Deep Learning Training on Distributed Embedded Systems

Sihyeong Park, Jemin Lee, Hyungshin Kim

Chungnam National University

Introduction

- **Deep Learning**
  - Machine learning based on multi-layer artificial neural network
  - Largely divided into two: **Training, Inference**

- **Excellent performance of Deep Learning**
  - Computer vision, natural language processing, speech recognition, self-driving car, etc.

Introduction

- **Training**
  - Generate a model with input data
  - Consists of repeatedly calculating multi-layer
  - Typically executed on a high-performance distributed system that supports multiple GPUs
- **Inference**
  - Perform for certain tasks such as object detection
- **Embedded System has limited resource**
  - Existing studies are not considered full-training on embedded systems without cloud offloading

Introduction

- **Smart Home Systems**
  - Diffusion of Internet-of-Things(IoT)
  - Many home appliances are applying deep learning
    - High-performance CPU like quad-core is used for appliances
  - Make easier to implement a distributed processing system using embedded systems

- **Risk of personal information leakage**
  - Devices collect data from their sensors and then send them to servers for training
  - Smart home systems incorporate an amount of sensitive information

Proposal

- **Distributed Deep Learning using Smart Home System**
  - In-Home local training, without server
  - Online learning about change of environment such as change of furniture layout and change of living pattern of people
  - Privacy protection possible
  - Reduced server usage costs

Experiment Environment

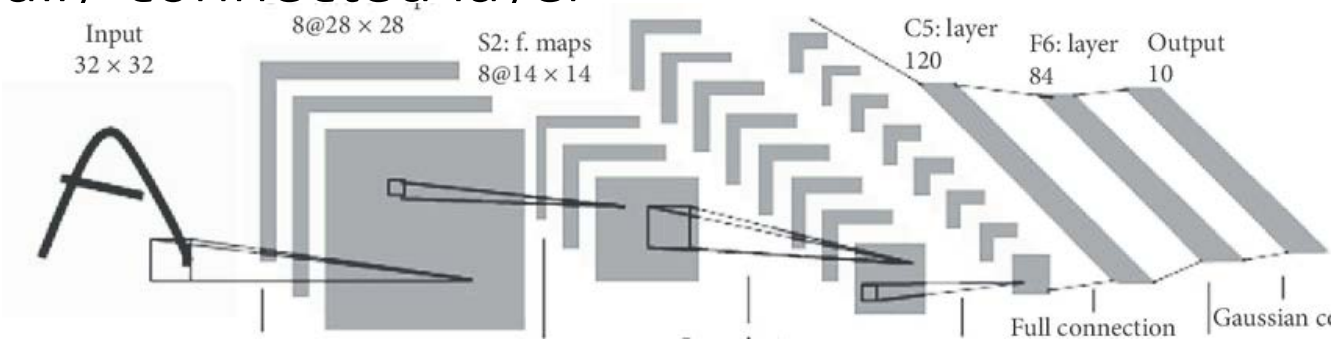
- **Distributed Deep Learning framework**
  - **MXNet**
    - Provides data and model parallel processing
    - Mobile devices to multi-GPU, multi-Devices
    - Distributed key-value storage based on parameter servers for synchronization

- **Distributed computing**
  - Raspberry Pi 3 Model B: 1~11
  - Connected with 100 Mbps LAN switch

Experiment Environment

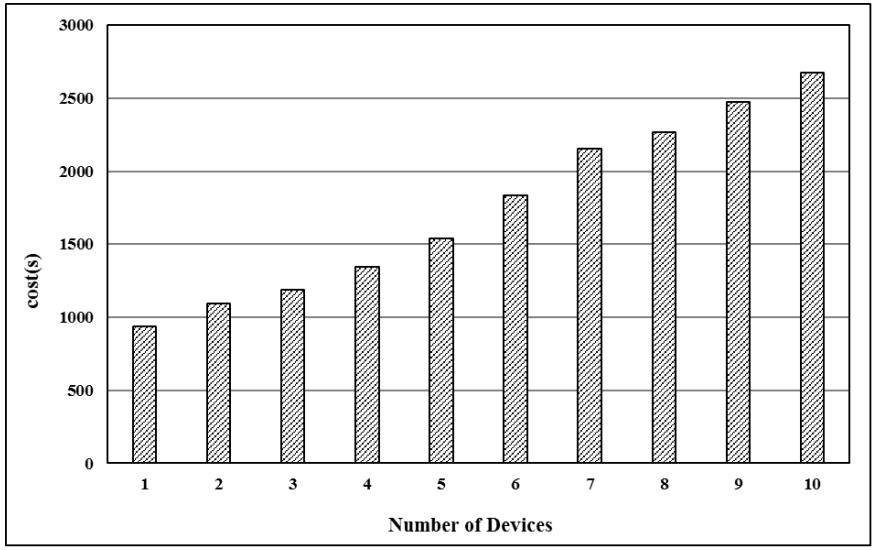
- **MNIST dataset**
  - Handwritten image of 0-9
  - 60,000 32x32 size images

- **LeNet-5**
  - 3 Convolution layers
  - 2 sub-sampling layers
  - 1 fully-connected layer

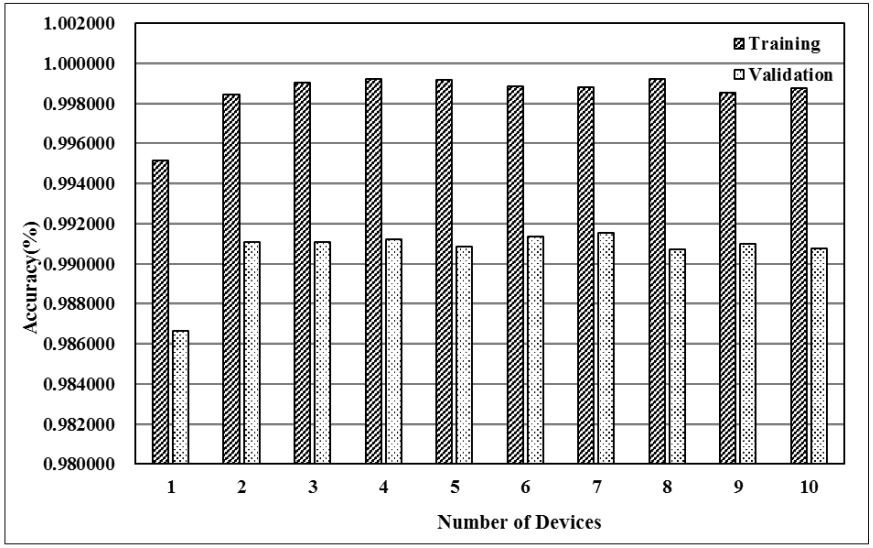


Experiment Result

- **Layer size:** 64
- **Learning rate:** 0.05
- **Number of epochs:** 10



Time costs



Training and
Validation Accuracy

Conclusion and Future Works

- **Trained LeNet model in distributed embedded system and measured execution time and accuracy for a handwritten dataset**
- **Using a larger model and a heterogeneous embedded system**
  - LesNet, AlexNet, etc.
- **Using Wi-Fi to distributed computing**