

The Coolearth Vision System (CEVS)

Description of Concept

The Coolearth Vision System (CEVS) is a Machine Vision (MV) system comprised of an automated visual quality control and/or identification system combined with a motion control system. This system allows for the automation of quality control/inspection stations and an overall reduction in labor costs. The Coolearth Vision System (CEVS) enables new products and processes to be devised and implemented.

Applications

Quality Control

The Coolearth Vision System (CEVS) provides a solution for increasing the quality and reducing the labor required for production. CEVS replaces what has historically been a labor intensive, time consuming process which only covered a small portion of the product. The vision system does 100% inspection of all articles produced at the speed of the manufacturing line, with a highly repeatable rejection of inferior quality articles. Possible inspection examples include: 1) checking the size and the shape of products (e.g. ensuring beef patties are round instead of oval); 2) verifying the color and hue of products (e.g. rejection of sub-par vegetables); or 3) checking for correct packaging (e.g.: rejecting candies that lack a wrapper.) Also, new forms of QC checks can be realized with thermal (FLIR) cameras that judge either the cooking or the freezing of a product to make sure it has been completely and evenly processed.

Secondarily, when used after a label applying station, the CEVS can check the quality of the label applied. Some of the checks might include, checking for fading caused by low ink levels or lines caused by a worn thermal head or clogged ink nozzles. This check allows more complex labels to be printed and applied with greater confidence and to verify that they are printed and applied correctly. Most of the current print and apply systems rely on a barcode reader to check if the label is applied correctly, with a barcode reader only capable of telling if the barcode on the label is actually readable by a barcode reader. Also, when the system detects a decrease in the quality of the printed labels (though still acceptable), personnel can be alerted to perform preventative maintenance on the labeling system during the next scheduled down time to reduce unplanned down time during actual production.

Automated Grading

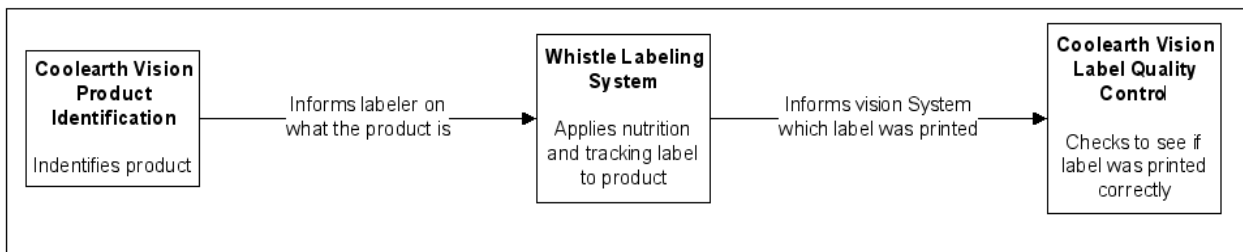
The Coolearth Vision System (CEVS) can be used to sort and grade products. Most grading processes that rely on visual or thermal inspection of the product can be accommodated. For example, grouping by like color, size or any combination thereof is possible at rates and levels of consistency not practical by purely human labor standards.

Identification of multiplexed products

In a large production plant many of the items produced are combined onto one final line for palletizing, and for other tasks that are consistent across the product line manufactured in the plant. This in turn requires that each product be pre-labeled with a barcode, identified by human labor, or that very careful timing and synchronization be employed across all of the product lines so the multiplexed line can tell what product is being processed in each instance. The CEVS eliminates this complexity via optical recognition of each item (distinguishing between them using wording on the container, or their respective colors, sizes, shapes, etc.).

Integration with other Coolearth shop-floor automation products

Multiplexed product line with Whistle Print and Apply station



By combining the Coolearth Vision System providing product identification with the weight and labeling system and the label quality system a robust and fully automated, comprehensive solution can be realized. Costs can be reduced by eliminating the need for products to be pre-labeled with a barcode before they are multiplexed.

Return on Investment

The system delivers significant ongoing operational savings to process-industry manufactures. In addition, the system typically pays for itself within one year.

Reduced QA labor costs

The system eliminates the need for QA inspectors. Furthermore it eliminates the need for stand-by labor to assist in the processing of products at times of surge production. See example information below:

| | |
|---|------------------|
| Total number of full time equivalent (FTE) | |
| - QA Inspectors handling real-time product Inspection on all shifts. | 4 FTE |
| Average annual salary of Quality Assurance personnel: | \$28,000 |
| Burden factor as a percentage of salary: | 40% |
| Total annual QA labor costs: | \$156,800 |
| <hr/> <i>Example Savings: \$156,800</i> <hr/> | |

Reduced customer returns

By inspecting 100% of product at each station, customer returns and claims are typically reduced.

Greater consistency in grading process

For products that require grading, performing this work with machine vision will result in more consistent, repeatable outcomes and results. As new grading standards are introduced they can immediately and consistently be applied across all manufacturing lines. The realized improvement in grading allows for a greater understanding of the value and quantity of inventory on hand. This in turn provides for better planning by MRP/MPS and APS optimization software.

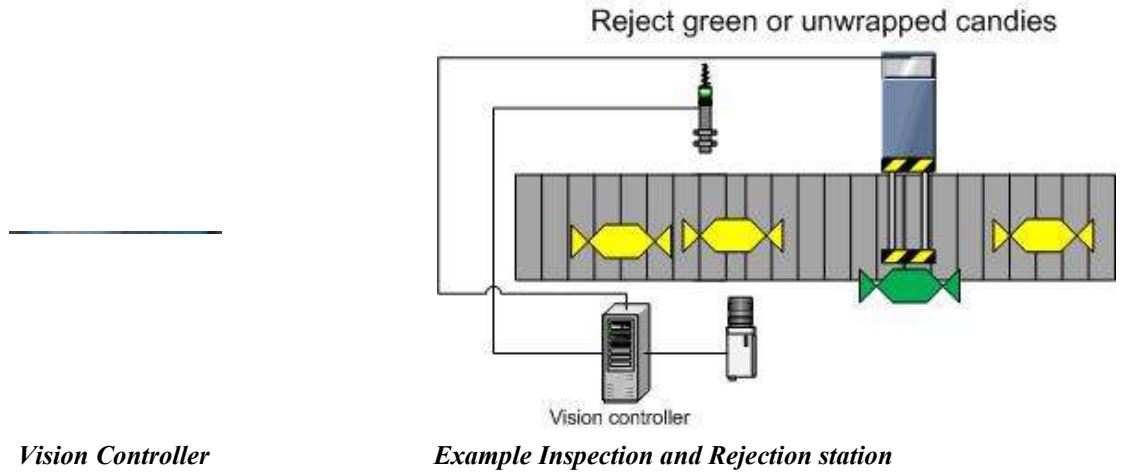
Higher quality product

This system allows for providing the very best products in support of premium customer demands and requirements. Also, the improvement in overall product quality and resultant customer satisfaction support creating higher margin products of those processed through the plant.

Technology

Hardware

The Coolearth Vision System (CEVS) uses robust, state-of-the-art hardware and software designed specifically to meet the challenges of the typical food and beverage manufacturer shop-floor environments. The heart of the standard system is the DIN rail-mountable, fan-less controller that supports up to 100 frames per second of processing and more than 1600 MIPS of calculation. The controller supports 3 Firewire industrial cameras, plus 29 lines of general digital I/O, 5 trigger inputs, VGA output and Gigabit Ethernet connectivity. In addition to processing video the controller can also be used to directly control steppers, servo's, relays and other devices that use TTL or 24v logic, thus it is possible to deploy a full inspection and rejection system with a minimal number of parts and complexity. For the most demanding of tasks, High-Speed industrial panel-mount computers using the latest in Intel and AMD processors, NEMA 4x touch-screen displays and 4 axis full motion control are possible equipment upgrade options.



A wide selection of Fire-wire, GigE and thermal cameras can be used depending on the application and requirements. The system also includes high intensity, long life (70k+ hours [8 year] run-time) LED lighting to provide for consistent, high quality image capture with minimal maintenance.

Software

Software for the Coolearth Vision System (CEVS) starts with the VxWorks real-time operating system, the same operating system used in elements of the Boeing 787 and NASA’s Mars Landers. Along with this, the system utilizes Coolearth-developed software written in National Instruments real-time LabView environment. A blend of custom developed algorithms and industry standard vision analysis enables us to deploy high-speed, very flexible inspection and identification systems with short implementation times. The system is easy to learn and use with a GUI that can be custom tailored to the specific application and requirements. Shape, volume, color, OCR, and other types of analysis are all built in.



Example of an operator status display showing the ‘score’ of objects. The unwrapped candy does not meet all requirements to be scored, and will be rejected, whereas the wrapped candy has a score of 91% and will be accepted

Training the system

All vision systems require some degree of training and calibration specific to the environment and the tasks assigned.

Product Quality Control

This is the most complex task that the vision system can accomplish. If the differences are fairly minor such as peas/corn or ground beef/chicken, then the system can be quickly adjusted by the end-user to the new product. If the difference is major, like going from peas to ground beef, then it requires loading a new inspection template to the system, which can be quickly and easily accomplished by the end-user provided that a template has been created by Coolearth. With a FLIR camera, it is possible to inspect freshly cooked products to make sure they are evenly and completely cooked to the proper temperature and not over/under cooked across the entire product.

Label Quality control

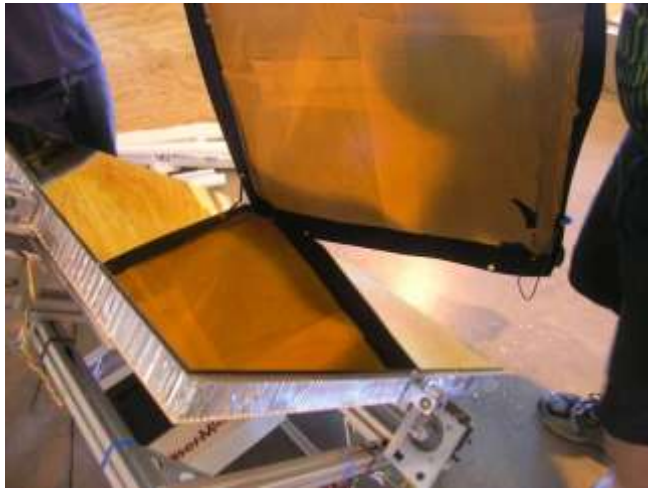
This is the simplest task that the vision system can accomplish, with the label inspection template being able to be changed at 1-10 Hz (hardware dependent) allowing every label to be inspected. Also the templates can be created by the customer by providing a simple JPEG or PNG image of the “perfect” label, or can be produced as needed by the Whistle Labeling System, enabling a completely automated check of the exact weight of the case printed on the case in a human readable format with a specific quality level that can be tied to a specific label. This enables premium products to have a higher label quality standard while also producing economy products at the same time that are held to a lower standard.

Product Identification

The complexity of this task can vary depending on the state of the products to be identified. If the cases differ in printing and/or labeling the system can easily be trained by placing the product to be identified in front of the system and then informing the system what it is looking for/at. The system is capable of differentiating between several dozen, different products at the same time (hardware dependent).

History

The Coolearth Machine Vision System (CEVS) was born out of research done by Coolearth for the [NASA power beaming centennial challenge1](#). Coolearth sponsored the [Lasermotive2](#) team with an automated vision based targeting system designed to find and track in real-time a robot as it climbed a 100 meter tether at high speed.



Computer controlled targeting mirror



Tracking control software

The vision system directed a 10 kilo-Watt laser on to a power receiver on the robot, using a computer controlled mirror that Coolearth also built and integrated into the vision targeting system.



Laser hitting Solar Panel

This combination of real-time, highly accurate identification, tracking and targeting gave Coolearth the experience to build vision solutions applicable to food and beverage process-manufactures.

About Coolearth

Headquartered in Seattle and in business for more the 10 years, Coolearth is a leading provider of supply chain execution solutions to food & beverage, chemical, and other process manufacturers. Solutions from Coolearth are designed to fulfill the unique needs of hybrid production facilities requiring integrated warehouse management and shop floor execution solutions. Coolearth products go beyond traditional warehouse management systems built for distribution centers by cutting costs and improving efficiency throughout the entire production facility. Coolearth's customers range from Fortune 50 enterprises with many installs to smaller producers all over North America.

1. http://en.wikipedia.org/wiki/Machine_vision
2. http://centennialchallenges.nasa.gov/cc_challenges.htm#power
3. <http://www.lasermotive.com/>