IEEE VR 2024
ORLANDO, FL USA

Training a Neural Network on Virtual Reality Devices: Challenges and Limitations

erc Advanced Grant Color 3.0

Motivation

In the last years, Virtual Reality (VR) has seen an exponential increase in the number of devices on the market and the number of users, this could solve computational problems by providing information that cannot be obtained from other types of devices, such as eye tracking data or information on human behavior in different simulated situations to predict events. In this approach, we have analyzed different VR devices (**Meta Quest, Meta Quest 2, and Meta Quest 3**) to measure their performance in battery usage and runtime by training an NN feed-forward on the handwritten digits MNIST database.

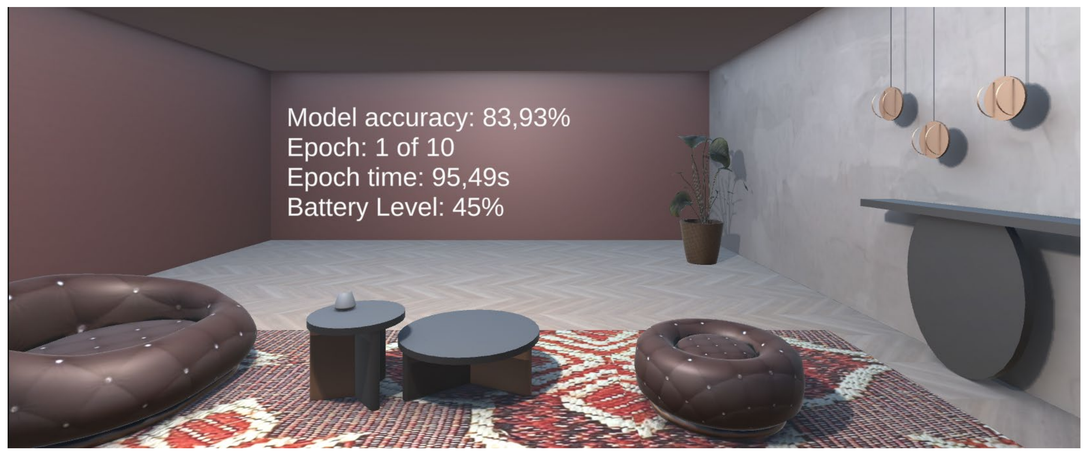

Fig. 1. Illustration of VR scene. Different parameters such as model accuracy, epoch number, time of the epoch, and the battery of the device are displayed.

Virtual Reality devices used

	Meta Quest	Meta Quest 2	Meta Quest 3
Released Date	May, 2019	October, 2020	October, 2023
System on a chip	Snapdragon 835	Snapdragon XR2	Snapdragon XR2 2ºGen
RAM Memory	4GB	6GB	8GB
Graphics (TFLOPS)	Adreno 540 (545-567)	Adreno 650 (up to 1.32)	Adreno 740 (up to 1.74)
Firmware version	v49	v54	v59

Table 1. Technical specifications of the different VR devices used.

Neural network architecture

We developed a **feed-forward network** in **C#** language under the **Unity graphics engine**. The network consists of a multi-layer structure with two hidden layers, each containing 150 neurons**, an initial layer with 784 neurons, and an output layer with 10 outputs corresponding to digits from 0 to 9**. For optimal performance, we selected parameters such as **10 epochs for training, a learning rate of 0.1, and a batch size of 8.**

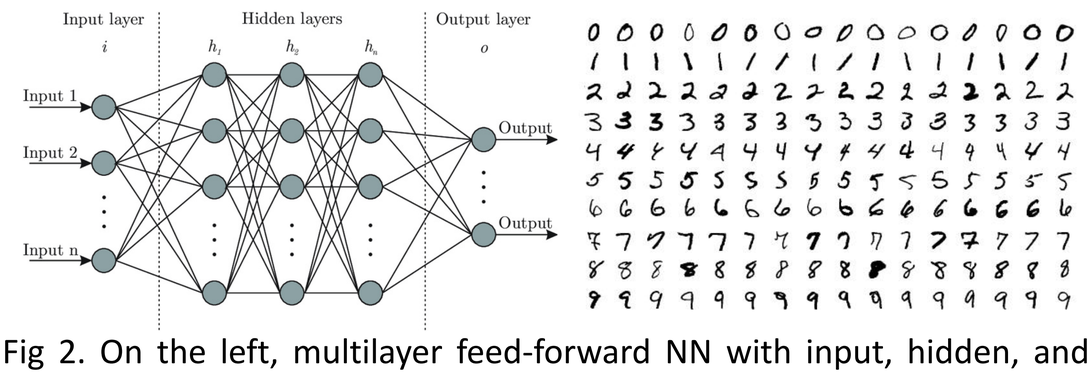

Fig 2. On the left, multilayer feed-forward NN with input, hidden, and output layers defined and interconnected with each other. On the right, images of digits from 0 to 9 used to train the network.

Results

Figure 3 depicts Meta VR devices' execution time and battery changes**. Quest 2 improves by 45%,** and Quest 3, claimed 2.5 times more powerful, needs firmware updates for optimal performance. **Additionally, Quest 3 shows over 15% less battery consumption than Quest and 4% less than Quest 2.**

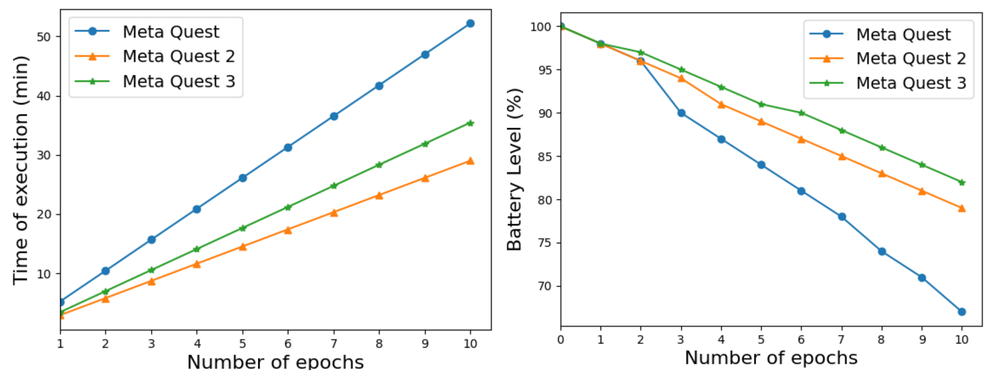

Fig. 3. On the left, the execution time after each epoch for all VR devices. On the right, is the battery percentage after each epoch.

Federated Learning on VR devices: A challenge

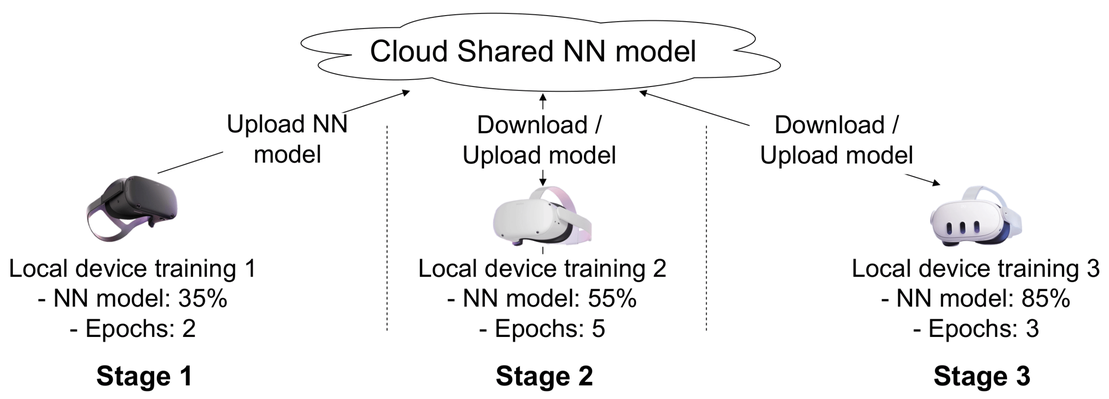

Fig. 4. Schematic of our FL proposal in VR using the cloud as a binding.

Conclusions

In conclusion, **it is possible to run real-time training algorithms on standalone VR devices**. This produces a battery drain on the devices although we see that **over the years and hardware optimization, it has decreased drastically and the execution time has been reduced as well.**

Francisco Díaz-Barrancas, Daniel Flores-Martin, and Javier Berrocal*

ID: 1054