Guide:
Transformational Use Cases for Computer Vision and Deep Learning
The combination of computer vision-based solutions and artificial intelligence (AI) present great opportunity for organizations across multiple industries. These technologies go hand in hand for many of today’s most impactful digital transformation and innovation efforts. This means that taking advantage of the potential of either means being ready to embrace them both. Despite their enthusiasm though, organizations can find their first implementations daunting.

Added to this, we are now challenged with building innovative and resilient business models and processes that will thrive in new economic and social circumstances. The scale and speed of change we have seen across the business landscape is huge, but it presents an opportunity to accelerate innovation and digital transformation. Computer vision and AI will play a crucial role.

This guide outlines a range of challenges from different industries that computer vision and AI can help to solve. Use them as inspiration for your own initiatives, whether you’re building on existing capabilities, or launching a digital transformation to drive your organization forward.
AI comes in many shapes and sizes, depending on the complexity and type of the task at hand. For example, machine learning may be used to run a recommendation engine on a retailer’s website. For complex, unstructured data like voice, video and natural language processing, deep learning would be used. The level of accuracy that deep learning delivers for such tasks has been improving rapidly. It is now able to meet or exceed human image and speech recognition abilities (see figure 1).

Achieving this level of accuracy depends on having a large, multi-layered dataset (a deep neural network) to train the deep learning algorithm. The more images it can review of bicycles and other objects, the more accurately it is able to learn what is, and is not, a bicycle. Once the training is done, the algorithm can be used to run inference in a real-life scenario.

Like any other type of AI, deep learning can be run across an organization’s infrastructure, from data center to cloud, to the edge. As video content is generally generated in high volumes, there is a case for running AI at the edge, close to the point of capture. This means:

- Latency is reduced as there is no need to wait for data to be transferred to the cloud or data center and back again. This is critical for real-time use cases like safety or defect checking on a production line.
- The volumes of data that need to be transferred for further analysis or storage can be reduced. This helps avoid overloading network and/or storage capabilities, which can be both disruptive and costly.

![Image recognition](https://via.placeholder.com/150)

**Figure 1:** Deep learning now meets or exceeds human image recognition capabilities
Every organization is different. What you need from your edge environment will vary depending on a multitude of variables, and on the industry you operate in (see figure 2). The beauty of today’s AI and computer vision technologies, which draw on open source and best-of-breed components, is the possibility to design bespoke solutions. Intel’s range of technologies can help, as can access to our extensive ecosystem of specialists in AI, computer vision and the Internet of Things (IoT).

With that in mind, let’s explore some examples of the ways Intel and our ecosystem have helped tackle organization or industry-specific challenges.

**Smart Cities**

Cities are complex, constantly changing organisms. The teams and departments responsible for keeping them running face different challenges daily. These range from granular issues like dealing with a burst water pipe, to city-wide priorities like keeping the city moving during a major event. With increased focus now on maintaining safety and hygiene in public spaces, new use cases are coming to the fore. Ensuring busy places like transit terminals and shopping centers support social distancing, for example, is now imperative for city governments.

Making sure that any issues that arise are dealt with in a timely manner means being almost omniscient. You must have visibility everywhere at once and be able to respond in real time. This is of course an unfeasible expectation for busy workers, but is a prime candidate for the use of computer vision.

Let’s take public transportation as another example. An insight.tech article explains, an edge AI solution provider used the Intel® Distribution of OpenVINO™ toolkit to develop a computer vision solution called Intelligent Video Analytics Recorder (IVAR). It worked with a national railway administration, which operates over 300 stations, to help give the organization better visibility across its network. The aim was to help increase efficiency and improve the passenger experience.

It started by implementing the solution at one station, which handles approximately 17,000+ people every day. The IVAR system analyzes camera footage in real time, monitoring foot traffic around the station and identifying abnormal behavior that the station staff should investigate. IoT sensors built into the IVAR edge systems also enable the detection of fires or intrusions into restricted areas.

In addition to these safety benefits, the solution helps the station staff improve the customer experience. It’s possible to adjust staffing in real time, based on current footfall in the station. For example, staff can open more ticket windows when wait time gets too long. They can also apply platform entry restrictions at busy times so that platforms don’t become too crowded.

As a result of these new capabilities, the railway administration has seen a significant reduction in crime rates, incidents and complaints from passengers.

The solution is built on Intel® technology, and supports open standards. This means the customer can take advantage of a choice of components, and easily scale or evolve its solution over time. Using the OpenVINO toolkit means that the software is also optimized for the hardware on which it runs, helping keep the system cost-efficient. Remote management capabilities also mean that security patches, updates and maintenance to individual devices can be conducted from a central location. This helps save time and costs, while ensuring any issues can be dealt with amazing speed.

**Figure 2: Multiple industry-specific use cases for computer vision and AI**

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Industrial IoT

Automation and robotics in manufacturing are rich areas for development as they can help reduce costs and boost efficiency. However, robotic systems often come from multiple vendors, and run on different subsystems, making integration difficult.

It can also be tricky to ensure accuracy when using robotics on the factory floor. The machine vision capabilities that have traditionally been used are reliable only in very controlled environments, with fixed rules. A speck of dust or grease on the camera lens can affect the accuracy of the system, and therefore the quality of the output.

NexCOBOT, an intelligent robotics system integrator, recently piloted the use of robots to conduct automotive assembly tasks. It used computer vision and AI powered by Intel technology, including the Intel Distribution of OpenVINO toolkit. This task was chosen for the pilot because – as a low-volume, high-mix manufacturing task – it requires high levels of customization and flexibility. This would be challenging for an automated system using traditional machine vision.

In the pilot, one robot shuffled a plate to change the placement of the LED modules to be assembled. AI vision then took photos of the plate and classified the correct module and color to be used. The robot then plugged in the module, tested it, and readied the line for production. The pilot delivered highly accurate and repeatable results, without the need for extra coding, even in a changing environment.

In order to make the solution compatible with existing manufacturing environments, NexCOBOT’s solution is open and modular. This enables:

• Support for high-mix, low-volume manufacturing needs
• Increased accuracy under varying environmental conditions
• Accelerated time to results, with no need to set up an identical environment each time

Retail

Brick-and-mortar retailers are challenged to reduce costs and optimize revenues as customer traffic declines, driven by the rise of online retail. At the same time, customers that do come into the store expect a more personalized, dynamic experience like the one they get online.

All retailers must therefore become digital retailers. In large part, this means becoming more data-driven: using data to optimize as much as possible, including supply chain, staff and resource management, and customer experience.

IoT systems integrator Advantech worked with Intel to develop an AI video technology tool called UShop EIS AI system to help retailers adopt this digital mindset. The system was based on Intel® technologies including the Intel Distribution of OpenVINO toolkit, and Intel® Vision Accelerator Design with Intel® Movidius™ Vision Processing Unit (VPU). It uses computer vision and AI to track and analyze customer behavior and product trends in real-time, in the store.

Computer vision and deep learning algorithms quickly and accurately identify human shapes as they move around the store. This anonymized data provides insights into how the store is performing and how the customer experience could be improved. For example, heatmaps show how shoppers walk around the store and interact with the space. This

This project is explored in more detail in this solution brief.
helps retailers make more informed decisions about overall layout and the placement of specific merchandise. It also interprets shopper behavior, such as reaching for a product on a shelf. This data can be combined with other sources, like radio frequency identification (RFID) data, to identify which products are picked up and purchased. It also helps spot those that are more often put back on the shelf, or ignored completely.

The ability to interpret customer movements and gestures means the solution is also able to help store associates deliver a more timely, attentive and personalized service. For example, if a customer seems hesitant or unsure, the system can alert a salesperson that they may need help with finding a particular item.

More general trend data can also help store managers manage traffic, set targets, and plan staffing. This can include the number of visitors in a day, or the fluctuations in traffic depending on time of day, or even current weather. As retailers are challenged with maintaining social distancing between customers, additional uses become apparent. For example, by understanding how customers move around a store, managers can implement one-way systems that feel natural to shoppers.

Advantech built its solution using Intel Vision Accelerator Design products to take advantage of their power-efficient deep neural network inference for fast, accurate video analytics. Intel Movidius VPUs can operate on customizable complex networks and network layers with high compute and ultra-low power consumption. This enables industry-leading performance per-Watt per-dollar.

This project is explored in more detail in this solution brief.

Healthcare and Life Science

There is huge potential for computer vision and AI in healthcare. They can help track human movement patterns through hospitals, or help doctors shorten the time needed for medical image analysis and make more accurate diagnoses.

One medical facility in Taiwan wanted to improve the way it identified and treated macula degeneration. Part of the retina, the macula can degenerate over time, leading to impaired vision and eventual blindness. As symptoms only exhibit in the late stages, it is often hard to identify the condition in patients until it is too late to treat.

However, by using an imaging technique called optical coherence tomography (OCT) early, it is possible to detect tell-tale macula-related lesions. This is traditionally a time-consuming and labor-intensive task though, which requires special training that is not widely available. It can also take weeks for results to come through.

The facility used the Intel Distribution of OpenVINO toolkit, running on Intel® hardware, to train and deploy a deep learning algorithm. In just two months, it developed a solution that could analyze the OCT visuals at human-like accuracy. As a result, patients now get their results within a day¹, even if they are in a rural location far from the nearest specialist. This means that this life-changing treatment is available to more people than ever before, and at a relatively low cost.

The platform on which this solution was built was developed by Intel and QNAP/IEI. It incorporates compute, storage, and network components, as well as developer kits and tools to enable quick development of deep learning applications.

Another application for computer vision and AI in healthcare is combining it with robotics to help enhance patient monitoring and remote treatment. Robotic devices equipped with vision technology can support telemedicine use cases by enabling a physician or specialist to be present for treatment or consultancy, even if they are physically distant. This helps reduce direct human contact in areas where disease transmission is a concern, while enabling remote communities to access specialist care without needing to travel. You can learn more about Intel™ telehealth and COVID-19 in this article.

The use of robots to help keep public areas hygienic has also been pioneered in the healthcare space. For example, robots can be used to blast rooms or equipment with UV-C light, which has been shown to kill complex viruses. As UV-C light is also dangerous to humans, the robots are equipped with computer vision technology to help them determine when it can safely activate the UV-C blast. It also uses it to navigate around the facility. There is potential for this technology to be used in other areas of heavy public use, such as transportation and other public buildings.

This project is explored in more detail in this solution brief.
Intel works closely with a broad ecosystem of hardware and software providers, as well as the wider open source community. Our aim is to ensure you have access to a range of tools and resources capable of addressing any challenge. We enable end-to-end AI environments, including IoT sensors, like video cameras, and IoT Gateway devices that help record, store and transcode video data at the edge. Our data center technologies power servers for storage and larger scale analytics of edge-captured data (see figure 3). Intel offers a broad range of vision products and software tools to help scale vision technology across infrastructure. These tools are designed to help match specific needs with the right performance, cost, and power efficiency at every point in an AI architecture.

The Intel Movidius VPU enables AI in edge devices by supporting demanding computer vision and AI workloads at ultra-low power. It combines highly parallel, programmable compute, with workload-specific hardware acceleration, and a common intelligent memory fabric to balance power efficiency and high performance. As a result, it’s possible to build deep learning and computer vision applications into devices like smartphones, drones, intelligent cameras and augmented reality devices.

The Intel Movidius VPU and Intel® Arria® 10 FPGAs have been combined to form Intel® Vision Accelerator Design products. This is a set of reference designs helps you optimize and accelerate deep learning algorithms. They offer power-efficient
It’s an exciting time in the evolution of computer vision technology. Game-changing applications of the technology are constantly emerging, and they bring with them opportunities to grow your business. Using the latest vision technologies, backed by powerful analytics and deep learning technologies, you can make better use of your data. You can also build new use cases that will drive innovation and support resilient growth.

At Intel we believe that now is the time to dive in and help realize the promise that this technology holds:

- The enabling technologies are available today, and thanks to tools like the OpenVINO toolkit that democratize access to sophisticated AI capabilities, cost-effective to implement
- They’ve been shown to work in practice. We have now moved on from theoretical discussions to being able to examine real-life implementations, like the ones outlined in this guide. There are learnings and best practices to be taken from stories like these and applied to your own projects
- Momentum is building across almost every industry to use AI. Those who continue to resist or lag behind now run a very real risk of being overtaken by competitors who are more inclined to innovate

If you have software developers on your team, they can benefit from additional resources such as:

- The Intel® DevCloud, a development sandbox that lets you develop, test, and run your workloads on a cluster of the latest Intel hardware and software. It includes integrated Intel® optimized frameworks, tools, and libraries for model training.

- Intel® System Studio is an all-in-one, cross-platform tool suite. It is purpose-built to simplify system bring-up and improve system and IoT device application performance on Intel® platforms. This helps deliver compelling solutions fast, while boosting performance, efficiency and reliability.

- Intel® Edge Software Hub, which is designed to help software developers customize, validate and deploy use case-specific solutions faster – and with confidence.

Key benefits of the Intel® distribution of OpenVINO™ toolkit

Maximize the power of Intel® CPUs, Intel® Processor Graphics, Intel® FPGAs, and Intel® Movidius™ VPUs with the Intel® Distribution of OpenVINO™ toolkit

**Accelerate performance**
- Access Intel computer vision accelerators
- Enhancing code performance
- Supports heterogeneous execution

**Integrate deep learning**
- Unleash CNN-based deep learning inference using common API
- Use 30+ pre-trained models and computer vision algorithms
- Validated on more than 100 public/custom models

**Speed development**
- Reduce time using a library of optimized OpenCV* and OpenVX* functions, and 15+ samples
- Develop once, deploy for current and future Intel-based devices

**Innovate & customize**
- Use OpenCL™ kernels/tools to add your own unique code
- Customize layers without the overhead of framework (on some platforms)

Figure 4: The key benefits of Intel® Distribution of OpenVINO™ toolkit

Conclusion

Ready to talk?
Intel does not control or audit third-party data. You should consult other sources to evaluate accuracy.

Intel technologies may require enabled hardware, software or service activation.

No product or component can be absolutely secure.

Your costs and results may vary.

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