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A Set of Smart Ring Gestures for Drone Control

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***Abstract*—We present in this paper the results of a frequency analysis of gesture commands frequently employed for human-drone interaction in the scientific literature, and we propose a set of gestures for controlling drones that can be performed with smart rings. Our method consists in the analysis of thirty-seven articles, which we examined closely to extract commands for human-drone interaction, including voice, gesture, and multi-modal input. Based on our meta-analysis, we present a set of six groups of commands for human-drone interaction together with a set of smart ring gestures to interact with and control drones. Our results can be used to inform the design of new interactive applications for controlling smart-ring drones.**

Keywords*—*user; human; drone; uav; interaction; control

I. INTRODUCTION

Application with drones can improve the quality of life of the people that interact with these devices. The great advantage drones present is their ability to fly and implicitly move quickly from one location to another without human supervision. Therefore, we find applications in all domains with drones, such as intelligent transportation [1], live construction inspection [2], security [3], etc. Enriching the users' experiences regarding personal drones has a great effect on multiple domains, in which we find haptic feedback in Virtual Reality [4], Mixed Reality [5], taking selfies [6], etc. Therefore, motivated by the desire to integrate drones into public space and interact with them using devices other than conventional ones with which drones come in basic equipment e.g., a controller, we propose a set of gestures using smart ringsfor the most common commands in the literature that aim to control the drone in order to extend to new applications that include these wearable devices.

We believe that our inventory will be useful to researchers and practitioners interested in the gestural commands that are most commonly used to interact with the drone and our proposed set of smart ring gestures designed to execute these commands. Even with small drones such as Parrot Mambo FPV, illustrated in Figure 1, and with Smart Rings ZERO, applications can be created to enrich the dictionary of gestures proposed by us in order to make the perfect photo [7] or new applications of human-drone interaction.

Fig. 1. Parrot Mambo Fly personal drone and Smart Ring ZERO

II. RELATED WORK

A wide variety of applications include human-drone interaction. These include: entertainment applications [8], [9], hands-free [10], emergency situation [11], search and rescue missions [12]. These applications recognize gesture commands [8], [9], [11], [12], voice commands [10], [13], [14], and even multimodal interactions [10], [15], [16], [17], [18]. User feedback is provided in different ways, such as visual [19], [20], haptic [4], [21], or with the help of a controller [22]. All these applications are intended to shape new ways of interacting with drones, such as using voice commands [13], multimodal interactions [15], or receiving feedback from the drone through different modes e.g., visual [20]. Therefore, this multitude of applications offer, in turn, a multitude of gestural commands that we have extracted and grouped to propose new ways to interact with drones usingsmart rings.

A. Interaction modalities with Drone and Users in Studies

As the popularity of drones has grown, drones have become more and more present in our lives, being integrated into many applications. For example, photo/video [11], [19], user security [15], [23], etc. Therefore, drones have led to new applications and implicitly to new ways of interaction. From the analysis of the 37 papers, we extracted all the interaction ways presented in each scientific paper. In the third chapter, we explain the methodology for identifying and selecting articles. Our results show that 81% of the interactions were gestural, 38% were multimodal, 27% used voice, 14% used a BCI/EEG headset, and 8% used mobile devices. For example, MohaimenianPour *et al.* [9] use a BCI/EEG neural headset for real-time detection of facial gestures to improve human- robot interaction. Brock *et al.* [17] propose an interactive map for drone users to open the space for more direct interactionswith drones. The analysis of the thirty-seven papers continued users' perspectives in the studies; 46% of the papers did not report any participants in the study, even if they discussed a certain way of interaction. A total of 473 participants were reported. The maximum number of participants was 110 in the work of Peshkova *et al.* [14], in which he made a participatorydesign of the most intuitive ways to control a drone. A single participant was reported in the work of Higuchi *et al.* [24], who developed a system that directly connects body movementwith drone movements.

B. Type of Scientific Contributions for Drone Applications

The thirty-seven scientific papers were divided into the following categories: (1) empirical research, (2) artifact, (3) methodological, (4) theoretical, (5) data-set, (6) survey, and (7) opinion, according to Wobbrock *et al.* [25] classification. The greatest scientific contribution was of the type of empirical research found in 95% of the articles. Following the artifact, which was present in 16% of the articles, we found the design of a controller [26] and eye gaze tracking systems [19]. We classified 11% of the works as theoretical publications. The rest of the contributions were less representative. For example,we found the work of Lee *et al.* [27], which presents a new human gesture prediction framework using computer vision forthe human-drone interaction where the set presents the date. This category represents 8% of the total number of worksthat complete the list of works [9], [28]. A single paper [29] has been classified as a survey proposing a graphical interface designed and centered on the human body for drone interac- tions. No paper has published a methodology or an opinion on human-drone interaction in our analysis.

III. A SET OF SMART RING GESTURES FOR DRONE CCONTROL

A. Methodology

We surveyed the specialty literature to identify all com- mands whose purpose is human-drone interaction. We searched for the most popular international databases of sci- entific articles, ACM DL[1], IEEE Xplore[2], and SpringerLink[3],

TABLE 1. DICTIONARY GESURES DRONE ASSOSASION WITH SMART RING

Commands		Count[1]	One Ring Gestures		Two Rings Gestures		Description commands
			First association	*Second association*	*First association*	*Second association*	
C1	**forward**	**13**	Circle clockwise	Flick to the right	Circle clockwise	Touch both rings simultaneously	The hands move away from the body
	backward	**9**	Circle counter-clockwise	Circle counter-clockwise	Circle counter-clockwise	Flick to the right using both hands	The hands approach the body
C2	**right**	**13**	Flick to the right	Clap once	Flick to the left	Use the hands as a hands fan	Hand moves to the right
	left	**11**	Flick to the left	Swipe on the ring upwards	Flick to the right	Raise hand and touch the ring	Hand moves to the left
C3	**up**	**9**	Raise hand and touch the ring	Touch the ring once	Touch both rings simultaneously	Flick upwards	Extends right hand
	down	**9**	Touch the ring once and flick to the left	Circle clockwise	Spread palms horizontally	Flick downwards	Extends left hands
C4	**fly higher**	**6**	Clap once	Raise hand and touch the ring	Clap once	Flick downwards using both hands	The right hand rises next to the body
	fly lower	**6**	Touch the ring once	Press imaginary button in mid-air	Rub hands	Circle clockwise	The right hand sits next on the body
C5	**turn right**	**4**	Draw letter “S” in mid-air[3]	Touch the ring once and flick to the left	Flick upwards	Clap once	Rotate right hand on the right
	turn left	**4**	“Call me” sign[2]	Press button on an imaginary remote control	Flick downwards	Rub hands	Rotate left hand on the left
C6	**take off**	**13**	Press button on an imaginary remote control	“Call me” sign[2]	Bring both hands in front and towards the body	Press several imaginary buttons in mid-air	Index finger moves upwards
	land	**9**	Press imaginary button in mid-air	Draw letter “S” in mid-air[3]	Press several imaginary buttons in mid-air	Bring both hands in front and towards the body	The two hands from a rectangle

[1]Total number of gesture commands form specialty literature.
“[2]*Thumb placed near the ear, little finger pointed at the mouth;* [3]*Letter “S” stands for “Security.*”, Gheran *et al*. [45].

[1]https://dl.acm.org/
[2]https://ieeexplore.ieee.org/Xplore/home.jsp
[3]https://link.springer.com/

using:

```
"query": {
   Abstract: ((user OR human) AND
   (drone OR UAV) AND (Interaction
   OR Control))
}
"filter": {NOT VirtualContent: true}
```

Following the query of the three databases, we analyzed from the title and abstract the articles that would be of interest to us. We saved 105 papers published between 2002 and 2021 that target the human-drone interaction from this analysis. The 37 papers that we analyze in detail present commands for interaction with drones. Therefore, the discussion was limited to articles showing the gestural human-drone interaction. The total number of commands extracted from the thirty-seven articles was 341. Investigating the articles, extracting orders, and proposing gestures with smart rings is the major contribution of this paper.

B. Results

We grouped the commands most frequently encountered in the specialty literature whose purpose is the interaction between human and drone in six categories; see Table 1.

C_1: - *'forward/backward'*, the drone moves forward or back [6], [8], [11], [14], [29], [30], [31], [32], [33], [34], [35], [5], [24], [14].

C_2: - *'right/left'*, drone moves left or right [8], [23], [11], [14], [29], [30], [31], [32], [33], [34], [35], [5], [24], [14], [14].

C_3: - *'up/down'*, raises or lowers the altitude of the drone [32], [33], [34], [12], [24], [14], [28], [22], [36], [37].

C_4: - *'fly higher/fly lower'*, the drone raises/decreases altitude but moves forward/back [13], [15], [16], [38], [39], [14].

C_5: - *'turn right/turn left'*, drone spins around its axis to right or left [8], [40], [22], [37].

C_6: - *'take off/land'* includes the launch of the drone for flight [8], [13], [15], [16], [27], [30], [31], [32], [41], [14], [42], [37].

Table 1 shows the commands most frequently met identified in our survey (thirty-seven articles out of one hundred and five) grouped into six categories, followed by two gesture proposals using a single smart ring, and two gesture proposals that are made with two smart rings, and the last column describes the gesture. The results of our study show that the distribution of commands in terms of frequency is uneven. For example, in categories *C1*, *C2*, and *C6* we find the most frequent commands in the literature: forward, right, and take off. We notice that the categories *C1*, *C3*, *C5*, and C6 present the most uniform distribution of commands so far, followed by *C4* with the least used gesture commands. Note that the other commands were also present in the literature e.g., 'fly-where-you-look' [19], 'precise location' [15], 'speed and hover' [20], [43], 'continue and take a picture' [12], [9], but we have focused on the most common. Therefore, for each category, we proposed four gestures using smart rings. Two gestures with a single ring are proposed and the other two with two smart rings. Associating smart-ring gestures with drone commands opens up new ways to interact with smart rings. The four proposals for smart ring gestures for the most common gesture commands in the literature are taken from the work of Gheran *et al.* [44], [45]. In which he presents a detailed study of smart ring gestures. The association of gestures with drone commands is our proposal to researchers to form new applications and interactions that include gestures with smart rings and drones.

IV. Conclusion and Future Work

In this paper we have presented the six categories of gestures that control drones, and for each we have proposed a set of commands using smart rings. Our study covered thirty-seven papers out of one hundred returned by queries to international databases according to the methodology in chapter three. Our work implements an important step in the human-drone interaction using smart rings, but also the effective proposal of the gestures that will be used for the most frequent control commands of the drone. Our study continued with the analysis of the type of article in which the researchers described their work, the type of gestures that were encountered in human-drone interaction, and also the number of study participants. These metrics are useful for extending new smart ring gesture sets. Our next plan is to implement an application to control the Parrot Mambo FPV drone with SDK available for Android[4], and its control with Smart Rings ZERO, present in Figure 1, also using SDK for Android. After the implementation of this application, we want to conduct studies with users in which to propose new gestures with smart rings for the most frequent drone control commands. Continuing these ideas will lead to new gesture input models using smart rings for human-drone interaction.

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