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Radio Frequency-Based Classification of Unmanned Aerial Vehicle Using Convolution Neural Network

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***Abstract*—As the number of Unmanned Aerial Vehicle (UAV) abuse cases are increasing, it is necessary to create a system that can detect and identify UAVs for safety. This paper proposes a method to classify UAVs based on radio frequency (RF) signals by transforming the time series RF signals to images and then classifying them using Convolution Neural Network.**

Keywords—Convolution Neural Network, Radio Frequency, Signal Classification, Unmanned Aerial Vehicle.

I. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), including drones, are being used for a variety of purposes, such as military, agriculture, and communication [1]. Drones with high potential application value do not have only positive applications for the world. Specifically, drones can be used for spying and terrorism and pose a potential threat. Thus, detecting and identifying these drones is the most important first step in a system of protection from drones. Many researches already have been done to detect and identify drones. Among them, there are some methods of identifying UAVs such as the radar-based approach using the Doppler effect, the audio-based method using an acoustic sensor, the video-based method using an optical sensor, and the radio frequency-based method [2].

However, each method has several drawbacks. For example, the method using audio and video has a disadvantage that the identification distance is limited, and in the case of radar, the micro-UAV with a low radar cross-section is not identified. The radio frequency-based search method has the challenge of discriminating the frequency of a specific target from several surrounding frequencies.

To solve this problem, in this paper, the radio control signal of a drone with a frequency bandwidth of 2.4 GHz and a Bluetooth signal with the same frequency bandwidth are transformed to images. After that, we classify them using Convolution Neural Network (CNN), one of the deep learning techniques.

II. METHODOLOGY

When converting time series RF data into spectrogram images, it is necessary to divide it to the necessary and unnecessary information. In other words, when reaching a steady state through a transient state from the noise section, the noise section becomes unnecessary information. The classification accuracy decreases when the length of the noise sections sometimes gets into the image as unnecessary information. So, in this paper, to remove this noise section, the start point of the transient state is detected. Next, we remove all data from the first data point to the transient state data point.

After getting the new data, it is converted into a spectrogram image using Short Time Fourier Transform instead of a meaningful general 2D plot image. Fig 1 is the spectrogram image. Frequency information can be analyzed at the same time while preserving the time axis data.

To classify RF signals of Bluetooth and drone, we construct a CNN model and use spectrogram images as the training dataset and the test dataset.

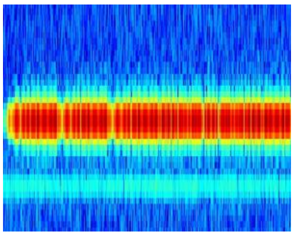

Fig. 1.Spectrogram Image

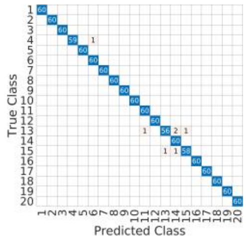

Fig. 2. Confusion Matrix

III. RESULT AND FUTURE WORKS

As shown in Fig 2, the final test accuracy of our CNN model was 99.42%. We will verify whether the proposed method is effective in situations exposed to noise by adding random noise to digital signals as well as adding signal classes of the same bandwidth in the future.

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