Project Write Up: Booting Zephyr RTOS with ML based TFLite Application on QEMU and RENODE

INTRODUCTION:

In today's technologically advanced world, every aspect of our everyday lives is reliant on devices that automate tasks. Because we rely on technology, it has become a necessary part of our lives. To perform its processing quickly and efficiently, every technological component/gadget/controller/device requires a microprocessor. RISC-V (an open source instruction set architecture) has grown in popularity and adaptability since the semiconductor revolution, but it is restricted by the number of applications and/or operating systems that can operate on it. As a result, if someone develops a microprocessor or microcontroller based on the RISC-V ISA, he or she may require a custom application to run on top of it. Because Intel and Arm processors have been around since the dawn of time, all software and operating systems are designed exclusively for these CPUs. There is a critical need for programmes to be built and/or ported in the RISC-V domain so that they can run on top of the RISC-V processor/controller.

Motivation

Using TensorFlow, create a Machine Learning-based Image Classification Model. After that, this model will be transformed to TFLite in order to run on an embedded device. The TFLite Model will run on the Zephyr RTOS. The Zephyr RTOS will then be booted on both the QEMU simulator and RENODE on top of a SoC.

Implementation:

. Model building and conversion into TFLite
. Inference on C after TFLite Conversion

An unquantized Tensorflow Lite model of person classification was taken which accepts 96x96 gray-scale images as inputs. Since embedded systems are low on memory and Zephyr has no file system, the .tflite model was converted into a C-array. Functions were made to fetch images and display output on the screen. Flat C-arrays of images were used as test data and were sent as inputs to the model. On inference on QEMU and Renode, binaries had to be built. Zephyr's

meta tool, West, came to the rescue and built those binaries, while specifying the board and SoC on which the application had to be executed on.

On Zephyr RTOS running on Renode on a Litex Vexx RISC-V SoC, a TFLite-based Image Classification Model was simulated.After creating a TensorFlow-based machine learning model for image classification, you may classify an image of a person and determine the likelihood that it is a human. It was subsequently translated to TFlite and a C++ inference was created. After that, we ran the Model on Zephyr RTOS (RISC-V port) to make it run on a RISC-V ISA-based embedded device. The Zephyr RTOS is then booted on RENODE on the Litex Vexx RISC-V SoC, together with our TFLite Image classification model.

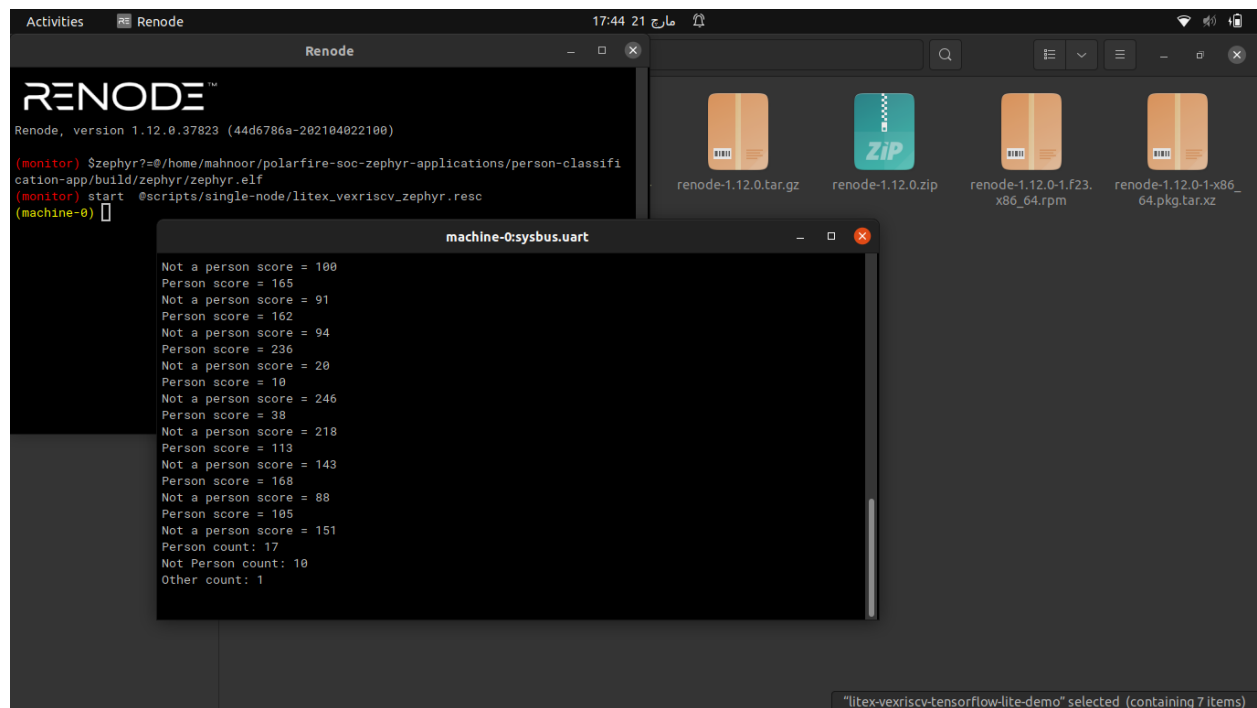Finally, Zephyr RTOS loaded and run our TFLite-based Image Classification Model on Litex Vexx RISC-V System on Chip, completing the simulation (SoC).

Figure 1: Model simulation on RENODE