Report Date: 09/23/2022
To: ematson@purdue.edu, ahsmith@purdue.edu and lee3450@purdue.edu
From: SharpShooter

- Donghyeon Na (201721402@sangmyung.kr)
- Hansu Jeong (201710982@sangmyung.kr)
- Minjae Kim (kmj5596@khu.ac.kr)
- Jeongwon Moon (bella7365@knu.ac.kr)
- Woojin Choi (twinsno119@sunmoon.ac.kr)

Summary
We continued our research by reading related papers and thinking about LoRa communication logic. There were three candidate system models in written last week's report. The team consulted with Dr. Smith to choose a final model of the report.

What SharpShooter completed this week:

- Reviewed some papers related to this research
  This research is related to networking and AI, so the team researched papers about LoRa networking, gunshot sounds, and computer vision. LoRa's main disadvantage is a low data rate, so the current plan is to divide and compress the photo to transmit faster [1]. Then, we will calculate the differences in pixel values when the photo is transmitted by LoRa before and after the shooting to predict the coordinates of where someone shot the gun [2].
  Another way to overcome the data rate limitation is calculating the location and transmitting the coordinates directly.

- Decided the topic of the paper
  Outdoor Long-Range Bullet Mark Detecting System with Low Latency Using LoRa and Computer Vision.

- Thought about new system architecture

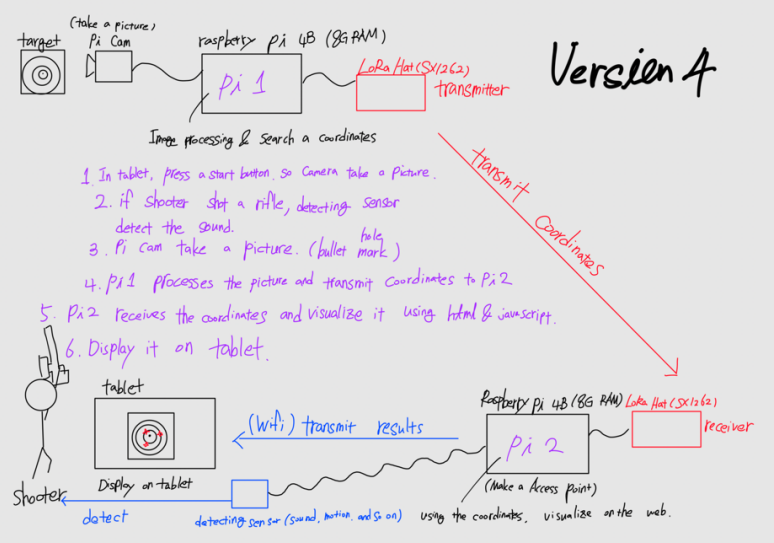

Fig. 1. New version of this research architecture

The new version of this research architecture calculates the coordinates of a shooting point using a Raspberry Pi 4B, then transmitting the coordinates to a LoRa receiver over a point-to-point link. This communication plays a significant role in this research.

- Thought about LoRa communication logic
  This research has three novelties compared to the previous team's objectives, including its use of Shotmarker, outdoor testing over a long range, and accommodating various bullet speeds.
  The previous research team had difficulties with the accuracy of their method in outdoor tests.
  This research should aim to control packet loss when receiver get packets. If there is any packet loss, transmitter should send the packet again that is lost during transmission. [2]

Things to do by next week

- Correct the abstract and introduction of the paper
- Implement the computer vision model such as YOLOv6 or Faster-RCNN [3]
- Collect the gunshot sound dataset [4]

Problems or challenges:

- Challenge about image transmission speed with LoRa
- Whether to use a thermal imaging camera instead of acoustic sensor [5]
- Aligning the height of the LoRa transmitter and LoRa receiver

References

[1] A. Jebril, A. Sali, A. Ismail, and M. Rasid, "Overcoming Limitations of LoRa Physical Layer in Image Transmission," *Sensors*, vol. 18, no. 10, p.3257, Sep. 2018, doi: 10.3390/s18103257.
[2] T. Chen, D. Eager, and D. Makaroff, "Efficient image transmission using lora technology in agricultural monitoring iot systems," in *2019 International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData)*, 2019, pp. 937–944.
[3] D. Fengtong, Y. Zhou, W. Chen and L. Yang. "Bullet hole detection using series Faster-RCNN and video analysis," *International Conference on Machine Vision, Munich, Germany* 2019, p.110410Q
[4] S. Tangkawanit, C. Pinthong, and S. Kanprachar, "Development of gunfire sound classification system with a smartphone using ann," in *2018 International Conference on Digital Arts, Media and Technology (ICDAMT)*, 2018, pp. 168–172, doi: 10.1109/ICDAMT.2018.8376517.
[5] X. Cao, G. Chen, Y. Zhao, W. Ren and J. Cao, "Design and Implementation of a Real-time Target Detection and Tracking System," *2022 24th International Conference on Advanced Communication Technology (ICACT)* , 2022, pp. 539-543, doi: 10.23919/ICACT53585.2022.9728813.