

Introduction

About Merck

Merck & Co., Inc. is a leading multinational pharmaceutical company that develops medicines, vaccines, biological therapies, and animal health products.

Problem

A drug formulation process is the formulation of medicinal products by combining many chemical substances. Each process is manually documented by the formulator, which introduces human error.

Motivation

We want to develop an automated documentation and monitoring system to enhance formulation processes' efficiency, robustness, and reproducibility.

Goal

Given a live video stream, QR Codes on samples, and a formulation process "recipe" as input, fill in the blanks of a process documentation template using information extracted from a video stream.

QR Code Detection

We use QR Code Detection to identify bags of ingredients. Once the QR code is detected, the start and end date-time, geographical location, and QR code reading(object name) are recorded.



ID	Start date of detection	Start time of detection	End date of detection	End time of detection	Location	Time Zone	QR Code reading
1	4/1/22	10:51:46:2384	4/1/22	10:58:36:295896	892, Frank Drive, Champaign, Champaign County, Illinois, 61821, United States	America/Chicago	Sugar
2	4/1/22	10:59:16:715726	4/1/22	10:59:16:799252	892, Frank Drive, Champaign, Champaign County, Illinois, 61821, United States	America/Chicago	Flour
3	4/1/22	10:59:17:304101	4/1/22	11:1:29:333773	892, Frank Drive, Champaign, Champaign County, Illinois, 61821, United States	America/Chicago	Sugar
4	4/1/22	11:1:29:770918	4/1/22	11:1:29:924465	892, Frank Drive, Champaign, Champaign County, Illinois, 61821, United States	America/Chicago	Flour

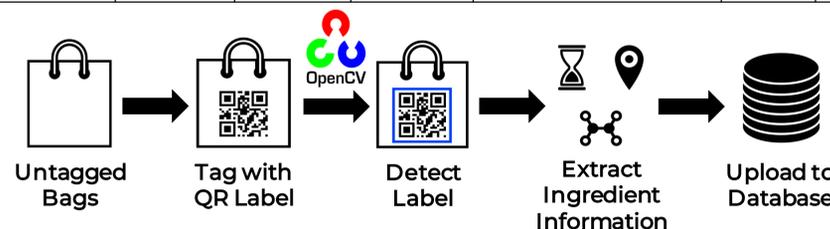


Figure 2 – QR Code Detection Workflow

Analytical Balance Detection & Tracking

We use the YOLOv5 object detection algorithm to determine if an analytical balance is visible. If it is visible, the algorithm zooms into the LED display. Image pre-processing enhances the contrast between digits and the background. TesseractOCR extracts the weight reading from the image and outputs them to the document template.

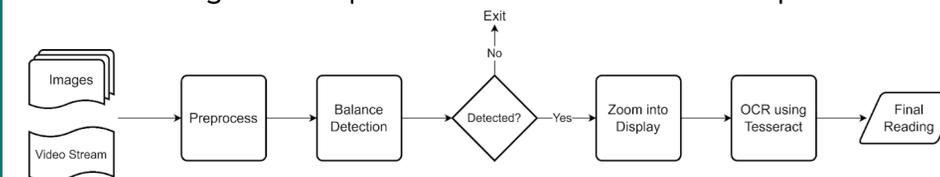


Figure 6 – Analytical Balance Workflow



Figure 7 – Balance Detection Examples

Project Workflow

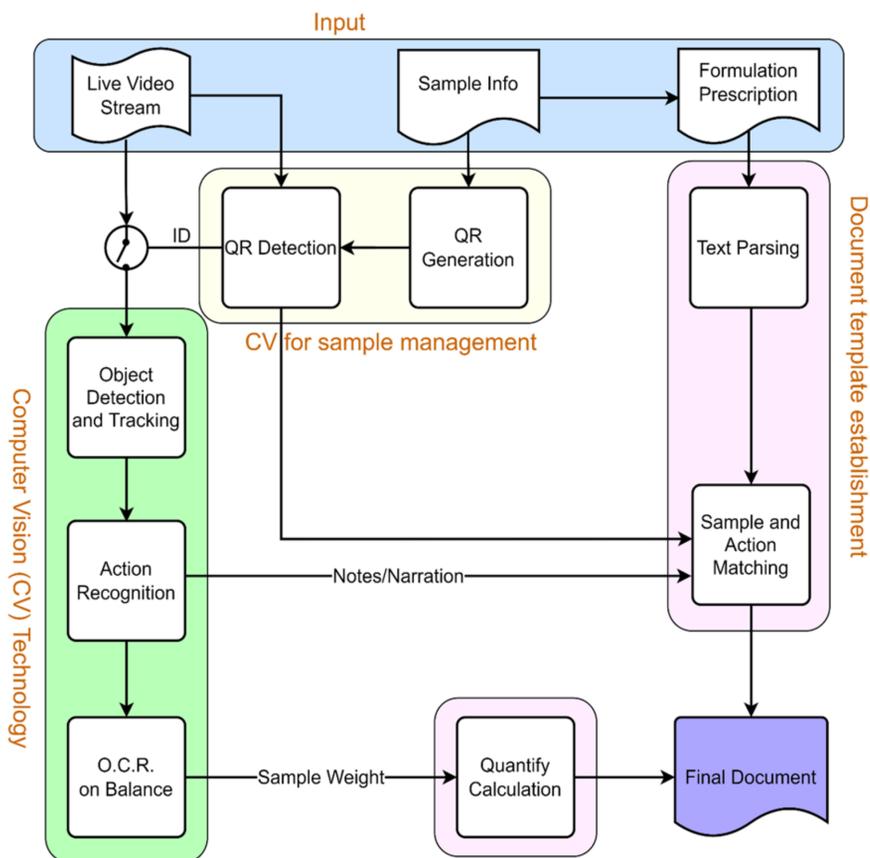


Figure 1 – Project Workflow

Object Detection & Tracking

We use a camera to capture real-time video frames and input them into a trained object detection model and trained object tracking model. Then, we draw bounding boxes around the objects and record the information. Once we have the bounding box information for all objects like bags, hands, and scoops, we can determine the action being performed using the relationship between the objects.



Figure 3 – Object Detection Examples

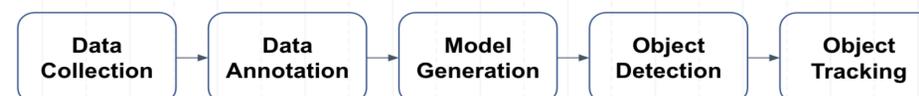


Figure 4 – Multiple Object Detection and Tracking

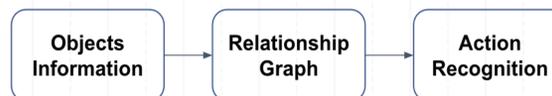


Figure 5 – Scene Graph for Action Recognition

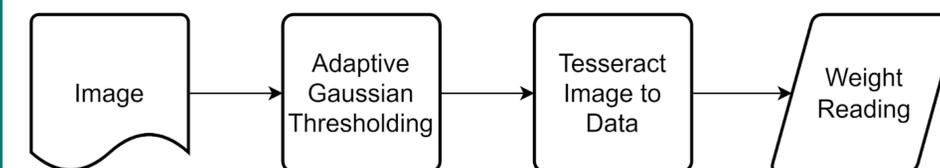


Figure 8 – Weight Reading Workflow

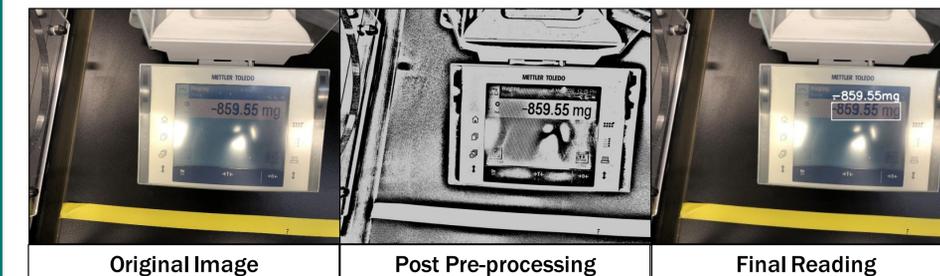


Figure 9 – Weight Reading Example

Acknowledgments & References

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- Our Merck mentors Dr. Ti-chiun Chang and Dr. Terri Bui
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- [TesseractOCR GitHub](#)
- [OpenCV](#)
- [YOLOv5 GitHub](#)

- [DeepSORT GitHub](#)
- [Roboflow](#)