

Digital Design

Physics AI Models Have Potential to Speed Weapon Development **BY JAN TEGLER**

San Mateo, California-based startup Luminary Cloud has released three new physics artificial intelligence models aimed at dramatically accelerating the design of collaborative combat aircraft, submarines and pump systems.

The company's SHIFT family of bespoke physics AI models can speed analysis of different design options for military platforms and components by orders of magnitude, said Juan Alonso, co-founder and chief technology officer at Luminary.

"In the physical world, we're interested in designing all kinds of systems, some military, where you have to simulate airflows, heat transfers, electromagnetics, structural analysis, etc., and for which there are really no good solutions to iterate through various different designs and do so very quickly," Alonso said.

Applying AI bounded by the constraints of physics to simulation enables Luminary to rapidly craft models capable of assessing variations in design configurations or operating conditions, he explained.

"The idea is that if you can do simulations of the physical world way faster and many of them simultaneously, you can create sufficient data to leverage what we call the physics AI revolution," he said.

In other words, Luminary can integrate its SHIFT physics AI models into a client's engineering workflow seamlessly via a secure cloud to help fast-track the design process.

"Say you're designing a new underwater drone. You can check different shapes. Let's put the fins in different places. Let's design propellers for these underwater drones, and let's assess the performance," he said.

An engineer can send a new design to the cloud-based SHIFT model, "and almost immediately out comes the actual performance of the proposed new design," he added. "We have built a platform that effectively automates most of the work such that instead of spending years trying to build one

such model, you can do it in a week."

In a late October press release, Northrop Grumman announced a collaboration between the defense giant, Luminary and NVIDIA's Computer Aided Engineering product team to create a new physics AI foundation model capable of accelerating the design of a spacecraft thruster nozzle.

Han Park, vice president of artificial intelligence integration at Northrop Grumman Space Systems, said in the release the new model marked the first step on the road to routinely using physics AI models.

"Physics AI is the next level of complexity in AI, and Northrop Grum-

man said in a statement, while declining to elaborate further.

PhysicsNeMO is a machine learning architecture that rapidly combs large datasets to help create models trained on data relevant to specific designs. NVIDIA did not respond to a request for comment on its role in the collaboration with Northrop Grumman and Luminary.

Alonso confirmed that no hardware as of yet has resulted from Luminary's collaboration with Northrop Grumman, but said Luminary is currently working with as many as six other defense industry firms. He declined to name them.

"You can imagine who they are — underwater vehicle makers, [collaborative combat aircraft] participants, including smaller companies or new entrants," he said.

Luminary's end-to-end process for creating its SHIFT models begins with generating large amounts of data relevant to a particular design, such as a swept aircraft wing. Engineer-



man is bringing this technology to our design engineers to dramatically speed up hardware development," Park said. "Using AI to make something small, like a spacecraft thruster, puts us on a path to do much bigger things, like using AI to design larger components or even an entire spacecraft."

Northrop Grumman views physics AI as an "important niche in the broader AI landscape, and that's the reason the company is focused on options that leverage NVIDIA's PhysicsNeMo, as Luminary Cloud's offering does," a company spokes-

ing and experimental design data are sourced from a client, he said.

Luminary's software runs simulations of that data to create datasets that can have "thousands to hundreds of thousands of simulations," Alonso explained, adding that the SHIFT platforms "can run a single simulation 100 times faster" than the legacy simulation tools many in industry use for design.

With datasets created, curated and prepared, machine learning architectures including PhysicsNeMo can be used to train the model, he said.

“Once you have a model that’s fully trained, you deploy it for what people call ‘inference,’ which means now you have a model of the physical world that is way faster than simulation and very, very accurate,” Alonso said.

With the SHIFT model completed, design engineers can query it to ask, “If I had another wing configuration or another thruster or another geometry or operating conditions, what is the outcome? Give me the answer very quickly,” Alonso added.

Luminary’s SHIFT models achieve accuracy within one percent depending on the quantity and quality of data they ingest, Alonso said.

Because the models are accessible via a secure cloud, an “engineer doing a dynamic database to develop flight control laws, for example, could have their laptop, not a supercomputer, connect directly to Luminary’s product and derive all the aerodynamic loads for development of the control laws,” Alonso said. “So, it’s easily integrated into existing workflows. The laptop

accelerating design processes.

“If you’re trying to ideate designs quickly and go through more of an open-ended creative process, I think these are really helpful and have come a long way,” he said.

The use of physics AI models in design workflows is still at an early stage. At this point, physics AI models work best when the data they ingest is extensive for a particular design space, Turner said.

“They can work well typically for a problem that is very close to the training data that went into it — say a winglet design, for example. Aerospace companies are likely to have decades of data on different winglet designs, so a physics AI model could probably produce a very high-fidelity simulation of a new design or variation,” he explained.

“I think the real test is when you branch away from the domain that your training data comes from, and you look at a new scenario or something that wasn’t included in the data you have,” Turner said. “That’s where

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tion, for humans, she said.

“It’s still computationally extensive, but if we’re clever about it — and that’s what some of our research is about — our AI scientists can go and do high-fidelity simulations in a way that is more computationally efficient,” Briscoe said. “That would allow us to explore wider design spaces than a human team could possibly do.”

Asked if physics AI modeling could help engineers assess design options much more quickly than traditional tools, thereby accelerating the fielding of military platforms, Briscoe responded: “That’s the dream.”

“I think design for more simple parts using physics AI models is more likely to be feasible in the near term as opposed to complex systems with kinetics and control systems, etc.,” she said.

Briscoe added there are a number of “hard problems” when using physics AI modeling for the creation of



is just an interface to the cloud.”

SHIFT models will also be made available this spring for on-premise use by clients wishing to employ them in very sensitive or classified design workflows, he noted.

Dan Turner, lead for Sandia National Laboratories’ Artificial Intelligence for Nuclear Deterrence Initiative, said researchers there are working on a project called Tungsten Rain with the aim of designing a “flight test body” using AI design tools.

Turner said emerging physics AI models offer promise for

something like a four percent error rate would be astounding. How far from your original paradigm are you when you’re looking at the error?”

Erica Briscoe, program manager in the Defense Advanced Research Projects Agency’s Information Innovation Office, leads DARPA’s efforts to harness artificial intelligence to make leaps — not incremental improvements — in design efficiency.

The promise of using AI in design processes is that it can automate a lot of the time-intensive work, known as design space explora-

comprehensive designs such as a submarine or an aircraft carrier.

“Say your AI system can come up with brand new designs,” she said. “If you’re talking about anywhere near a complex system, the number of designs you can come up with is near infinite, especially when you’re talking about 3D printing parts with all of the degrees of freedom that you have.”

“The more degrees of freedom you bring in, the more your design space explodes,” Briscoe noted. “Then it gets really hairy to make any claims about optimization there.” **ND**