

Background

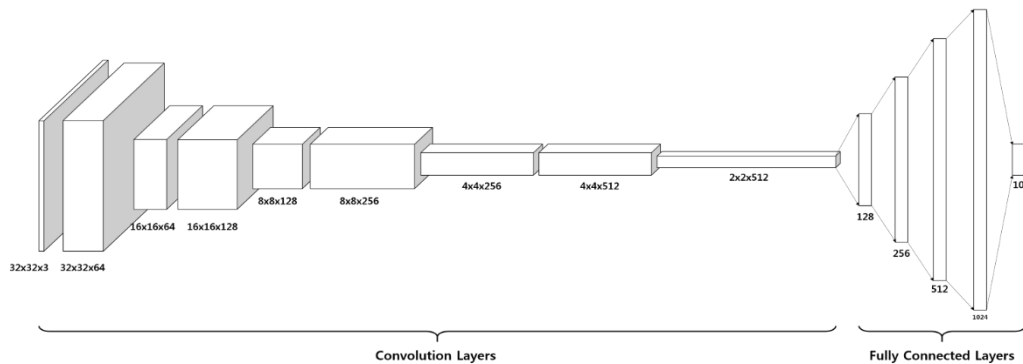
Clean potable water is need of every living being. Unfortunately, in most part of the world people find hard to get water free from bacteria and other harmful microbes. In rural areas, due to harmful bacteria and microbes, infant deaths are in significant numbers. Currently the water sensors are chemical based and needs good amount of time and human effort to monitor the quality of the water.

Introduction

Using machine learning techniques, image classification can be performed with good accuracy. This works on extracting feature map, defining weights for each feature in training dataset and comparing these features on input image, finally obtaining prediction of input image being one of the classes defined by training dataset. Similar approach of image classification can be used to recognize microbes in an image obtained using microscope.

Solution proposal

Idea is to build an IoT device which can detect harmful microbes. Convolution neural network is used on pre-trained model to detect the presence of harmful microbes. This model is pre-trained on images of harmful microbes. This method of learning is called supervised learning. Water samples are placed under USB microscope and the input image is obtained using USB microscope connected to [RZ/A1LU Development Kit](#). This image is then provided as input to CNN in multiple segments. Due to limited memory of [RZ/A1LU Development Kit](#), CIFAR10 is used which handles input RGB image of 32x32 pixels. Caffe framework is used to train the model graph, quantized to 8-bits to reduce the memory footprint. ARM's CMSIS-NN is ported on to [RZ/A Software Development Kit \(SDK\)](#) for [IAR's Embedded Workbench for ARM](#). FreeRTOS is used to communicate/synchronize between tasks such as USB IN task, classification task and peripheral task. As memory is limited memory pool support in FreeRTOS will be used for effective use of memory. The topology of CIFAR10 looks as show below,



The number of microbes classes will be 10 which is also the maximum label that is supported by CIFAR10.

BOM

1. [RZ/A1LU Development Kit](#) Main processor running CNN.
2. [RZ/A Software Development Kit \(SDK\)](#) SDK for SoC initialization and device drivers.
3. [IAR's Embedded Workbench for ARM](#) IDE and Toolchain.
4. [FreeRTOS](#) For communicating and synchronizing among various RTOS tasks.
5. USB microscope.

Block diagram



Further enhancements

This system can be enhanced to automate water examination using robotic arm controller using [RZ/A1LU Development Kit](#) by collecting water samples every periodic interval and placing it under microscope. Also, notifying authorities can be performed using AWS whose server will be contacted using WiFi.

Conclusion

The horizon of this kind of project/system is broad. ML on edge device can solve many real-world problems with good accuracy. This system can be extended to any support many other application involving image classification such as medical imaging.