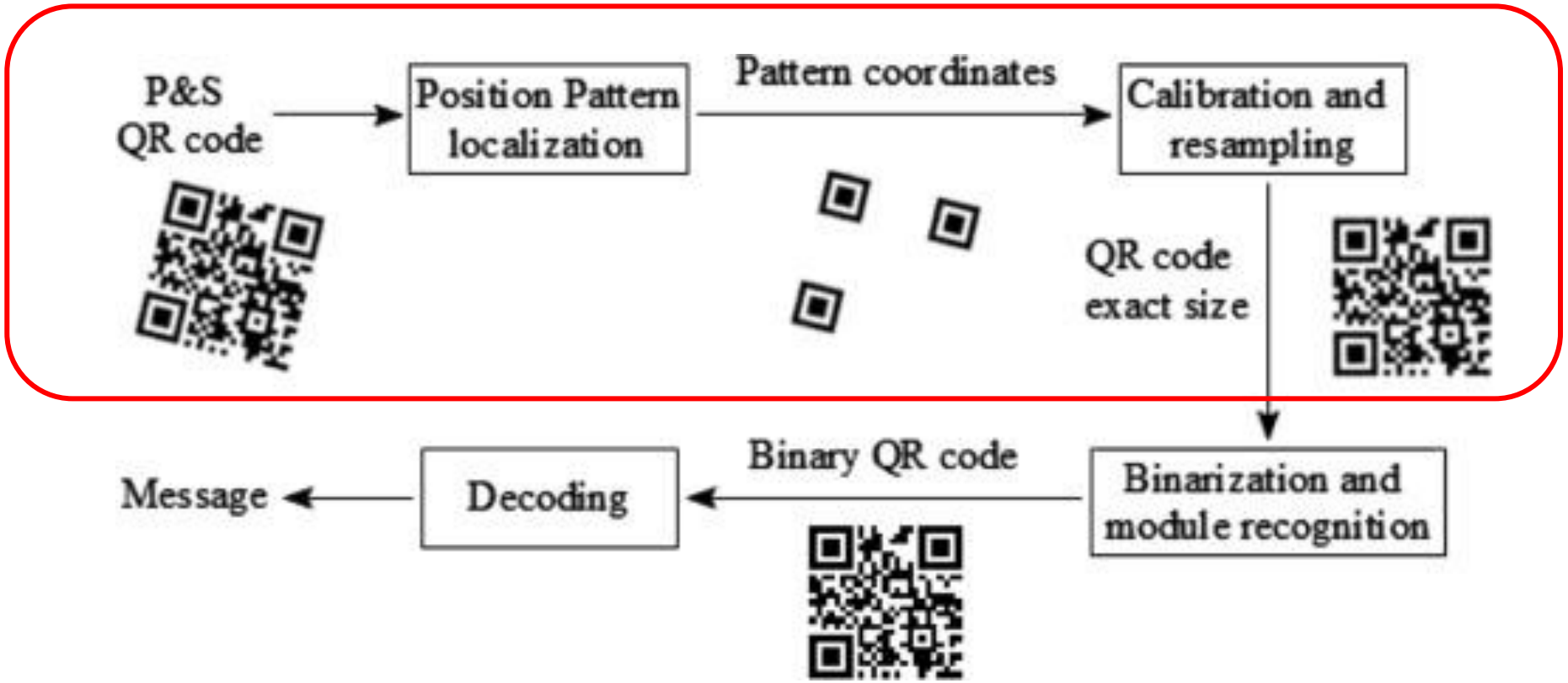
Data Limits

- Numeric only - Max. 7,089 characters
- Alphanumeric - Max. 4,296 characters
- Binary (8 bits) - Max. 2,953 bytes
- Kanji/Kana - Max. 1,817 characters

QR Code Recognition

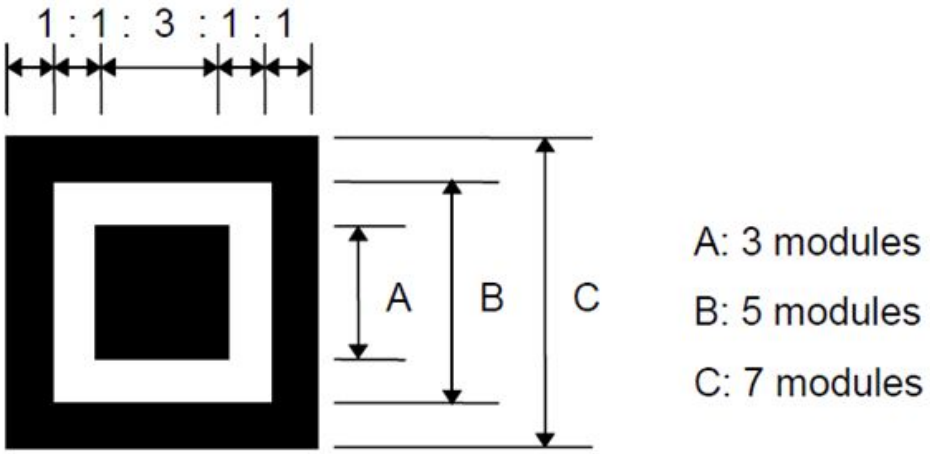


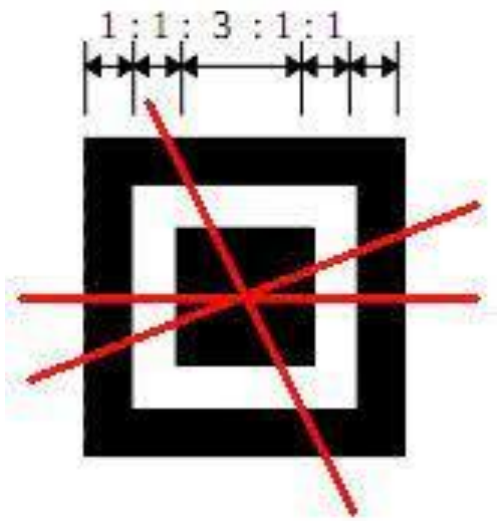
QR Code Recognition



QR Code Detection Problems

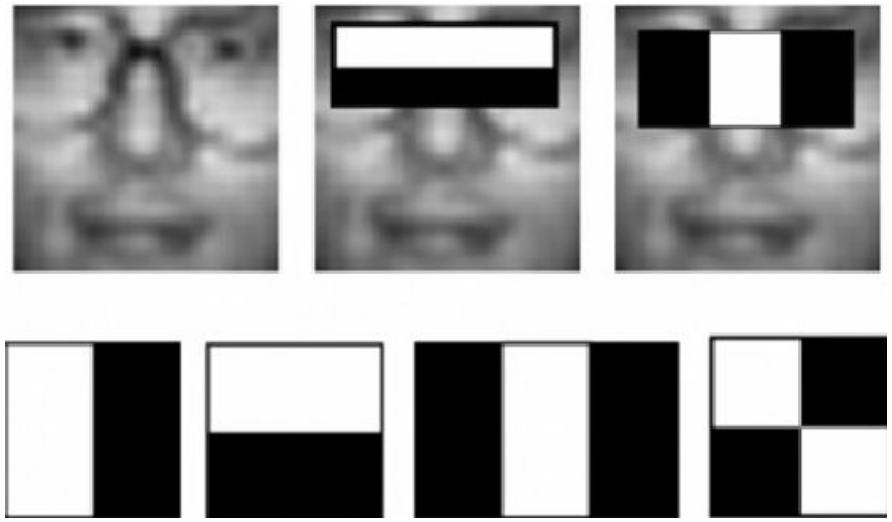
- Finder Pattern





Fast QR Code Detection in Arbitrarily Acquired Images (2011)

- https://ieeexplore.ieee.org/document/6134743
- Viola-Jones rapid object detection
- Video frames of size 640 × 480, around 125ms



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Modern Detection Methods

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QR Code Detection YOLOv3:
https://github.com/Gbellport/QR-code-localization-YOLOv3

Modern Detection Methods

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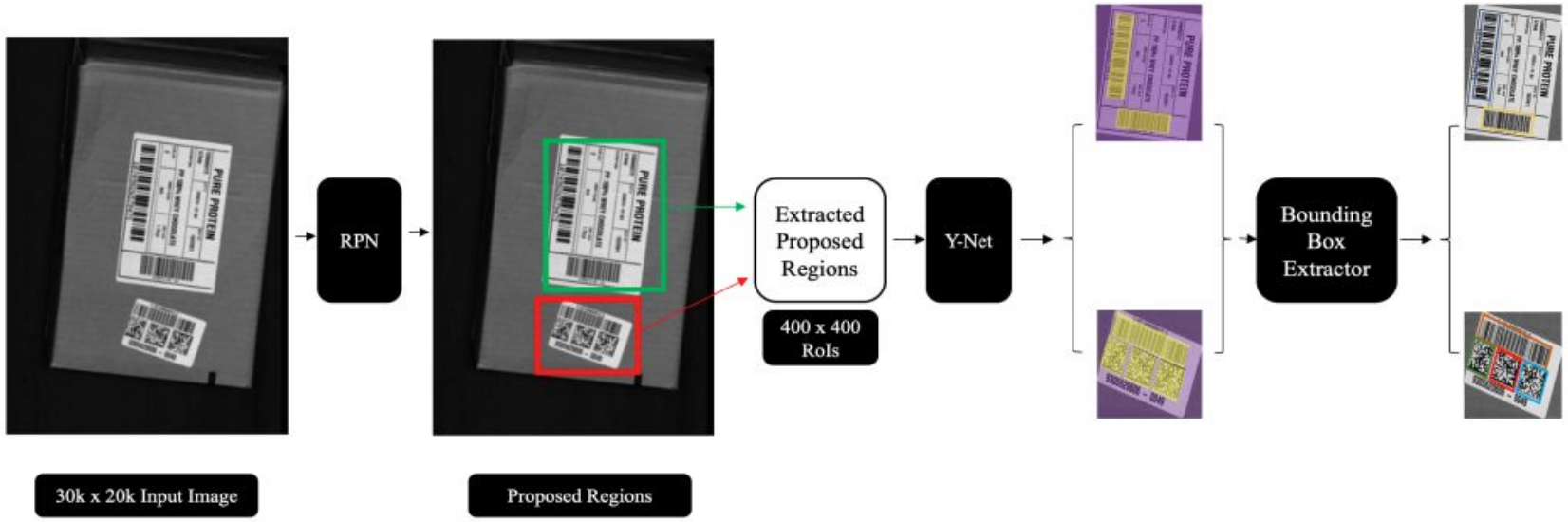
FAST, ACCURATE BARCODE DETECTION IN ULTRA HIGH-RESOLUTION IMAGES (2021): https://arxiv.org/pdf/2102.06868.pdf



	mAP (all)	AP_{50} (all)	AP_{75} (all)	mAP (small)	mAP (medium)	AR_{50} (all)	AR_{70} (all)	AR_{80} (all)	AR_{90} (all)	Latency (ms)	Resolution (px)
Mask R-CNN [10]	.466	.985	.317	.340	.489	.990	.740	.279	.023	94.8	448×448
YOLOv4 [11]	.882	**.990**	.989	.815	.897	**1.**	**1.**	.995	.873	40.5	320×320
Ours	**.937**	**.990**	**.990**	**.903**	**.945**	**1.**	**1.**	**1.**	**.972**	**16.0**	400×400

Simple Implementation

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Requirements

- Python3
- Opencv