# Introduction

In today's highly competitive world, businesses are always looking for ways to improve their processes and increase efficiency. One area where this is particularly important is the product packaging process. In many industries, workers are required to take products from bins or other storage containers, and errors can occur if they take products from the wrong compartment. This can lead to wasted time, lost profits and even to the dissatisfaction of the client.

To address this problem, we have developed the Recognition POC application, a software tool that uses machine learning and computer vision to improve the accuracy and efficiency of the work process. The application uses a camera placed above the bin, which is divided into compartments, to process recordings and detect the hand of the worker as they reach into the bin to take a product. This allows the application to determine whether the product was taken from the expected compartment or not.

# System Architecture

The Recognition POC application consists of two parts: a recognition system and a recognition API.

Diagram

Description automatically generated

Figure 1 System architecture

The Recognition system is a combination of machine learning and computer vision technologies that are responsible for analyzing recordings and video streams and detecting when a hand has taken something from a bin. The recognition system can work with multiple recordings and cameras simultaneously. When a product is taken, an event is triggered, and the application can store information about that event in various places such as databases, sockets, and others. Currently, the system writes the event to a PostgreSQL database.

The recognition API is a .NET application that can read from the database and provides endpoints for accessing information about product-taking events that have been recorded by the recognition system. It provides two endpoints. The first endpoint returns information about the last object taken from a specific port. The second endpoint returns whether something was taken from a specific compartment in a predefined period, based on the port and compartment specified.

# Application workflow

To monitor the action, a video camera is set up and calibrated to ensure it is positioned correctly above the box. The application processes the video feed using the OpenCV library. For each frame, the application checks if a hand is present. If a hand is detected, the application then checks for three conditions to determine if the hand is taking an object from the bin.

The first condition is the speed of the hand movement. It is common for the hand to move faster toward the object it wants to lift, and then slow down as it reaches the object. If the hand is slower than a predefined value, it is considered that it may have slowed down due to picking up an object.

The second condition is the position of the hand. If the hand is extended or slightly bent, it is considered that there is no object in it. However, if the hand is in a position as if it is holding or taking an object, this condition is met.

The third condition is the change in direction of the hand. If the hand is predicted to continue moving in one direction, but it starts to come back, this could indicate that the hand has changed direction because it has taken something.

If all three conditions are met, it can be concluded that the hand is taking something from the bin at that moment. The coordinates of the hand are then used to determine which compartment of the bin the object was taken from.

# Conclusion

In conclusion, the Recognition POC application is a valuable tool that can help streamline the work process and improve efficiency and accuracy. By using a combination of machine learning and computer vision technologies, the application can detect when a worker takes a product from the wrong compartment of a bin and reduce errors that can occur in the work process.