FEASIBILITY OF PIEZOELECTRIC VIBRATION ENERGY HARVESTER POWERED WIRELESS TRACKING OF FALCONS

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INTRODUCTION

- There are 25,000 falconers in the UK alone and an estimated 10,000 radio tracking devices used for falconry [1].
- The greatest limitation with devices is the short battery life of the radio and GPS transmitters.
- The purpose of this study is to assess the feasibility of using piezoelectric generators to harness the motional energy of birds in flight.
- This will help to both extend the battery life and provide a secondary power source after the primary battery has depleted.

DESIGN

- A prototype has been developed that consists of a piezoelectric transducer integrated with a power conditioning IC and super-capacitor.
- The system is designed to retrofit onto existing tail mounts and spring clips.
- Prototype had to be comfortable and aerodynamic while in use so weight an size had to not exceed that of transmitter.

Figure 1. PPA-1022 PZT transducer [2]

PROCESS AND PROTOTYPE

- Simulating the conditions calculated from video captured of the falcon wearing the transmitter while flying.

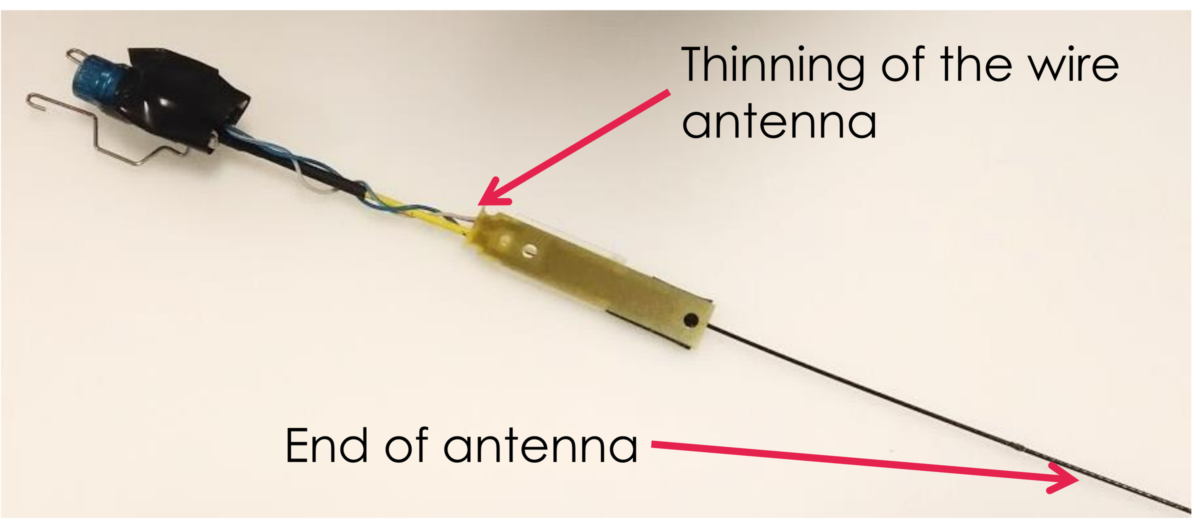

Figure 2. Prototype and transmitter

- Optimal positioning of the piezoelectric transducer was found to be where the covering of the steel antenna became much wider
- Prototype added 3 g extra weight to the transmitter for a total of 10 g.

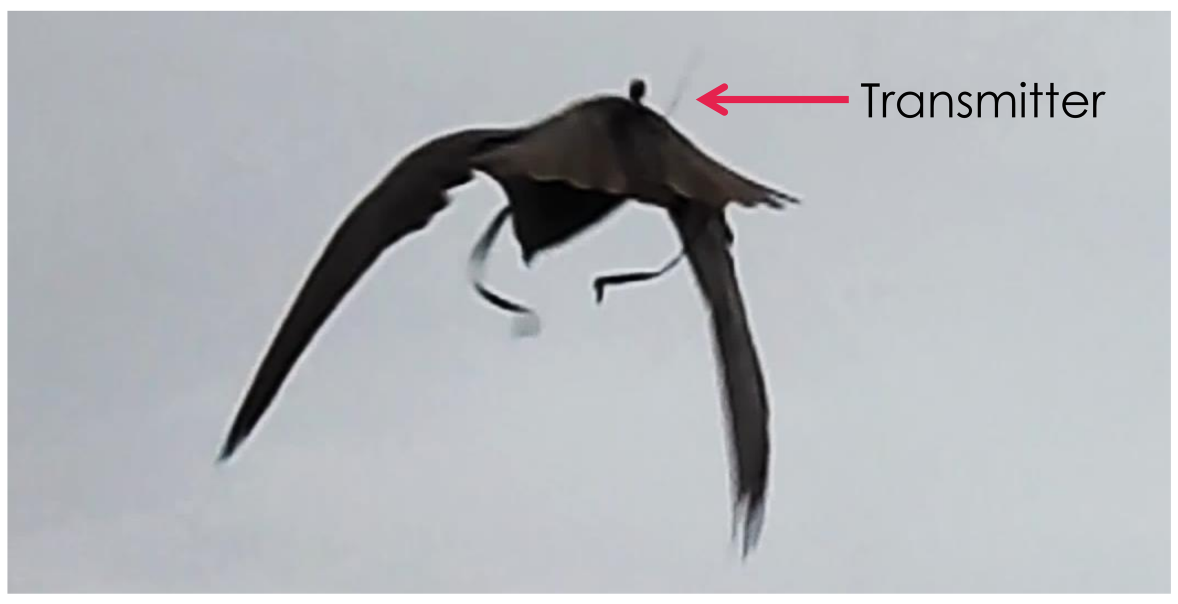

Figure 3. Video image showing movement of transmitter and post-processing to determine tail motional dynamics during flight

Figure 4. Prototype in place on Gyr falcon

- The prototype has been tested by mounting onto the deck feather of the falcon's tail.
- The generated electrical energy stored in a super-capacitor is shown in table 1.

Figure 5. Buck the Gyr Falcon during a show [3]

RESULTS

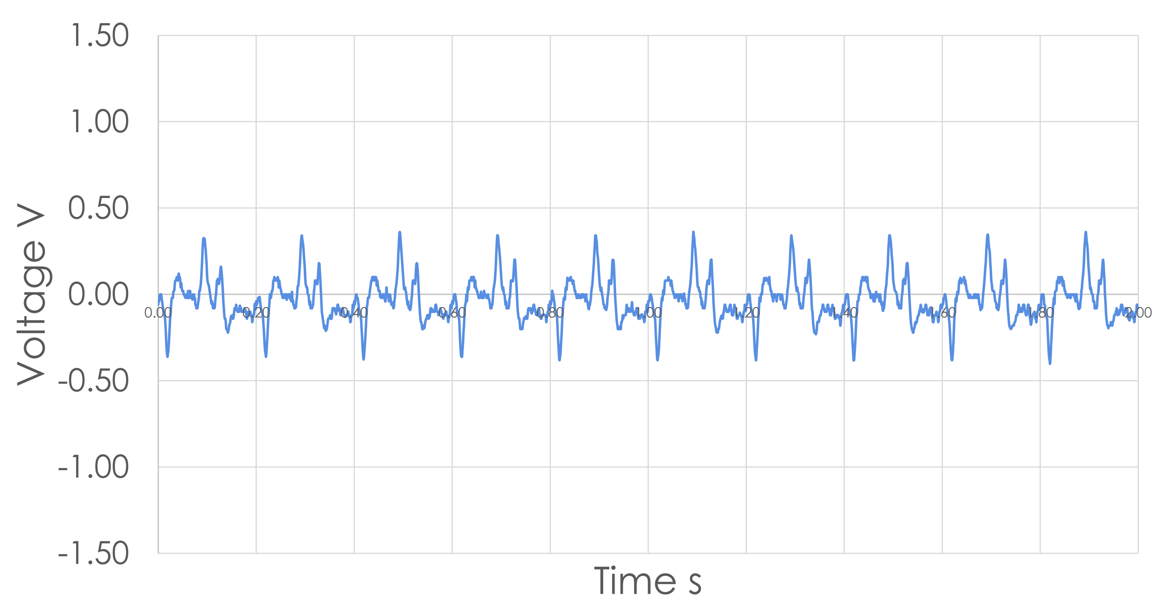

Figure 6. PVDF transducer [4] voltage produced when placed at the end of antenna.

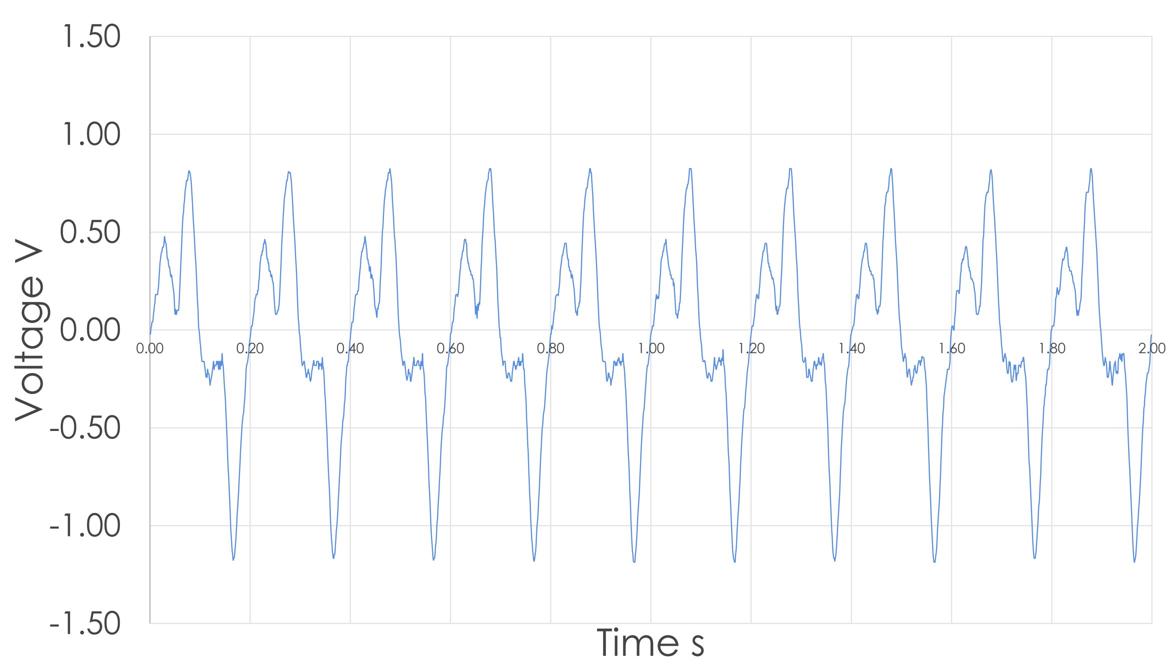

Figure 7. PVDF transducer voltage produced when placed at thinning of wire antenna.

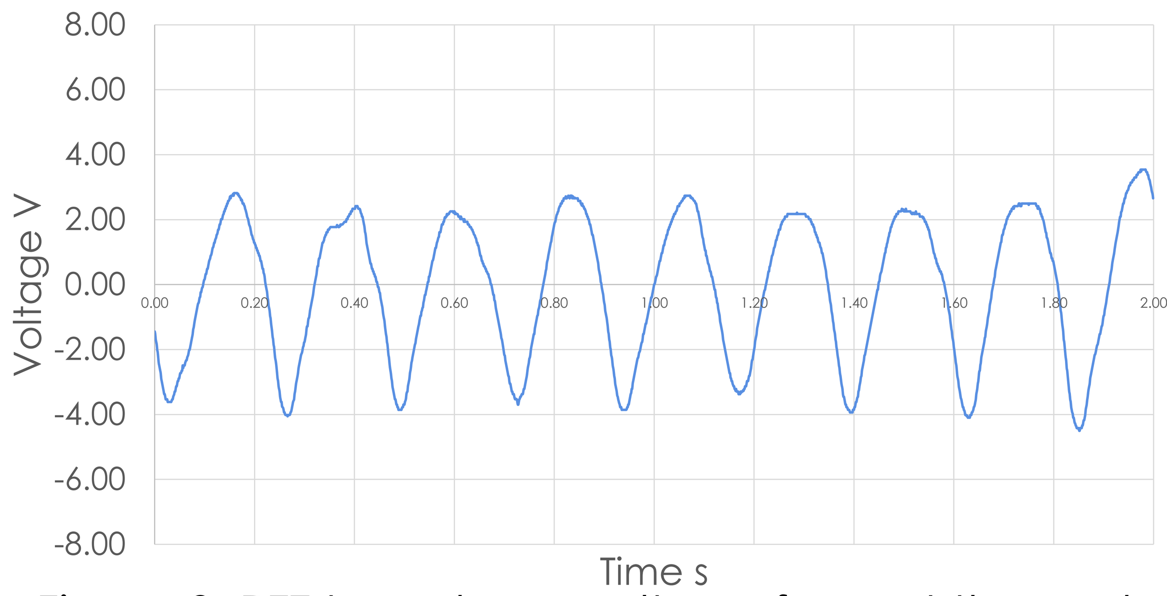

Figure 8. PZT transducer voltage from at the end of antenna

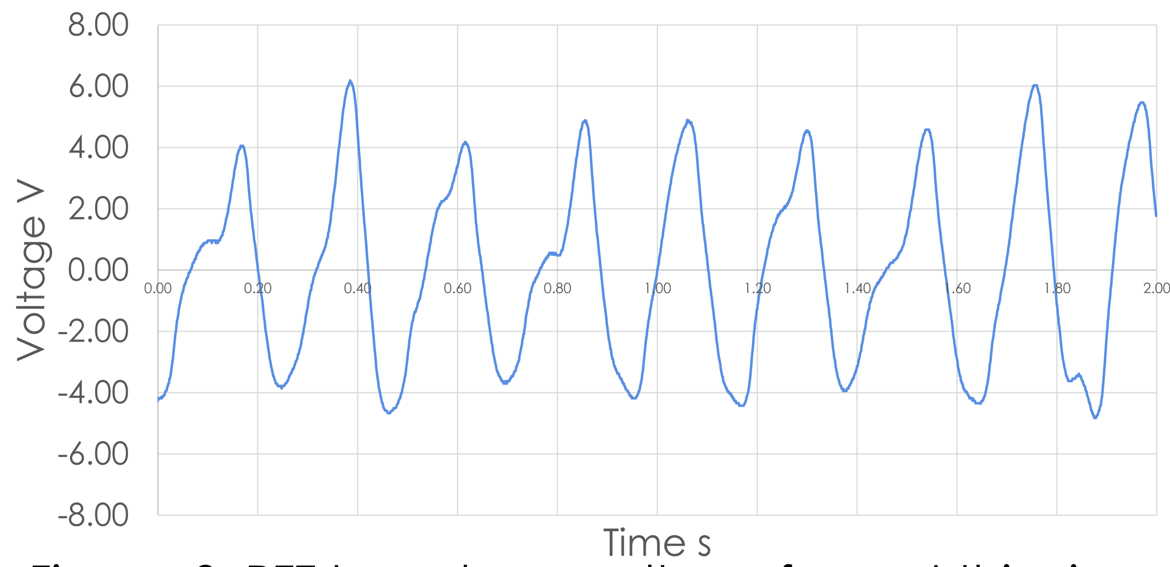

Figure 9. PZT transducer voltage from at thinning of antenna

Table 1. Field trial results from testing PZT transducer on Gyr flacon for 5 minutes of flight

	Starting cap. voltage (V)	After flight voltage (V)	Energy stored (J)
Test 1	0.005	0.057	6.67e-6
Test 2	1.223	1.302	1.56e-5
Test 3	1.230	1.344	3.25e-5

- Test 1 was carried out on an overcast day where the Gyr falcon flew around chasing pigeons.
- Test 2 was carried out on a sunny day where the Gyr was distracted by a wild peregrine falcon trying to take his territory.
- Test 3 was carried out on a sunny and warm winded day where the Gyr flew further from the falconer.

CONCLUSION

- Theoretical feasibility study for a design specification of 2.7 cm^3 and 8 grams predict that it is possible to attain up to 0.28 mW.
- Falcon tail dynamics during flight has been analysed and various energy points identified.
- Successful field trial has been conducted.
- Future work entails longer flight recordings.

REFERENCES

[1]"House of Commons - Environment Audit Committee: Written evidence submitted by the Hawk Board", *Publications.parliament.uk*, 2017. [Online] https://www.publications.parliament.uk/pa/cm201213/cmselect/cmenvaud/140/140vw06.htm.

[2] P. PPA-1022, "Piezo Product: PPA-1022", *Mide Technology*, 2017. [Online] www.mide.com/products/piezo-product-ppa-1022.

[3]"Falconry & nature gardens". [Online] https://chestercathedral.com/falconry-nature-gardens/.

[4]"FS-2513P PROWAVE, film sensor, piezoelectric, 80Hz", 2016. [Online] http://uk.farnell.com/prowave/fs-2513p/sensor-piezo-film/dp/1007374.

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