

# The Technology Revolution and Budo : Drones, Virtual Reality, and the Future of Judo

○Takeru SATO<sup>1</sup>, Takayuki YOKOYAMA<sup>2</sup>, Keisuke MIYAKE<sup>3</sup>, Tatsuya INADA<sup>4</sup>

1 Faculty of Education, Kogakkan University      2 Sports Development Center, Setsunan University

3 School of Health and Sport Sciences, Chukyo University      4 Graduate student, Graduate School of Faculty of Education, Kogakkan University

## Introduction

The term “multicopter” is a broad one encompassing “drone,” but in this paper both will be referred to collectively as “drones.” Due to the rapid pace of development in recent years, drones have been in the spotlight as a technology with applications in various fields. Today’s Information and Communication Technology (ICT) environment is experiencing dramatic changes in adapting to current trends. These drone technologies have also begun to be used in the field of sports. Because drones are capable of filming from angles that used to be impossible with conventional tools, in fast-paced sports such as snowboarding and freestyle BMX, unmanned vehicles can film athletes from the sky, and so they are used in various situations, with further developments expected in the future. Recently, drones have been developed to such a level that athletes can communicate interactively with them, and the drones are capable of automatically taking off or landing. Drones can track athletes automatically, keeping them in the frame owing to the evolution of gyro-stabilization technology. As a judo coach, I am especially interested in the possibilities that drones have for my sport. Recently, in judo competitions, a new system with a single referee has been implemented. A single chief referee is in the contest area supported by two assistant referees outside of it. These assistants help the chief referee to make decisions by either monitoring the competition directly or by inspecting footage of the competition shot by two separate fixed digital video cameras. According to Hironori Hayashi, a researcher at Biwako Seikei Sport College, when evaluating a throw, differences in the viewing angles or levels of referees could produce different evaluations. This finding indicates that there are limitations in evaluations made from fixed angles, and if we consider the smooth progression of the competition and appropriate evaluations of techniques during a judo match, the necessity of capturing images with highly mobile cameras from more perspectives becomes clear. Because the aforementioned drone technology can track an athlete automatically and allow referees to monitor the competition from any line of sight, it is possible to judge a competition from more angles. However, until now, there have been no studies on the feasibility of using drone technology to film judo competitions.

## Purpose

The present study aims to clarify the current status of drone technology in order to explore possibilities for using drones that can film matches from more angles during judo competitions.

## Methods

The drone used in the present study was a DJI Mavic Pro, which is a leading-edge drone system equipped with a highly sophisticated compact flying camera. The actual flight time of this drone was measured both when it was hovering and automatically tracking a target (a pedestrian in the present study). The measurement was conducted until the battery was discharged to 30% (BL = 30%) and 20% (BL = 20%) in order to preserve enough power to return safely to the base station. The wind speed and noise level generated by the Mavic Pro in an environment

similar to the ones found at judo competition were also measured. The wind speed was measured at 90 cm above the floor with a Floureon GM816 digital wind meter when the Mavic Pro was flying (at 4m, 3m, and 2m) above the floor; the average wind speed was obtained for each flight level. The noise level was measured at 130 cm above the floor using the Small Sound Level Meter (Sanwa Supply, Inc.) when the Mavic Pro was flying (at 4m, 3m, and 2m) above the floor; the maximum noise level (in dB) was obtained for each flight level (Fig. 1). In order to provide a point of reference for the wind velocity and sound levels, the amounts during a judo competition at a high school were measured.

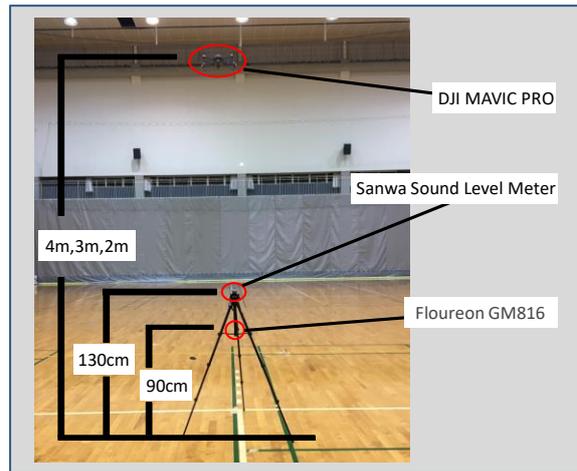


Fig. 1 Measurement of sound level and wind speed

## Results

The actual flight times when the Mavic Pro was hovering were 18 m 20 s (until BL = 30 %) and 21 m 10 s (until BL = 20 %). When it was auto-tracking a target, the flight times were 17 m 27 s (until BL = 30 %) and 19 m 56 s (until BL = 20 %). The (average) wind speed and (maximum) noise level of the Mavic Pro when it was flying at 4, 3, and 2m above the floor were 2.2 m/s and 77.6 dB, 3.3 m/s and 79.3 dB, and 3.9 m/s and 83.2 dB, respectively. For judo competitions, when we look at the sound level of an ordinary high school competition space, the highest values measured were: 83.7 dB for the first measurement, 96.4 dB for the second one, and 81.0 dB for the third one. Also, the lowest sound levels recorded were: 59.6 dB for the first measurement, 60.7 dB for the second one, and 61.4 dB for the third one. In measurements of wind velocity, no wind was found (Table 1).

Table 1 Environment data in arena

Drone used in empty arena				Actual competition at high school judo tournament (no drones)			
Hovering altitude (m)	Noise level (dB)		Wind speed (m/s)	Number of times	Noise level (dB)		Wind speed (m/s)
	Maximum value	Minimum value	Average		Maximum value	Minimum value	Average
2.0	83.2	70.3	3.9	First time	83.7	59.6	0.0
3.0	79.3	65.7	3.3	Second time	96.4	60.7	0.0
4.0	77.6	62.3	2.2	Third time	81.0	61.4	0.0

\*Values measured for 1 minute

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## Conclusions

When we compare the highest measurements obtained for sound levels, the first and second measurement for a high school competition space was clearly found to be higher than measurements taken while the drone was in use. However, for the lowest measurements, the sound level measured in a high school competition space for judo was lower than the one found when using the drone. We can conclude from this that when there is a great deal of excitement at a judo competition, the noise will be at a greater level than that produced by the drone. Whenever a drone is used, it produces some wind, and in a judo competition space, where there is normally no wind, we have to expect the production of intermittent wind. Although my research suggests the levels are so low that there would be no significant impact on competition, further research on these needs to be done.

- 1) Hironori Hayashi, Hiroataka Okada, Katsuyuki Masuchi, Yoshihisa Ishikawa, Takanori Ishii, Michito Sakamoto and Koji Komata: Study of factors affecting different opinions expressed by Judo referees and judges regarding throwing techniques, Japan Society of Physical Education, Health and Sport Sciences, 55(2), 363-378, 2010.