ARMOR LAB IS USING MOTION CAPTURE DATA TO DEVELOP NEXT-GEN WEARABLES

VICON'S LOCK LAB IS THE NETWORKING TOOL MAKING IT POSSIBLE

Photo credits: Alingo Loh

Professor Ken Loh, Director of ARMOR Lab

Sometimes the challenge inherent in a motion capture project isn't the tracking itself – it's integrating every other data source into your digital ecosystem. The ARMOR Lab at UC San Diego is currently working on a new, potentially life-saving sensor technology that might not be possible without the use of Vicon Lock Lab to synchronize the project's complex data streams.

The ARMOR Lab at UC San Diego was founded by Professor Ken Loh with a mission to develop materials, technologies and algorithms that can be used to protect and enhance the performance of both physical structures and the human body. The Lab acquired its Vicon system using funding provided by the Defense University Research Instrumentation Program (DURIP) and the Office of Naval Research (ONR) in early 2021. It had a very specific purpose in mind – to develop a low-cost, wearable sensor that can measure human performance over long periods of time.

"I've been working closely with the Office of Naval Research on various topics related to how to better protect and monitor the health of the warfighter, the soldier, in all sorts of scenarios, especially when they're deployed." explains Loh.

"We're developing these sensors based on fabric that could be affixed onto different portions of your body to measure how your muscles engage during different types of movements or training activities."

While the current main focus of the research is soldiers, ARMOR Lab is also working on other applications for the technology, for athletes and the general public.

The benefit of such a system is twofold, says Loh. "By knowing how people move, you can begin to assess their physical health and set up a performance baseline. That information can then be used to understand how people are performing those certain activities to help them increase their performance, so that they become more capable at whatever skill they're trying to develop, whether it be throwing a baseball, shooting a rifle, running faster, etc."

Furthermore, having that baseline data will enable users to pick up on any changes that could indicate an injury. "You can now potentially intervene in a timely fashion to prevent something catastrophic from happening," says Loh. From there, he anticipates being able to use data gathered during recovery to assess how well rehab exercises are being performed and potentially find improvements that could speed up recuperation.

"You can now potentially intervene in a timely fashion to prevent something catastrophic from happening."

Photo credits: Alingo Loh

AN EVERYDAY SENSOR

A key aspect of these wearable sensors is their relatively low cost and unobtrusiveness. "Our hope is that these sensors will become standard issue," says Loh. They would be used not only in specialized environments or for time-limited assessments in the field, but as a matter of course during everyday operations throughout a deployment.

To keep the sensors both durable and affordable, ARMOR Lab, through funding support from ONR, had to find the right materials as well as measurements that they could take with relatively simple sensors. "The sensors, called Motion Tape, use elastic fabric tape, based on kinesiology tape that a lot of our athletes and tactical athletes wear from the injury prevention and pain mitigation standpoint," says Loh.

"We've built our sensing materials directly onto this tape. We're measuring skin deformation on the surface, and we're relying on those measurements to back-calculate what's happening."

The skin deformation, Loh says, indicates what's happening below the surface at the muscular level. Linking those measurements to global movements backed by trusted data is where ARMOR Lab's Vicon system, comprising 12 Vero 2.2s and a Vue camera, comes in.

"The Vicon motion capture plays a critical role in helping us understand how people move during those types of activities, but it also serves as a great reference and gold standard for us to compare our measurements to, and for verification and validation purposes," says Loh.

"We have these pieces of tape mounted at different positions such as the shoulders, the legs, the neck. We're collecting data from our tape sensors, and we stream the data through the Vicon Lock Lab. At the same time, we have markers all over the body and the camera is picking up the 3D positions of each of those markers to tell us how people are moving."

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Photo credits: Alingo Loh

FILLING A GAP

The data from ARMOR Lab's sensors isn't just functioning as a stand-in for the sort of information you could get from optical tracking or an IMU, however.

"Technologies like motion capture give you very detailed information about how the body is moving in the sense of where your different limbs are, and where you are in 3D space," says Loh. "But what it doesn't tell you is how your body and specifically how your muscles are engaging to do the things that you're doing. Our goal is to fill that gap. So we're putting these sensors directly over major muscle groups, like your biceps, for instance, to see if your biceps are engaging and, more importantly, how much they're engaging to perform functional tasks."

To create a context for that data, ARMOR Lab needed a platform that could bring together a broad range of data sources. "I think one of the great things about Vicon is its versatility - not only being able to do what it's meant to do to capture the positions of the markers, but also being able to bring in a lot of different sensing streams, from all sorts of sensors," says Loh.

"Part of that challenge is learning how to do that. Especially if you're working with new prototype sensors, like we are. We have the IMUs from Vicon, but then we have EMGs that we're trying to stream at the same time, our own sensors, force plates –- the list goes on and on. It becomes a little bit challenging to synchronize everything to make sure that the data that we're getting is not only high quality, but does not have any errors that are caused by the user."

That challenge made one feature of Vicon's ecosystem, in particular, a draw for Loh. "I think the biggest selling point is really the Vicon Lock Lab being able to connect with all sorts of different sensors, since our goal with using motion capture is not necessarily to do an in-depth study of the human body, but rather to look at what my other sensors are telling me combined with motion capture. That gives me a holistic view of the person's physical health or physical performance."

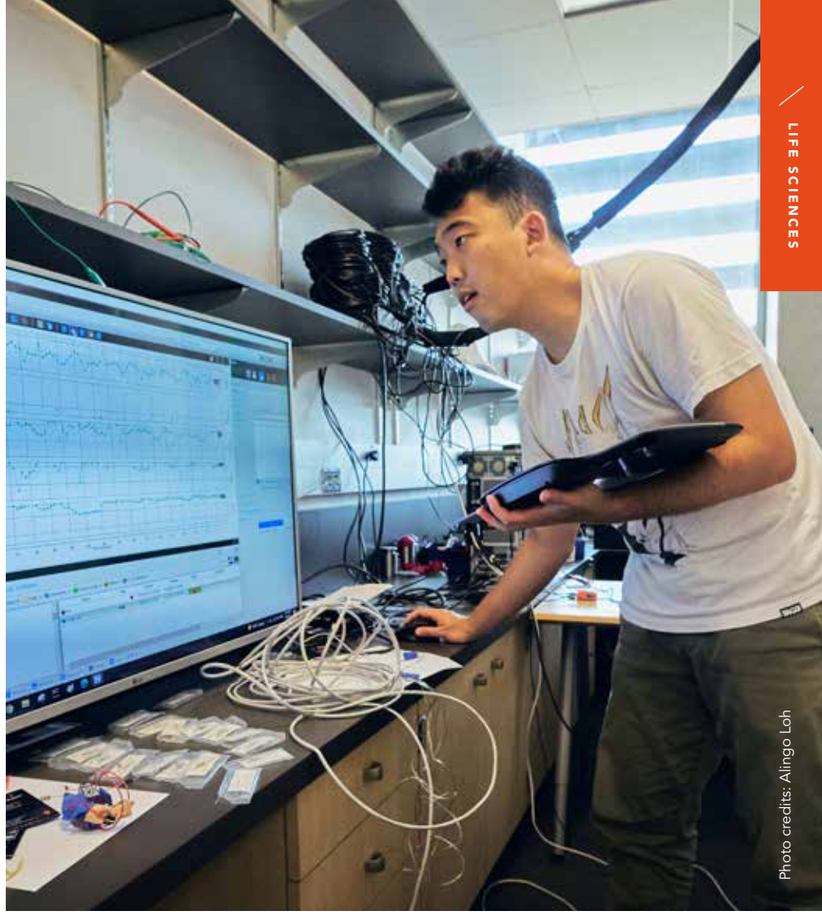

Photo credits: Alingo Loh

PROOF OF CONCEPT

It's still very early days for the project, but Loh says that ARMOR Lab is already gathering valuable data. "It's been very insightful in terms of capturing the differences between untrained movement versus a trained athletic movement. They're pretty stark, and it begins to allow us to classify whether a person has been trained effectively just from the data. And what's kind of cool, too, is that we've been able to show that the sensors do in fact pick up how much your muscles engage, which I think adds another layer of depth in terms of the richness of information that you can capture."

Despite being in the early stages of the sensor project, Loh already has one eye on the future.

"I think, moving forward, we are looking to expand our lab. My vision from a research perspective is, we're getting all this great data on the human body. But really, how do you take all these different data streams and be able to holistically assess the person, and then take it further? And say, 'How do I predict performance?'

"One of the bigger visions that we're working towards is creating a human digital twin. That's where I think motion capture and some of the new sensors we're developing, and what our collaborators are developing, will play a huge role."