USING MACHINE VISION AND BLOCKCHAIN FOR FOOD INSPECTIONS

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Problem Statement

Regulatory agencies such as Canadian Food Inspection Agency (CFIA) must complete extremely manual inspections. These are required to ensure that companies are adhering to the many regulations put in place by themselves as well as other agencies.

This process is extremely important to ensure a level playing field is in place, and that all companies are operating as they should. This allows for other companies to trust that their competitors are following the same procedures.

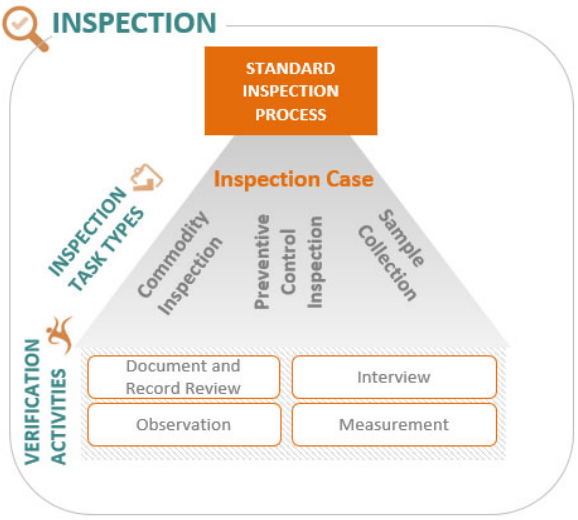
Following the Canadian Inspection Agencies "Guidance for food inspection activities", the following key items are inspected in relation to commodities:

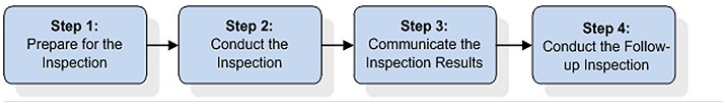
- Food label verification
- Container integrity verification
- Grade verification of food
- Ingredient verification
- Net quantity verification (checking actual quantity vs claimed)
- Nutrient content and claims verification

As you can see, the inspection and regulation of the above is extremely important for consumers and businesses alike.

It would be difficult to deny the importance of regulations regarding the above items. People and their health depend on the accuracy of this information. Consumers rely on this information to make purchasing decisions, and businesses rely on these processes being followed to create a fair and common business landscape.

See below for an overview of a standard inspection. This was gathered from the CFIA website.





Although the processes are extremely important and useful, they are also subject to many issues. As you can see from the list above, many things that must be inspected are done so visually, which can be subjective and error prone. Perhaps even more concerning is the fact that inspections are performed infrequently and are often set up in advance, allowing businesses to gather / stage information beforehand.

Questions

So how can we utilize these valuable processes but make them more accurate, timely, efficient, and trusted?

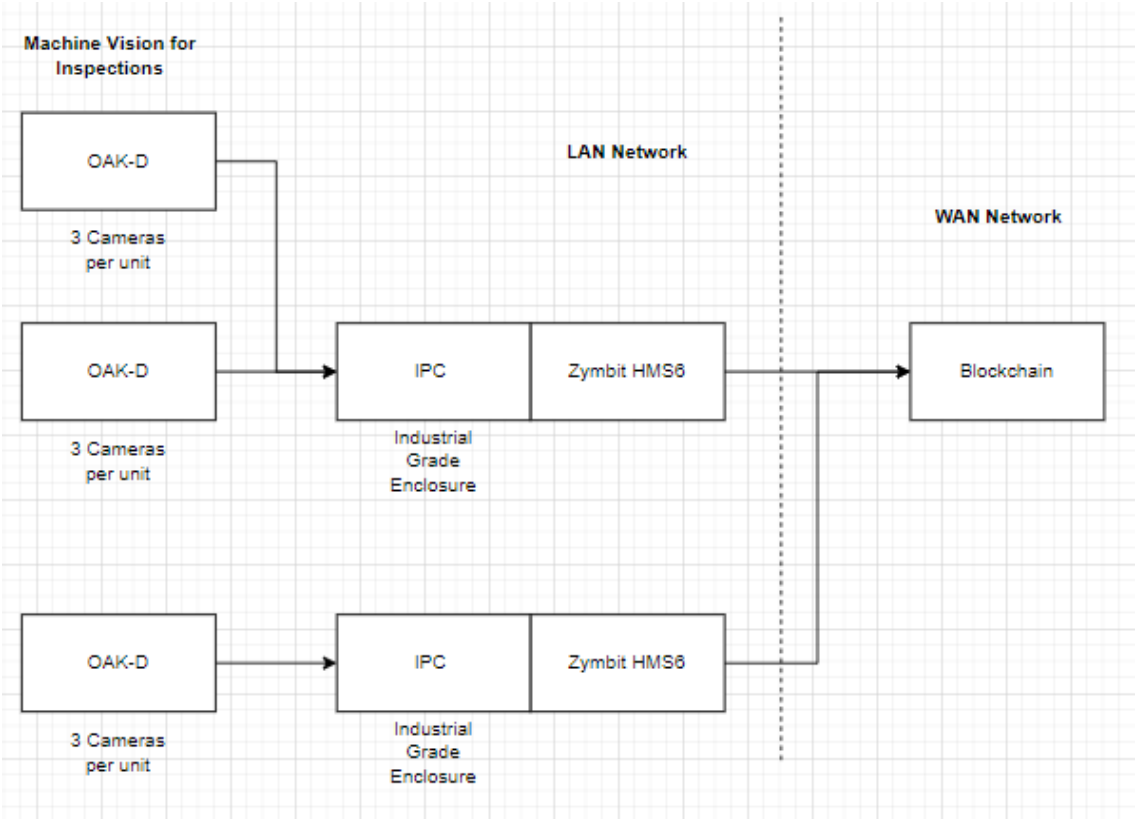
How can we ensure consumers and businesses can trust the information they are being told?

How can we offload the busy inspectors from many of their tasks, while also allowing businesses to self regulate / certify with only high level guidance?

Technology, machine vision, and blockchain will be shown in a proven concept to allow for data to be captured effectively, securely, redundantly, and immutably using AI, machine vision, and blockchain technology.

The Solution

Ascend Data Tech has developed a solution that provides redundant machine vision with verifiability that uses cost effective and advanced components. This system is capable of capturing data such as text, using optical character recognition (OCR) and performing quality inspections. It is also capable of confirming regulation based data on basic rules that are already being followed by inspectors. This information is also well documented by the CFIA, which allows for little subjectivity in the determination of the results.



The Hardware

The Camera is an OAK-D which is used as an extremely capable camera, with three cameras (one 12 MP and two 1 MP) to allow for redundancy, and a CPU capable of 4 Trillion Ops/sec and a memory bandwidth of 450 GB/sec.

The OAK-D Camera

It is used to solve the problem of deployment of custom AI algorithms. Prebuilt packages are implemented to complete basic tasks such as OCR. Custom code was developed to allow for inspections and grading.

The system is designed to communicate directly with the blockchain through use of a small computer, that is also verifiable through the use of a Zymbit embedded security module. This allows for the signing of data, while creating an additional layer of security.

The current gateway / CPU is a Raspberry Pi 4 B, but to ensure compatibility in an industrial setting, a ruggedized industrial grade enclosure was chosen. This allows for the device to be put into a manufacturing environment. Current software is also easily runnable on an industrial PC (IPC).

It should be noted that this system is designed to be scalable, both in the amount of cameras per CPU, and the amount of CPUs (or nodes) there are in the network.

The Software

Common programming languages are utilized to allow for connectivity to various blockchains. The current iteration is running on the IOTA public blockchain, but various others, including custom deployments, could be offered.

Results

Using the system shown above, the following major benefits were found:

- Consistent and accurate food label inspections
    - OCR algorithm is extremely accurate
    - Redundant cameras inside of unit add confidence in image processing
    - Multiple cameras used to increase accuracy
    - Information gathered
        - Nutrient information
        - Ingredient list
        - Origin information
- Food grading can be determined in live time
    - CFIA inspection instructions can be easily programmed to allow for the system to complete product grading in live time
        - Including measurements, colour, and shape
- Results stored on blockchain
    - Creating an immutable record of information

The above concept was developed to provide a solution to a large problem; the manual, inaccurate, and infrequent data that is captured in typical food inspections.

Using redundant cameras and cutting edge OCR algorithms, a highly accurate system is developed. Common OCR accuracy is 99%, allowing for high levels of confidence in the data. With the addition of a second and third camera, especially running a different (but equally as accurate algorithm) it would be expected to get the accuracy levels extremely close to 100%.

Next Steps

This solution is a great next step, but is only part of the overall industrial data that can be captured. It is also not the only data that is captured during a normal CFIA inspection. In fact, the other data points from devices like automated machinery can be captured using custom industrial data connectors. This adds data resolution that was not able to be captured previously.

An example of where this data capture would be useful (and in the best interests of both businesses and consumers) is the following procedure noted in the “Operational procedure: Food ingredient verification”, in the section titled “6.2.2.1 Inspection procedure at the manufacturer level”. It is concerning that in this document it is stated

that during an inspection of a ingredient list in question, and after making a note of the claimed ingredients from the manufacturer, that:

“If possible, observe a batch of product as it is being prepared to confirm the actual amount of each ingredient added. **If this is not possible, use the company's make sheet** (that is, the form employees complete when they prepare a batch of product) from a previous production run or the batch formula used by employees on the floor.”

What this demonstrates is that if the process cannot be seen, it is acceptable to let the customer show you their own recorded data. This is hoping that the customer being inspected is being truthful, which is not always the case. Some customers could assume data accuracy, but be incorrect based on their math or basic assumptions.

Through basic automation and or data connectors to existing machinery, the equipment completing the process will send the data to the blockchain. To continue with the example above, this would provide all stakeholders the confidence that the ingredient lists are correct and have not been tampered with. This system would also be far more accurate than the allowable 20% deviation that the CFIA allows manufacturers to **deviate from their stated ingredient list.**

This will add not only trust from the business to the regulatory agencies, but also trust between businesses, and perhaps more importantly, trust between businesses and consumers.

Summary

Through the use of these technologies, each person or business involved in the process is able to benefit significantly. .

A **summary of benefits** for various stakeholders is shown below:

Businesses

- Ability to trust other businesses who are mandated to provide the same level of regulation adherence
- Receiving a lesser insurance rate, due to higher quality control standards and ability to quickly solve a recall (and also have a lesser chance of one occurring in the first place)
- Self certifying data to regulators
- Offering a product with verifiable and accurate information, which gains customer trust and offers higher value for their product

Regulators

- Lesser cost to pay regulatory inspectors and other associated overhead
- Provided with more accurate data from the manufacturer
- Ability to monitor regulation adherence far more often, with limited time spent completing the action
- Creation of an integrated standard that is not susceptible to human subjectivity

Consumers

- Data provides trust in the information being presented to the consumer
- Provides them confidence in their purchasing decision, especially when paying a premium for products that are create a net benefit to society