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White Paper

The future of AI in the A&D industry

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Artificial intelligence (AI) is playing new roles in many aspects of our lives. New importance is being placed on building AI systems that bring autonomous operation to the aviation industry. Now that a new roadmap is in place for the safe and ethical dimensions of AI, aerospace and defense (A&D) organizations have a target, and AI will play a much more dominant role.

Using AI to fly an airplane will be an enormous achievement; the ultimate reflection of AI's ability to manage complexity. It will be a critical piece to implementing the changes that will be required in the next decade as A&D organizations reassess manufacturing automation in their factories. The recent pandemic, furloughs, bankruptcies and retirements are all impacting productivity and widening the talent gap, forcing the industry to adopt new technology such as AI to reimagine their business.

What is AI and machine learning?

AI, like so many technology buzzwords, can mean different things to different people. For us, an AI system is one that leverages software functions created through a machine learning process rather than through traditional programming. Data, rather than source code, is the critical element. The performance of an AI application is shaped by the data used to train the application.

Without going into detail on machine learning algorithms or approaches, which is beyond the scope of this paper, we can generalize that the power in AI comes from machine learning's ability to model complex systems and environments far beyond what we can reasonably build in traditional software.

Imagine building a speech recognition system through traditional programming — having a function for every word or a case statement for every pronunciation or accent. It would take a staggering amount of time to cover even 10 percent of the English language. Machine learning models, on the other hand, have made short work of this task, to the point that robust and accurate systems can understand a full vocabulary from hundreds of languages and accents.

Analytical AI vs. operational AI

Today, two distinct classes of AI applications are emerging across industries. The first is analytical AI, as in the type of system that can predict when a machine is going to fail, detect credit card fraud or recommend the next book to buy on Amazon. Operational AI, the second class of AI applications, actually does something in the physical world. It can manage a factory process, fly a plane, drive a vehicle or act on predicted events. It's artificial intelligence at work.

Analytical AI is maturing

The development tools and environment for building analytical AI applications are rapidly maturing. Previously, data scientists wrote Python code to enable most algorithms and approaches to machine learning. They did a lot of heavy lifting, extracting from various sources and then transforming the data to ingest into AI algorithms.

We can now address some of the more complex challenges the industry is trying to solve. Where does the industry need to pivot, from a technology point of view, so it can thrive during moments of disruption? We can also see coming technology advancements such as the introduction of more drones and air taxis.

What the industry really needs to do is to scale up the building of complex operational AI systems. We need the self-driving car level of AI across the A&D industry. To do this, we need a different approach to developing AI systems. The scale of data needed to train these complex systems is many orders of magnitude larger than what has been done before. This data must be well-managed through a significantly more complex machine learning system, where AI software is often trained in stages, leveraging data that is synthetically generated at key points. We must also consider the testing and validation environment, since we are talking about building systems that operate complex machinery in the real world.

Operational AI in A&D: Three use cases

Unlike AI development for analytical use cases, the development of toolchains and methodologies for complex operational AI is only just emerging. We believe that success in any complex operational AI endeavor will be determined most critically by having access to a robust development ecosystem.

Factory automation. Many of the woes in A&D over the past 10 to 15 years have been caused by the inefficient supply chain, which has created cost overruns, delays and even bankruptcies. Many companies are struggling with major supply chain problems, from a lack of control — in both delivery and timeliness — to a lack of quality control. Across the industry, supply chain problems have cost companies tens of billions of dollars in unnecessary costs. In short, the supply chain in the A&D industry has been a major problem.

The automotive industry is highly digitized and highly automated from a manufacturing standpoint, because there is a relatively stable and manageable supply chain of 10 or 15 original equipment manufacturers (OEMs), along with cooperation and partnerships so everyone can invest in automation. By contrast, the global aerospace industry lacks this level of partnership and, critically, the necessary manufacturing volume to make similar investments. A&D companies depend on a very deep and unwieldy supply chain with almost no automation and very little planning control or quality control.

In terms of delays and quality issues, the root causes are poor manual processes and poor manual planning. Underpinning automation, the industry also needs a strong digital foundation where both machine usage and labor can be tracked and optimized automatically. Automation not only brings conformity and control, but it also brings an automatic improvement in quality that is sorely needed. The answer to automating in A&D lies in using general-purpose robotics, more specifically, cobots (collaborative robots), which are general-purpose humanoid robots that can work among a human population on both factory floors and typical A&D production lines. Cobots introduce automation at a much lower cost because retooling of manufacturing programs is not needed.

These cobots still need to be programmed, and that's where AI comes in. Programming traditional automation solutions is an expensive proposition, as each task needs to be custom programmed to fit a particular factory and production line. With AI, programming countless different tasks one by one is not needed. AI plus cobots enable the automation of that operational program and factory at high, low and no scale, and at a dramatically lower cost, so that implementing automation is achievable, given the constraints of the aerospace industry.

Air traffic management. AI is critical for managing the anticipated disruptions in this industry over the next 10 years. One such disruption being watched closely is the pending introduction of drones and air taxis, often known as urban air mobility systems. Thus, the second use case is building an AI air traffic controller.

Today, air traffic management is generally managed by people. Based on many projections of this growing industry, in 15 – 20 years there will be 30 times the volume of air traffic flying over a large city such as Los Angeles than there is now. Human beings would be hard-pressed to manage that huge amount of air traffic, and it may be impossible.

But this is not the type of problem where more humans can be added and each person given a smaller slice of the air traffic pie when we consider the amount and type of new air traffic expected to operate, especially at the 0 to 3,000-foot level. Given all this, there is wide consensus that the industry needs AI to manage this exponentially higher level of complexity.

Fully autonomous vehicles. This third use case is obvious because we are inundated with news about the self-driving car every day. First, being autonomous is different from being unmanned. Drones flying today don't have pilots sitting in them, but they are still overseen by a pilot from the ground. Such drones have a ground station that has aspects of a cockpit repurposed on a desk, with a human flying the drone remotely.

The future progression from this state is full autonomy, where an AI system is constantly evaluating and reacting to the airspace and making decisions to act in accordance with its mission. The impetus for fully autonomous flight is the same as it is on the ground. A new, generally accepted roadmap has now been published and with autonomy, not only can we imagine a more efficient world, but we can imagine a safer one as well.

Creating complex operational AI systems

To create complex operational AI systems in the A&D industry, very different needs must be met for data management and for algorithm creation and implementation. Very robust simulation is also needed in the testing phase. Above all, there is a strong need for a solution that enables complex operational AI DevOps.

When training an AI system, there are two datasets. First is the historical dataset for the predictive use case containing the instances of what is being predicted. Next comes a testing or validation dataset. In the complex operational world, organizations often investigate neural networks to handle the pattern recognition. Algorithms can be used to automatically build better and better neural networks, based on the performance of the best-performing neural networks from past iterations.

But given the much higher complexity of the environment in which pattern recognition and training are run, higher-level approaches must be considered. For complex operational AI, the various machine learning approaches demand data at a higher scale and management at a greater complexity.

What is needed is a tiered approach to building different datasets. Start with a dataset that is focused on the physics of what you are trying to model; then build a dataset that accounts for the operating environment. After that, extrapolate the data to create a dataset that is orders of magnitude larger.

Algorithms then need to be constructed to create synthetic data to fill into that next-larger phase. Plus, building a robust simulated environment that matches real life can be a key factor in acceptance, and where necessary, certification. For example, certifying an airborne system is all about proving it is safe, and complex operational AI DevOps can play a crucial role in providing a robust simulation environment in the testing phase.

Operational AI is not easy, but it is possible

Building complex operational AI systems is no simple task. There are many challenges in managing the development environment and specific workflows. Data management over the full development life cycle is key, as is using the right technology to manipulate, extrapolate and scale data. It is essential to build a system that effectively manages and curates the data that represents the foundational dataset; then integrates, manages and curates the data from that environmental representation dataset; and ultimately provides the platform and simulation for the synthetic extrapolation of that merged dataset into a much, much larger dataset.

It is no easy feat to provide the data hosting, management and curation environment through these data stages that are each so massive in scope. Providing the simulation environment is enormous, because that is the “secret sauce” needed to be able to take that large dataset, combine it and then extrapolate it to ultimately produce a robust algorithm.

The good news — not only for the A&D industry but for all industries — is that a solution does exist that provides the DevOps environment to make all this come together and work at scale. DXC Robotic Drive is the first solution that provides a soup-to-nuts development toolchain and management environment for building complex operational AI.

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