

Shout COOEE!

SP Cup Bonus Task Submission

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I. INTRODUCTION

This paper details how *Shout COOEE!* mounted a microphone array to the underside of a drone in order to collect audio recordings to submit for the 2019 IEEE Signal Processing Cup: Search and Rescue with Drone-Embedded Sound Source Localisation. Both static and dynamic data with and without a sound source were collected. However, for the purposes of the competition, only the static .wav files without a sound source were submitted.

A. Component List

- NI 9171 cDAQ [1]
- NI 9220 16-Channel C Series Voltage Input Module [2]
- NI 9923 Front Mount Screw Terminal Block for 37-Pin D-SUB Modules [3]
- 2x2x2 Microphone Array (uses 8 Freetronics Microphone Sound Input Module[4])
- 3D Printed Microphone Array-Holder
- Intel Aero Ready-To-Fly Drone [5]
- PX4 Software [6]
- MATLAB w/ Data Acquisition Toolbox and Robotic Systems Toolbox
- Flex 13 OptiTrack Motion Capture System [7]
- Speaker
- Mini-USB to 6-pin serial Port Adaptor Breakout Board [8]
- Mini-USB to USB Adaptor Cable
- Micro-B USB 3.0 OTG Cable [9]

II. EXPERIMENTAL SETUP

The drone was flown inside of an automated systems laboratory. The laboratory was fitted with curtains around its perimeter in order to minimise sound reverberations during the experiment, as shown in Figure 1. A Flex 13 OptiTrack motion-capture system was also installed around the perimeter of the room in order to track the drone's position in real time. The eight motion-capture cameras positioned on rails around the top of the room tracked the drone via the motion-capture markers placed on top of the drone. The system is capable

of six degree-of-freedom object-tracking to sub-millimetre accuracy. This tracking data was used to obtain ground truths against which our DOA estimation algorithm could be tested.



Fig. 1. Laboratory room set-up

The microphone array (Figure 2) was secured to the underside of the drone.

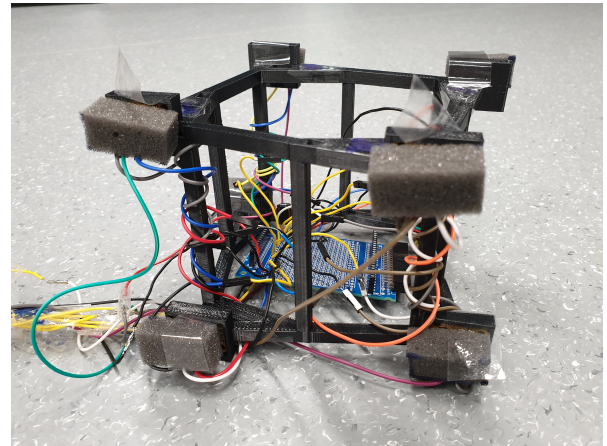


Fig. 2. The 3D-printed microphone array holder and microphones

The microphone array was 3D printed using the UNSW School of EE&T's 3D printer and its design was based off of the array geometry provided to the team in micPos.txt [10]. The schematic used to print the array is shown below in Figure 3.

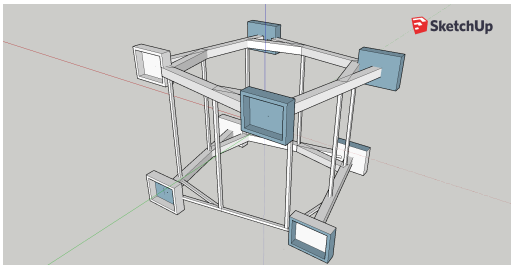


Fig. 3. Schematic for the microphone array

The array was powered via a Mini-USB to 6-pin serial port breakout board (pictured in Figure 4).

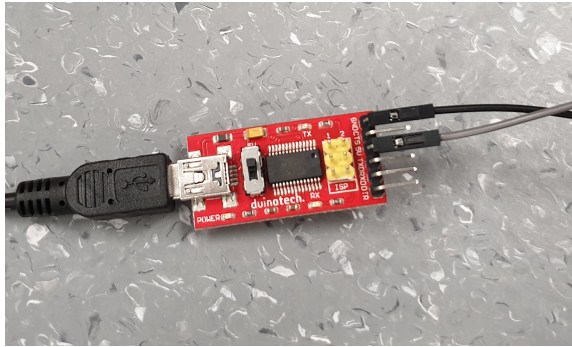


Fig. 4. Mini-USB to 6-pin serial Port Adaptor Breakout Board. The left-hand side is connected to a Mini-USB to USB adaptor cable, the right hand side has the VCC and GND cables connected to the rails supplying the microphones

The breakout board was connected via a Mini-USB to USB cable to a Micro-B USB 3.0 OTG cable connected to the drone. In other words, the microphone array was powered via the drone's portable power supply, as pictured in Figure 5.



Fig. 5. Side-view of the drone/array set-up. The white cable is the Micro-B USB 3.0 OTG cable and connects the drone's power supply to a PCB, pictured at the bottom of the array, which serves as the power rails for the microphones

The microphone array outputs were connected via wires to the NI 9923 Terminal Block. This was connected to the NI 9220 Input Module that was in turn connected to the NI 9171 cDAQ. This configuration is shown below in Figure 6.

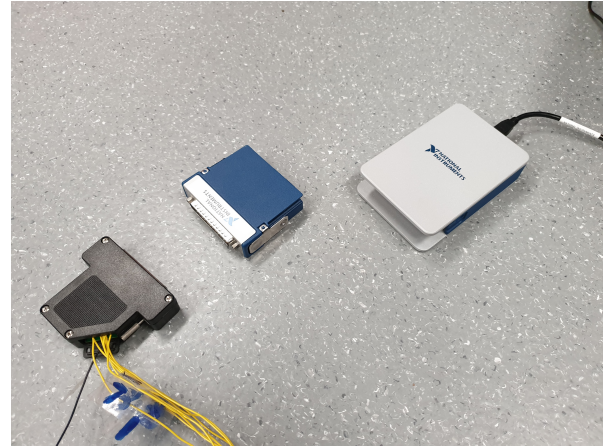


Fig. 6. ADC set-up using the NI 9171, NI 9220 and NI 9923

The NI 9171 cDAQ was connected via a USB cable to a laptop running MATLAB. The MATLAB script used the Data Acquisition Toolbox Add-On to collect the 8-channel recording of the microphone array. These recordings were then normalised and combined into a .wav file using the 'audiowrite' function. The laptop was also connected to the speaker (see Figure 7, which was used as a speech source when recording dynamic flight data.



Fig. 7. Speaker / Laptop Set-Up

III. EXPERIMENTAL PROCEDURE

Two types of experiments, static and dynamic, were conducted to record audio data for the 2019 IEEE Signal Processing Cup.

In the static experiment, the drone hovered in a fixed position with no speech source present. The objective of this experiment was to collect data allowing the drone's ego noise properties to be analysed. The drone was positioned on top of a cushion (to provide a soft landing if we lost control of the drone, as the microphone array was located at the bottom of the drone and would thus take the brunt of the

force if the drone crash-landed). The drone's motors were then armed, the MATLAB recording script started and the PX4/OptiTrack Motion-Capture system set to record. Once all the recording software had started, the drone (manually-piloted) took off and hovered for approximately 90 seconds before landing. The 8 microphone recordings were combined in a .wav file and cropped to remove the audio recorded while the drone was not in flight. The static data we collected are labelled 'SPCUP19_Shout COOEE_StaticSubmission1.wav' and 'SPCUP19_Shout COOEE_StaticSubmission2.wav' and is included in the team submission. Both files were sampled at 44.1kHz, in accordance with the audio files provided to us by the competition organisers. Summary statistics of both audio submission files are shown below.

	Take-off	Landing	Length
StaticSubmission1	0-7s	1m13s-1m19s	1m19s
StaticSubmission2	0-7s	1m19s-1m25s	1m25s

In the dynamic experiment, audio was recorded in the presence of a speech source while the drone performed in-flight manoeuvres. The objective of this experiment was to produce a data set of dynamic, in-flight recordings with which our DOA estimation algorithm could be tested. Again, the drone was positioned on top of a cushion to minimise any potential damage to the drone array. Before the drone took off, the motors were armed, the recording software was executed but this time, the speaker was used as a sound source of human speech. Once the drone had successfully taken off, the drone pilot performed typical manoeuvres that would be expected during realistic drone flight. These manoeuvres included dives, dips, rotations, turns, altitude changes, etc. Multiple recordings and flights were performed in order to compile a comprehensive data-set which covers a broad range of realistic flight scenarios. In addition to the audio recording from the microphones and the position tracking of the drone, a video was recorded during the experiment for visual confirmation of the drone's position in relation to the speaker.

The dynamic data was not submitted as a sound source (the speakers) was used during the recordings, which is contrary to the SP 2019 Cup Syllabus, which states that the recordings 'should not feature other sound sources than the UAVs noise or wind'. However, a ground truth file (named '2019-02-04-15-53-42.bag') and the MATLAB script used (named 'extract_pos.m') to extract the DOA angles from the file are included in the Bonus Task submission for viewing if interested. The 3D position of the drone was tracked by the motion-capture system throughout the flight whereas the position of the speaker was obtained prior to the flight, using the same system. Additionally, a video of a dynamic data flight was also included too (named 'Dynamic_Flight_Video.mp4'). A 'readme.txt' file is included to describe the purpose of each file in the Bonus Task submission.

IV. BIBLIOGRAPHY

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