Report Date: 10/14/2022
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Summary
The research was continued with 3 teams. IoT & Computer Vision team succeeded in transmitting short-range coordinates through LoRa communication outdoors. Sound detection team collected gun sound dataset and implemented a deep learning model for gunshot sound classification. Paper team revised the Abstract and Introduction section of the paper and researched prior studies to write the "Related Work and Motivation" section.

What SharpShooter completed this week:

- Collected the sound dataset
  To create an ML/DL model that distinguishes gun sound, data related to gun sound is required. The collection of datasets [1] include sounds other than gunshot sounds for a better accuracy. Mel-Frequency Cepstral Coefficients (MFCCs) were extracted from sound data and converted into a spectrogram.

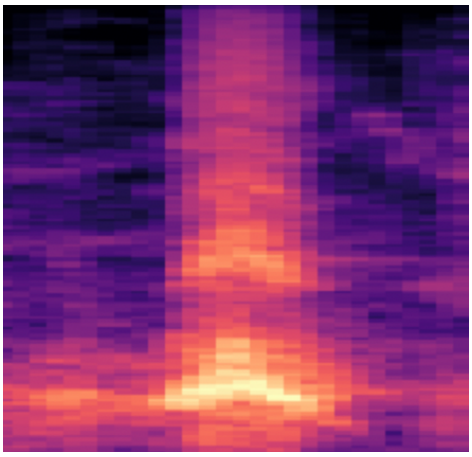

Fig. 1. An example of spectrogram image extracted from sound data

- Implemented gunshot sound binary classification Deep Learning Model
  Implementing gunshot sound binary classification deep learning model is completed by using UrbanSound8K dataset. This is just a draft, however, by adding the dataset, high-accuracy model will be made. Deep Learning Model utilized PyTorch Framework, and the structure is as follows.

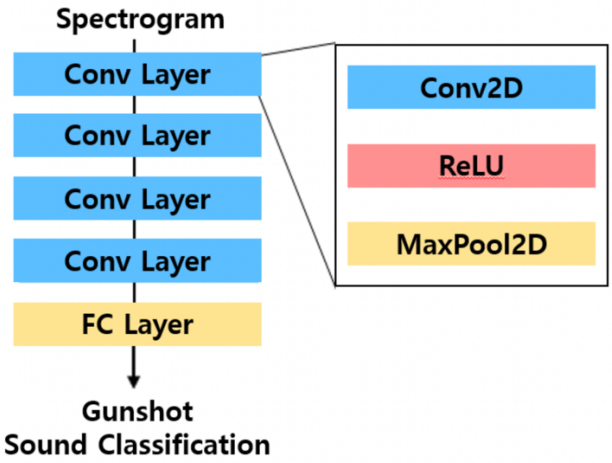

Fig. 2. Convolution Neural Network (CNN) architecture used in classification of gunshot sounds

Our network consisted of 4 convolutional blocks and a fully connected layer. Each convolutional block consists of Rectified Linear Unit (ReLU) activation function and max pooling layer (kernel size = [2 x 2], stride = 1). Max pooling is applied to the output of the last dense block, resulting in a 2-dimension feature vector which is converted by a fully connected layer into a classification for the gunshot sound.

- Built up the automation for the test
  For the test, Raspberry Pi needs to be automated. By using Crontab in Linux, the Raspberry Pi can be automated.

- Conducted the first outdoor test
  Outdoor test was conducted, LoRa transmission succeeded at the distance of 350m. The experiment was conducted at 9AM (Temperature: 2 °C, Humidity: 48%, Wind: 3km/h).

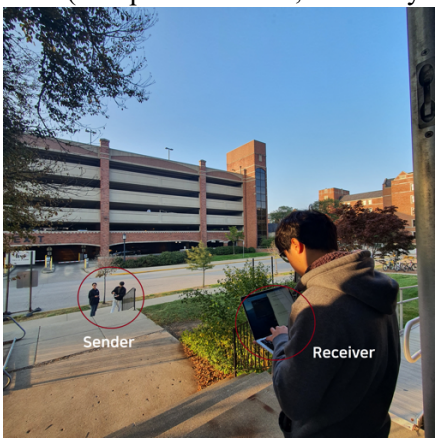

Fig. 3. Conducting LoRa communication test in outdoor

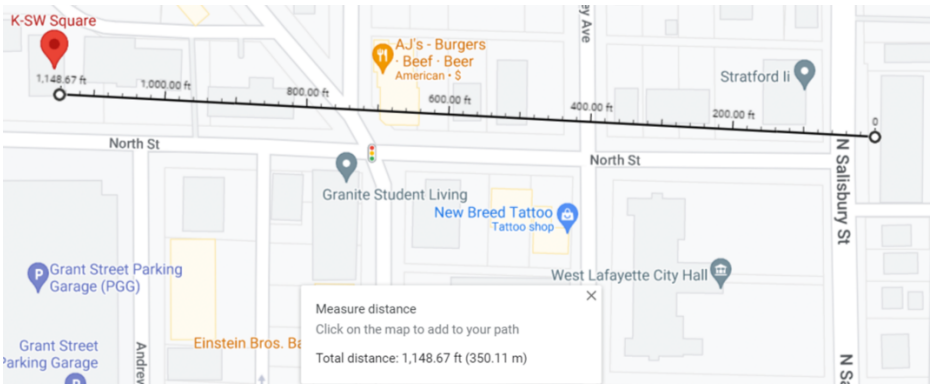

Fig. 4. Distance measured using GPS after performing LoRa transmission

Things to do by next week

- Modify parameters of current CNN model for gunshot sound classification or building new CNN models that derive the best performance
- Research about Socket communication
- Study related to sound processing such as MFCC and Mel-spectrogram
- Study related to LoRa image transmission
- Write the Relative Work and Motivation section of the paper

Problems or challenges:

- When coordinate transmission was performed through outdoor experiments, the garbage value was also transmitted. It seems to have been influenced by buildings and moving vehicles. Furthermore, an alternative to image transmission via LoRa communication is needed.
- The camera setting position must be determined for target segmentation, excluding the background from the image. This paper considers installing at the bottom of the front of the target [2].

References

[1] J. Salamon, C. Jacoby and J. P. Bello, "A Dataset and Taxonomy for Urban Sound Research," Nov. 2014. [Online]. Available: https://urbansounddataset.weebly.com/urbansound8k.html
[2] D. Andreea, “OnTarget: An Electronic Archery Scoring,” 2021, *arXiv preprint arXiv:2104.01622*.