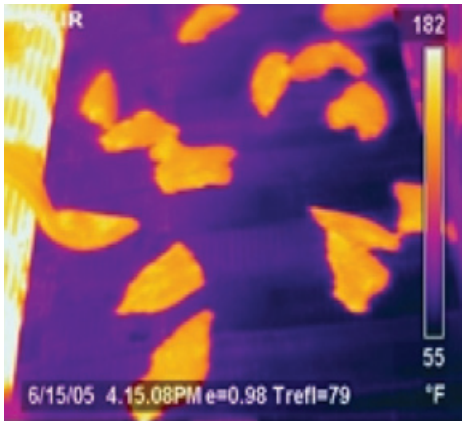
Thermal imaging cameras in the food industry

FLIR A310 is a fixed mounted thermal imaging camera. It can be used for all types of monitoring in the food industry.

In the food industry, it's essential to carefully control the temperature of perishable goods throughout production, transportation, storage, and sales. Repeated warnings about illnesses due to tainted and improperly cooked foods highlight the need for tighter process control. Because this almost always involves a human factor, food processors need tools that automate crucial operations in a way that helps minimize human error while holding down costs.

Thermal imaging cameras are such a tool. Using FLIR thermal imaging cameras, you can make automated non-contact temperature measurements in many food processing applications. Analog video outputs can be viewed on video monitors, and digital temperature data, including MPEG4 video outputs, can be routed to a computer via Ethernet.



An IR temperature measurement and thermographic image are used to locate undercooked chicken tenders and stop the line so undercooked ones can be removed.

How It Works

The main elements doing non-contact temperature measurements in the food processing industry are a thermal imaging camera and associated software. They act as "smart" non-contact sensors to perform 100% inspections, measuring the temperature of equipment, refrigerated products, and cooked foods as they exit the cooking process.

Thermal imaging cameras are easy to use, small, and can be positioned almost anywhere as needed. They can also be used to inspect package sealing, and improve efficiency in other food processing operations.

FLIR thermal imaging cameras have firmware and communication interfaces that enable their use in automated process

This thermal image shows bottles being filled automatically, so bottles that are over-or under-filled can be removed. If a bottle or jar is made of dark colored glass or plastic thermal imaging cameras are much more effective than visible light cameras.

control. Third-party software makes it easy to incorporate these tools into automated machine vision systems without the need for extensive custom-written control code.

The use of thermal imaging cameras in food processing is growing for applications such as:

- Oven baked goods
- Microwave cooked meats
- Microwave drying of parboiled rice and other grains
- Inspecting ovens for proper temperature
- Proper filling of frozen meal package compartments
- Checking integrity of cellophane seals over microwave meals
- Inspecting box flap glue of overwrap cartons
- Monitoring refrigerator and freezer compartments

Thermography for Quality Assistance And Product Safety

Thermal imaging is first and foremost a quality assurance (QA) tool. Controlling the quality and safety of cooked meat products is an excellent use of this technology. A permanently mounted thermal imaging camera can record the temperature of, for example, chicken tenders as they exit a continuous conveyor oven. The objective is to make sure they are done enough but not over-cooked and dried out. Reduced moisture content also represents yield loss on a weight basis. Thermal imaging cameras can also be used for inspection on microwave precooking lines. Besides improving product quality and safety, overall throughput can be increased. An additional benefit is reduced energy costs.

Equipment Monitoring

In addition to cooked food inspections, thermal imaging cameras can monitor conveyor ovens. They can even be part of a feedback loop to help control oven temperature.

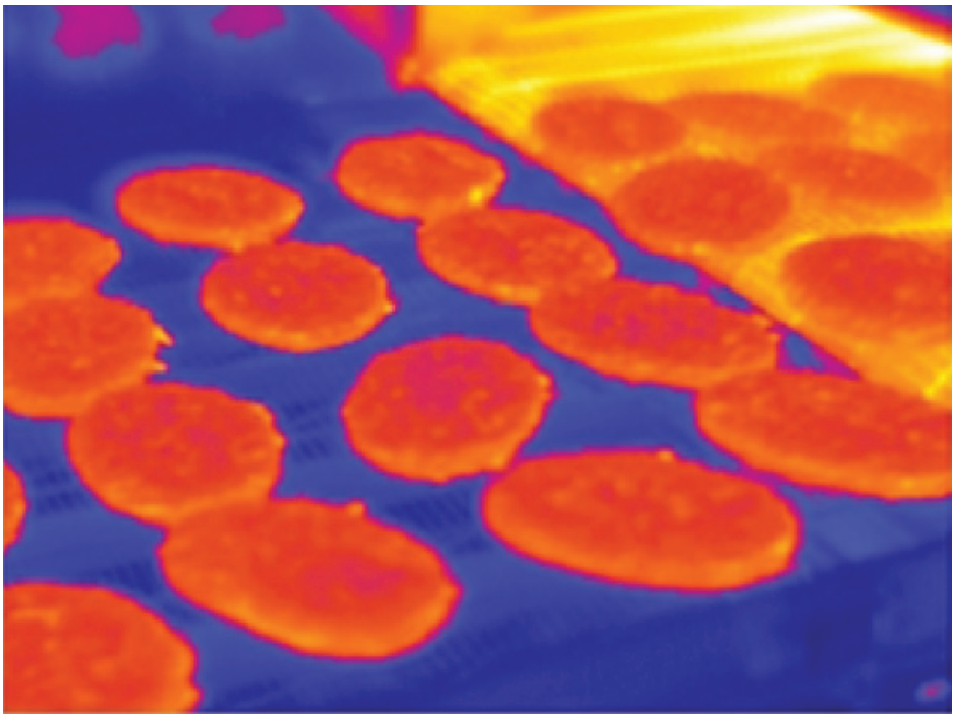
Another use of thermal imaging cameras for conveyor ovens is monitoring temperature uniformity across the width of the conveyor oven cooking belt. If a heating element inside an electric oven fails, or you get uneven heating across an air impingement oven, one side of the product stream may be cooler. This can be quickly discovered with thermal imaging cameras.

Quality inspections of this sort are much more difficult with conventional contact type temperature sensors. Thus, thermal imaging cameras can help correct variability and improve quality before a lot of product is scrapped.

Packaging Inspections

Software is available that allows thermal imaging cameras to locate objects and patterns in the images. One application for pattern matching is in the production of frozen meals. Thermal machine vision can use pattern recognition software to check for proper filling of food tray compartments.

A related application is automated 100% inspection of the heat-sealed cellophane cover over finished microwave meals. A thermal imaging camera can see heat radiating from the lip of the container where the cellophane heat-seal is formed. The temperature along the entire perimeter of the package can



Thermal image for checking hamburger doneness by measuring temperature

FLIR A310

Also in the food industry, production engineers and technicians are faced by the demand for higher production output at a constant quality and at lower cost. The FLIR A-series thermal imaging cameras are the most effective tool available for infrared machine vision, closed loop process control and quality assurance imaging, helping you to validate and increase product quality and throughput and thereby give a competitive edge and increased profitability.

The FLIR A310 is a fixed mounted thermal imaging camera. It can be used for all types of monitoring in the food industry.

Features incorporated in the FLIR A310 are:

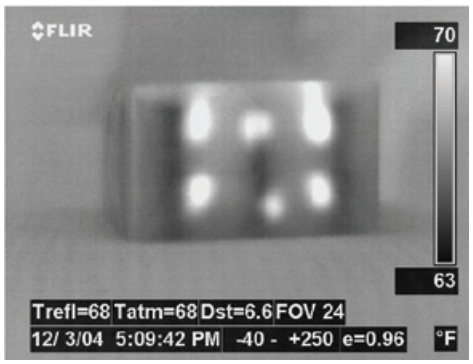
- Built-in extensive analysis functions
- Built-in alarm functions
- Ethernet/IP and Modbus TCP compliance
- Easy sharing of analysis, alarm results to PLC's.
- PoE (Power over Ethernet)
- Digital inputs/outputs
- Built-in 100 Mb Ethernet connection

be checked by using the thermal image with machine vision software. This type of program matches the geometric pattern in the image and its temperatures against the temperatures in a pattern stored in a computer memory. An added function in such a system could be laser marking of a poorly sealed package so it can be removed at the inspection station.

An issue affecting product safety indirectly is the integrity of cartons that overwrap and protect food containers. One of the most cost-effective ways of sealing overwrap cartons is to use heated glue spots on the carton flaps. In the past, the integrity of the spot gluing was determined by periodically doing destructive testing on several samples. This was time-consuming and costly.

Because the glue is heated, a thermal imaging camera can "see" through the cardboard to check the pattern and size of the applied glue spots. The camera can be set up to look at predefined areas of the flaps where glue should be applied, and verify spot sizes and their temperatures.

The digital data collected is used for a pass/fail decision on each box, so bad boxes can be immediately removed from the production line. The data is automatically logged into the QA system for trend analysis, so a warning can be generated if an excessive number of boxes begin to fail.



The camera can be set up to look at predefined areas of the flaps where glue should be applied, and verify spot sizes and their temperatures.

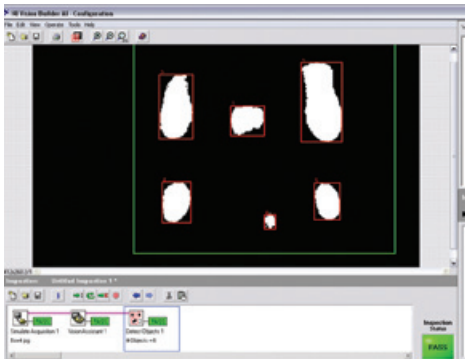
Yet another application for thermal imaging cameras is monitoring container filling operations. Although this is seldom a product safety issue, it does affect yield and compliance with regulations. Different areas on the bottle can be defined and used to trigger an alarm and remove bottles that are over-or under-filled. Thermal imaging cameras are a better alternative to visible light cameras when a bottle or jar is made of dark colored glass or plastic.

Automating measurements

Application software currently available for thermal imaging cameras includes a wide variety of functions that support automated food processing applications. This software complements and works in conjunction with firmware built into thermal imaging cameras. The imaging tools and libraries in these packages are hardware- and language-independent, making it easy for food processing engineers to quickly implement thermal monitoring and control systems.

Thermal imaging cameras themselves provide the user with different operating modes that support correct temperature measurements under various conditions. Two functions commonly found in these cameras are a spotmeter and area measurements.

The spotmeter finds the temperature at a particular point. The area function isolates a selected area of an object or scene and



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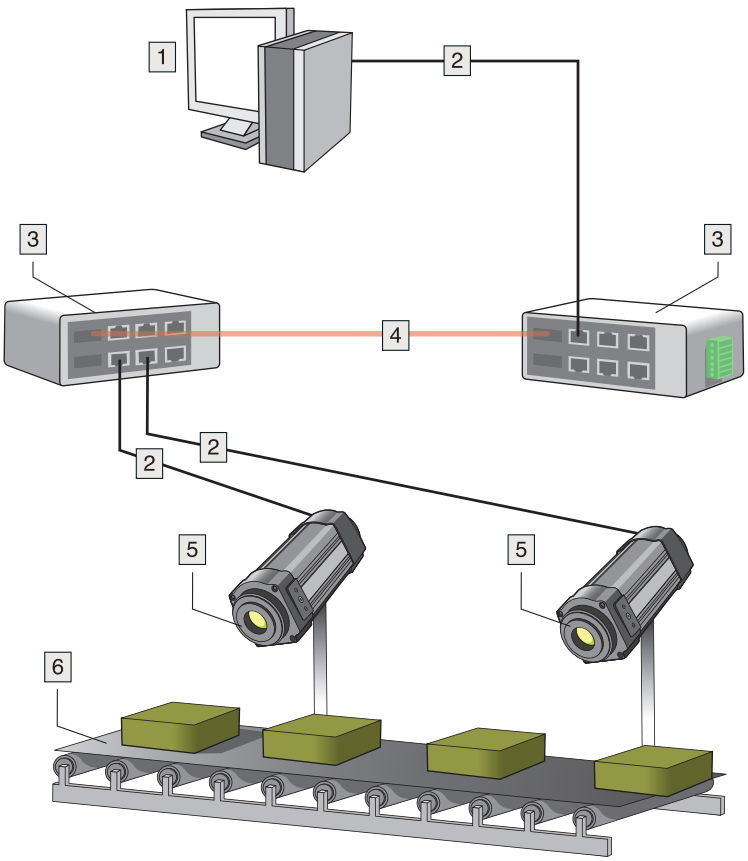
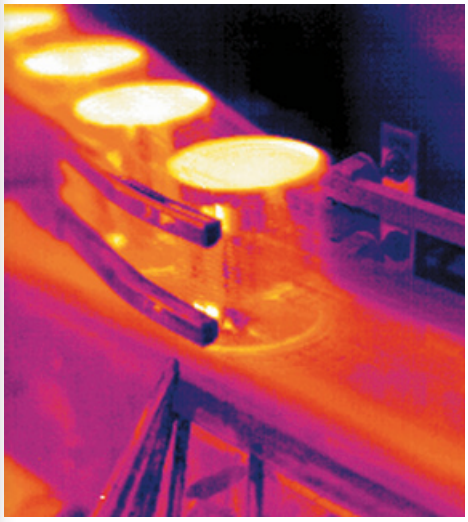


1 *Computer or PLC*
2 *CAT-6 Ethernet cable with RJ45 connectors*
3 *Industrial Ethernet switches with fiber optic ports*
4 *Fiber optic cable*
5 *FLIR A310*
6 *Food process to be monitored, e.g., items on a conveyor belt*

Typical Go/No-Go inspection system using thermal imaging cameras



Process monitoring of production line

usually provides the maximum, minimum, and average temperatures inside that area. The temperature measurement range typically is selectable by the user. As an adjunct to the temperature range selection, most cameras allow a user to set up a color scale or gray scale to optimize the camera image.

In conveyor oven applications, the area function is typically used because pieces of cooked product are often randomly located on the conveyor. The camera can be programmed to find and measure the minimum and maximum temperatures within the defined area. If one of those setpoint temperatures were to fall outside the user-defined limits, an application program running on a PC or PLC would instantly trigger an alarm, alerting the operator to check the thermal image on a video monitor or PC to find and remove the bad product, and/or adjust the cooking temperature.

In the case of local monitoring, an IR camera's digital I/O can be used to directly trigger an alarm device without additional software. However, food processing often benefits from higher level analytics that are available in third-party software that runs on a PC.

These out-of-the-box solutions do not require the writing of application source code. By adhering to commonly used machine vision interface standards such as GigE Vision® and GenICam,™ a wide range of functionality is supported by this software.

A simplified block diagram of conveyor monitoring is shown. One thermal imaging camera is adequate for many applications, or a thermal imaging camera may be combined with a visible light camera to record other target object attributes, such as color.

For more information about thermal imaging cameras or about this application, please contact:

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