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PreciTaste's QSR Brain Software Uses AI Machine Vision at the Edge for Precision Forecasting in Quick Service Restaurant Food Production

The QSR Brain system deploys high-performance AI inference technology at the edge in order to calculate and guide crew to optimal food production levels throughout the day.

PreciTaste

"With the Intel® Distribution of OpenVINO™ toolkit, we were able to accelerate the inference of our models, which allowed us to run near-real-time object detection on the edge."

—Mathias Sundholm, head of AI, PreciTaste

Managing production in a sustainable way in a quick service restaurant (QSR) location requires careful calculation of the amounts and timing of food preparation in order to ensure that food is fresh and always available. But over- and underproduction are hard to avoid.

To help address these inefficiencies and reduce the resulting food waste, AI software partner PreciTaste created QSR Brain, an AI machine vision system for digital management in the food service industry. Optimized with the Intel® Distribution of OpenVINO™ toolkit, QSR Brain senses and digitizes restaurant operations and uses AI inferencing to guide food production at retail locations. This allows QSRs to more efficiently service the demand for food items, whether it comes from customers walking in, using the drive-through, or ordering online.

With this combination of AI inferencing technology at the edge and point-of-sale (POS) data augmented by computer vision–detected customer and vehicle sensing, restaurants are able to calculate the optimal production levels in near-real time throughout the day, update the kitchen and inventory instantly, and guide crew members to complete the necessary tasks precisely when they're needed. This results in production that is more sustainable, with less food waste, faster speed of service, cost savings from better-managed inventory, and the consolidation of production tasks.

Challenge: Manually run QSRs face production inefficiencies that impact freshness, service times, and waste

Over 194,000 QSR locations were operating in the US as of 2019.[1] With their traditional manual methods, food production is scheduled beforehand or is reactive once orders start coming in. Crew members must often decide between overproduction, which leads to waste and stale food, and underproduction, which leads to slow service and stockouts. With notoriously high staff turnover and minimal training, crew members need a more-precise way to plan the timing and quantities of food preparation, and managers need processes that are more sustainable.

Solution: Matching production to demand based on predictions updated in near-real time, according to vision sensing

By measuring the number of customers entering the store and drive-through, combined with prior sales information for comparable numbers of customers, QSR Brain uses AI inference technology to create a forecast that predicts the number of prepared burgers, chicken, fries, or other items required to meet demand. Also included in the calculation is data about the historical demand on similar days (e.g., Tuesdays in April), actual foot traffic, and vehicle orders as measured by vision AI, local weather, direct streams from POS, and local events. In addition to using vision

OpenVINO™

AI to quantify foot and vehicle traffic, QSR Brain also uses Intel® RealSense™ cameras in the kitchen to capture both depth and visual information. This volumetric data senses a 3D profile of the food, helping the system perform live inventory monitoring by quantifying the food being cooked and that is available to serve. The system compares the actual available inventory it observes against the demand forecast. This comparison yields an optimized production schedule that updates throughout the day in response to real traffic and real production as it is happening. If it calculates that more food is needed, it sends cooking instructions to the kitchen staff via touchscreen monitors mounted near the cook stations. All of this data is uploaded to the cloud to help management gain operational insights.

The QSR Brain digital management functions include:

- **Customer tracking:** Computer vision tracks and quantifies how many customers are in the ordering area of the restaurant

- **Vehicle tracking:** Computer vision tracks and quantifies vehicles in line or entering the drive-through

- **Available inventory and work in progress inventory sensing:** Vision and depth sensors quantify the food that is cooked and available to serve

- **POS interface and order parsing:** Orders from POS are received and parsed to ingredients (e.g., two double cheeseburgers → four burger patties, four cheese slices)

- **Demand modeling:** The system predicts how much of each item will be sold in the next five, 10, and 15 minutes, based on historical data, customers, and POS orders

- **Kitchen task logic and cook commands:** If the available inventory is too low to service the predicted demand, the system decides that the crew should cook more food

- **UI/UX:** Passes calculated decisions to crew

- **Reporting dashboard:** Calculated key performance indicator (KPI) reports are passed to management

Figure 1. QSR Brain dashboard.

How it works

The on-site internet connections at many QSR locations across the US are unreliable, making it unlikely that they could connect directly to the cloud for AI computing. Instead, the QSR Brain solution runs AI on-site at each location using small form factor computers capable of performing AI inference at the edge to make operational decisions. To provide functionality at each restaurant, each location contains its own local instance of QSR Brain, including the sensors and computing devices.

QSR Brain synchronizes the back-of-house production with demand from all sales channels via a suite of embedded cameras and sensors, with up to 15 video streams. Within each restaurant, sensors gather data about inventory levels; the data is then sent to an edge device that computes important points:

- Computer vision identifies and counts food

- Sales forecasts are analyzed and parsed for each ingredient

- The system mathematically determines when more food should be cooked

- Instructions are sent to a touch UI that instructs the crew to cook more food
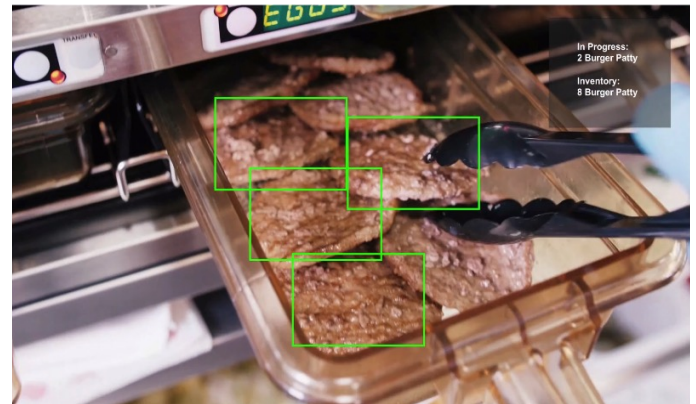

Figure 2. The QSR Brain system quantifies the available food in real time, instructs the crew to cook more food, and updates inventory.

Intel hardware provides both the computation and the specialized sensing for QSR Brain. During platform development, PreciTaste used the Intel Distribution of OpenVINO toolkit to help tune the video analytics workloads for the embedded Intel® processor and VPU. Intel Atom® and/or Intel® Xeon® processors were typically used, depending on the necessary computing power, along with Intel RealSense cameras and management technology. The use of Intel's platforms and array of devices enables PreciTaste to easily organize and integrate the major functions into modular systems.

"It is at the core of our mission to reduce the world's food waste and offer an alternative and smarter way to produce food in the industrial, commercial, and domestic space."

—Ingo Stork-Wersborg, founder of PreciTaste

OpenVINO™

The Intel Distribution of OpenVINO toolkit

With preoptimized libraries of functions and kernels, the Intel Distribution of OpenVINO toolkit helps developers code, optimize models, and deploy deep learning inference, computer vision, and hardware acceleration models in heterogeneous environments. The toolkit was easy to learn and use, enabling the PreciTaste teams to overcome a gradual learning curve and get the modules working faster.

OpenVINO also allows PreciTaste to upgrade and swap out hardware as improved options become available. New OpenVINO-compatible hardware can be dropped into the system with minimal changes to the architecture or setup.

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Intel RealSense Technology

With Intel RealSense technology's vision and depth sensors, PreciTaste can capture a 3D profile that effectively measures the volume of a food by sensing the depth and ingredient fill levels in pans. The sensors quantify the food that is cooked and available to serve, providing a major source of information for QSR Brain to make decisions based on volumetric assessments of the available inventory.

PreciTaste found that Intel RealSense technology delivers a cost-efficient way to measure the available inventory of an array of ingredients, with a camera that provides both vision and depth information. They look forward to continued integration with the technology in deployments going forward.

Federated learning at scale

For franchises with dozens, hundreds, or even thousands of QSR restaurant locations, the solution generates a multitude of data points that can help management gain operational insights. While local AI manages each restaurant, cloud-based computing manages the reporting, skill transfer, and federated learning. Each of the local AI agents sends summarized KPI data to a cloud-based dashboard so management can gain operational insights. Training of the AI models takes place on-site for the first restaurants.
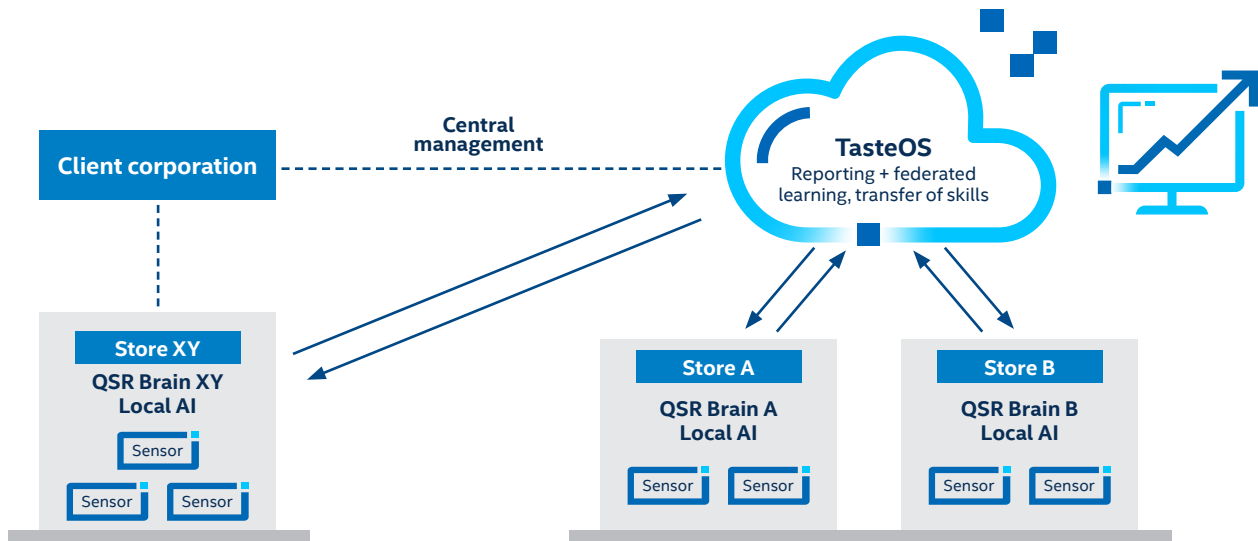

Figure 3: Cloud-based computing enables federated learning at scale.

Key benefits of the solution

PreciTaste found that the use of the QSR Brain system is having a marked operational impact at major QSR franchisors by providing a more sustainable solution. The company's customers include four of the largest 10 QSR restaurants in the US. Overall, their use of the solution ultimately resulted in faster service, more-efficient management of food production, and labor efficiencies. One restaurant reported doubling its operating profits.[2]

Speed-of-service improvements lead to sales boost

PreciTaste found that for some customers, speed-of-service improvements averaged up to 33 seconds, leading to an 8 percent sales boost during peak hours, with an overall sales increase of 4.8 percent.[2] Not only is the bottom line improved, but shorter waits in line make for a better customer experience.

Reduced food waste from more-efficient management of the food production process

The industry average for food costs is 30 percent of net sales.[3] But a significant proportion of this food goes to waste due to overproduction and quality issues. With precision forecasting, the QSR Brain system is able to manage food production more efficiently in each restaurant, which results not only in fresher food and a better taste experience but also leads to a marked cost savings from reduced food waste. By only producing what is calculated to be necessary, each restaurant cuts food waste by more than 80 percent, which saves 2 percent in food costs. This food waste savings alone pays for 270 percent of the solution cost.[2]

Improved labor efficiencies lower labor costs

Staff turnover rates in the industry are extremely high. The system's intuitive guidance makes it easy for new employees to work without much training by just following the instructions on the screen. PreciTaste found that AI management eliminated or consolidated kitchen production tasks by 40 percent, leading overall to a 4 percent reduction in cost of labor.[2]

Cost-efficient solution provides flexibility and scalability

PreciTaste's customers found that their investments in hardware and AI-as-a-service (AIaaS) fees were well worth the expenditures, saving its cost tenfold or more. The average single-restaurant revenues for PreciTaste's customers are over USD 2M, with average food/paper costs of 30 percent and labor costs of 30 percent.[2] Typical results from installing this system included a 2 to 3 percent boost to revenue, a 5 to 10 percent reduction in labor costs, and a 1 to 2 percent reduction in total food costs.[2]

What's more, customers can choose from hundreds of off-the-shelf devices on a global scale and use devices that can be either embedded or stand alone. The software is easily scalable for rapid deployment nationally.

A key goal for PreciTaste is to build stable architectures going forward that can deploy AI to a growing set of QSR applications at the edge. They feel that their use of Intel® CPUs and GPUs with OpenVINO and RealSense edge sensor and management technology will provide them with flexibility and value well into the future. They hope to continue to benefit from new innovations in hardware for faster and better-organized inference.

Conclusion

PreciTaste's QSR Brain, combined with Intel Distribution of OpenVINO toolkit, showcases a novel solution for precision food production forecasting at the edge. Not only does it limit food waste and provide savings in cost and production time for QSRs, it also paves the way for innovative solutions across many more industries in the future.

About PreciTaste

PreciTaste is a US-based company that develops new solutions for the professional cooking industry that are built on artificial intelligence and machine learning.

precitaste.com

Learn more

PreciTaste QSR Brain

QSR Brain uses AI inference technology and edge devices to predict the orders of approaching customers and vehicles as well as live inventory monitoring, making food production more efficient.

Learn more ›

Intel Distribution of OpenVINO toolkit

This toolkit gives developers easy-to-access libraries, frameworks, and pretrained AI models to achieve faster time to market for AI vision solutions.

Learn more ›

Intel RealSense Technology

Intel RealSense is a portfolio of computer vision technologies that include cameras, sensors, and management software. Its depth and tracking technologies are designed to give machines and devices 3D depth perception capabilities.

Learn more ›

1. Source: Statista report, https://www.statista.com/statistics/217561/number-of-quick-service-restaurant-franchise-establishments-in-the-us/.
2. Results based on PreciTaste customer financial data.
3. Source: Bloom Intelligence report, "Restaurant Benchmarks," https://info.bloomintelligence.com/hubfs/Miscellaneous%20Downloads/Restaurant%20Benchmarks.pdf.