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Personage-Drone interaction using Emotional Encoding

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Abstract

Drones may soon become universal because of its popularity as they are being used in many day-to-day activities. It thus become condemnatory to make use of drone through natural human drone interaction (HDI). Prior works on drone's interaction reveals that adding on emotional concepts is a way to success in accessing the robots more efficiently.

Keywords: Drone ; UAV ; affective computing.

Introduction

Generally drones are unmannered aerial vehicles (UAV) without a human pilot aboard. Personal drones are radio controlled technologies which were used to take pictures or videos by hobbyists and professionals .With the development of technologies, drones have become self-determining and follow a path or a person without any guidance of a pilot. In future, Drones can be implemented in many fields to support human tasks such as travel guidance, military applications, sports field and even in exploring and rescue missions. It has become unfavorable to create natural HDI as there is increase in the use of drones.

For processes such as memory, social interaction, memory logical choices, empathy and in many other support processes, emotions play important role, especially in human interaction.

The emotion encoding in human drone interaction is socially accepted even in domestic environment due to its intelligent interaction and decision making [2]. Drones being flying robots identify the emotions by adding some facial features or pace based on the circumstances. Although they are non anthromorphic they exhibit many physical features in human interaction. These facial features or pace are being used by drone designers to identify different emotional states.

The reflection of the drone to the user command is being returned by adding an emotional state .In case, the drone crosses the control range it has to exhibit a scared emotion .Similarly it would look confused if the command is not understood or when the battery is low it looks tired. Although the drone is controlled by one person it supports multiple user interaction as all can look at the flight path.

In this paper we inspect the three emotional states of the drone based on its movements .It basically explores the drone's movements and flight path to encode emotion [figure 1].

Figure 1: Example of three different flight paths to reflect different emotional states of the drone (Each personality profile is represented by a colour: Adventurer Hero: Red, Anti-Social: Blue, Exhausted: white).

Related works

The drone is used in several scenarios for example it is used to observe things which is out of the person's field of view, delineate accidents from above or even help people when shopping. The flying buddy visualizes several situations where the drone extents human abilities [3].the drone based flying displays proposed by Schenegass is a personal companion

that supports people in emergency situations [4].In order to enable such situations , acceptable collocates interactions should be provided so that it can be mediated (that is using a phone or a remote)[5]or directed (that is using vocal or signals).there are many feedback techniques used for HDI , for example: by adding LEDs to communication direction around a quad copter . These results show that interacting with the flight path was user friendly and user felt safer interacting using this technique for communicating [9].

The Daedalus drone which shows various emotional states was modified based on drone's flight path using Laban effort system by Sharma ETL[12].later four predefined movements :space ,weight ,time &flow was added to the drone .using this four criteria ,participants could differentiate various emotions states . This work shows that humans can differentiate the drone's flight path.

APPEARANCE OF HRI

The combination of verbal and non-verbal human robots provides the needful features towards HRI. It includes non-verbal communication in Hoffman & Ju's process; the non-anthromorphic robots can recognize emotions [15]. Similarly emotions can be revealed through energy, schedule, approach and intensity which were proposed by Novikov and Walts [20].The outcome of these works show that although drones are non-anthromorphic in nature they can detect the emotions by using flight path (i.e. there is no necessity of adding facial features).
Models of emotions in HRI

With reference to [21], six facial expressions can be universally recognized for six different emotions: surprise, anger, disgust, sad, happy and fear. Previous research access facial expressions for the following mental states boredom, confusion, interest, surprise and happiness [22] or fear, happiness, anger, sadness and surprise. The range between arousal and valence is used by researchers to view the emotions and the aspects of emotions. For example Kismets [2] emotions are being mapped among the three values: arousal, valence and stance [2].

Keeping in reference the limitations and other features of drones, we would not use an existing model to apply our work, instead an emotional model space for drones can be defined.

EMOTIONAL MODEL SPACE FOR DRONES:

In this session, the emotional model space for drones is being designed in such a way that the emotions are identified by the user and performed by the drone. This design can be analyzed as:

1. The emotions are been mapped with personality models.
2. The physical characteristics that would best fit the emotion is mapped with the drone movement

a.EMOTION VS PERSONALITY

The personality can be evaluated for a long span of time whereas the state of emotion is immediate .Considering this relationship, first we identify the emotional state, then match the personality that best fits the drones movement ,to constitute thus personality and the emotion is being evaluated by tracking back to the corresponding emotional state.

b.EMOTIONS AND PERSONALITY TRAITS

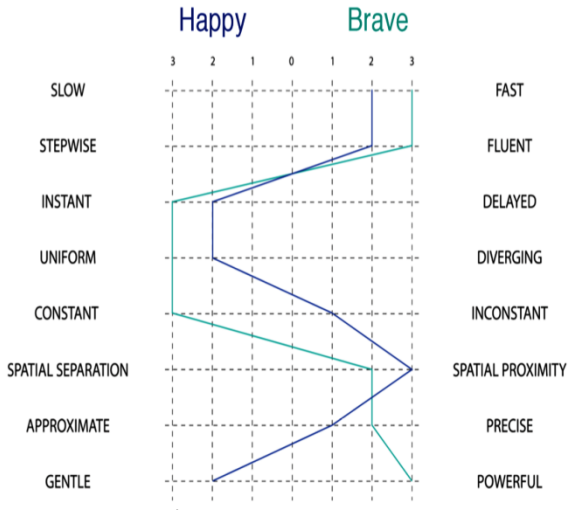
In order to choose the appropriate range of emotions, the characteristics of animals and humans are glanced based on the prior works. We know that users interact with the drones as they interact with humans and animals. Specific personality traits is been used to identify the characteristics of the user .For instance ,the Grimms' Snow-white Tale where the seven dwarfs are the key personalities which is well known across cultures .Similar personalities are found in Peyo's Smurfs.The following are the emotional states : Brave, Dopey, Grumpy, Happy, Sad, Scared, Shy and Sleepy. It is made sure that the aggressive traits are not been implemented .For instance, Anger; if implemented could be dangerous on the drone and environment.

System design

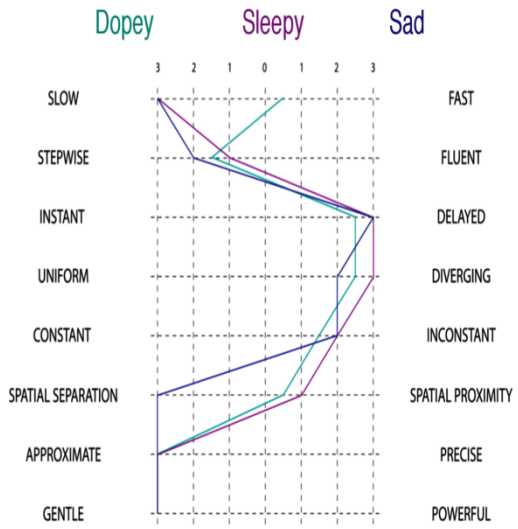
Characteristics of stereotypes of personality and Matching emotions

Personality (Emotional States)	**Characteristics**
The Big Boss(Brave)	Confident and disciplined. Looks directly at a person. Never does backwards; instead turn around and moves forward. Directly executes commands although it may take the charge and do the task its own way.
The Goofy	Slow towards reaction.

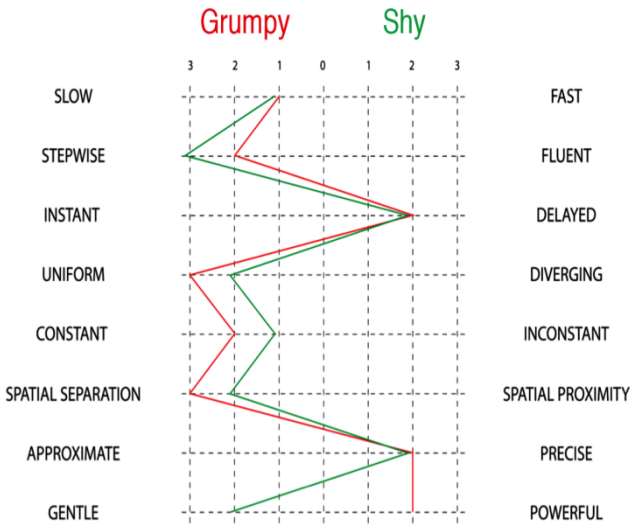
Comedian(Dopey or Sleepy)	Moves sloppily and wobbles. Unpredictable .
The Detached Philosopher(Grumpy)	Introvert. Have to repeat commands. Drags along.
The Lovable Romantic(Happy)	Affectionate(closer to the user). Moves and reacts quickly;creative .
The Peaceful Artist(Sad)	Self-pitying,keeps its distance. Small movements. Flies low to the ground.
The Sneaky Spy(Scared)	Anxious . Nervious,insecure. Scared when called.
The Model Student(Shy)	Takes coaxing for commands. Starts slow with some delay that changes over time.



Adventurer Hero Drone



Exhausted Drone



Anti-Social Drone

Figure 2. interaction profile for each stereotype of personality.

INTERACTION PROFILES FOR EACH STEROTYPE OF PERSONALITIES

In the figure the interaction profiles which was similar was chosen, sorted and merged. In specific Dopey, Sleepy, and Sad together can be put in the Exhausted Drone. Grumpy and Shy Where combined in the antisocial drone and Adventure hero drone was formed by putting together Happy and Brave. Finally we have four different stereotypes of personality models that comprises he emotional model space.

Implementing personality models onto the drone:

In this session, the hardware and implementation of the stereotype of personality is being described.

Here the parameters are associated with the physical properties of the drone and is being modified based on the position of the drone, the speed, angle of rotation, the user's direction and attitude(figure 4) as well as drone's reaction time and completion of commands. In figure(2), the Antisocial drone is much faster than the Adventure and Exhausted drone. The different personality model have been tested based on the approximate speed and other parameters in figure(3).

Table 2. control parameters for the three personality models.

Personality		**Control Parameters**		
	Speed(mph)	Reaction Time(sec)	Altitude	Special Movements
Adventure Hero	7.7	Instant	High	Spins/Flips
Anti-Social	4.4	Delay(2s)	Middle	Starts and Stops
Exhausted	1.1	Delay(3s)	Low	Wobbles

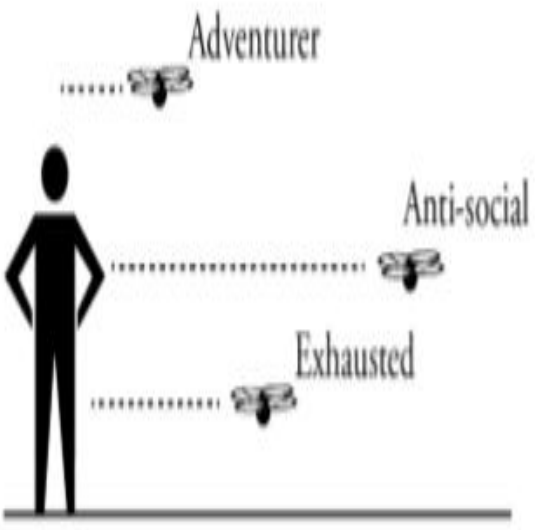


Figure4. drone's altitude.

HARDWARE AND INFRASTRUCTURE:

AR Parrot 2.0 drone is being used with a WI-Fi network and it being controlled by a hosted web interface. Through the drone 2.0 API, the commands are sent. The web interface is based on an open source drone browser. Based on the drone's stereotype of personality, from a drop down list,speed and other parameters can be set automa tically. Some movements such as up, down, left, right are basic translations where as some were pre-defined paths. These paths may include animations as well as movements in x, y, z plane. For example, in figure ,when the drone has finished the task, the acknowledge function when performed is a simple mode in the Adventure Hero while the Anti-social drone faces the user first and the looks away by turning back. To build pre-defined paths, longer commands were used.

PERFOMANCE MATRIX

A user study was conducted to validate the stereotype of personality models. In this test, the participants were made to recognize the emotional states rather than the stereotypic personality.

(a)PARTCIPANTS:

A user study was conducted across the 3 personality models with 20 volunteers from 18-30 years old (10 male,10 female) where most of them were aware of drones before and even one participant owned one.5 tasks per personality model were portrayed to the volunteers. These tasks and models were sorted randomly to avoid collision and make learning more effective. This user study took approximately 30 mins per participant.

(b)TASK AND PROCEDURE:

Here participants were made to identify the movement of drone and reactions to the commands given and explicate the emotional states to the observation. The 5 tasks per personality model which was given to the participant were observed by standing beside the experimenter and noticing the reactions of the drone. These tasks were selected from a list of human-drone interaction works. This study was conducted on a large lawn which was protected from wind squall.

(c)MEASURES

An interactive session was conducted where people where asked about the different emotional states of the drones which they acknowledged. As emotions can be expressed in different languages and variations ,we were forced to use a special pattern .The best emotional state was chosen by the participant which would best fit the drones behavior from the eight labels (afraid ,brave ,dopey, grumpy, happy, sad, shy, and sleep)after seeing the five tasks given for one personality model.

These eight labels were considered as primary keywords. In case if they felt any other labels were appropriate to match the drone's behavior, they would circle that and apply it and was therefore considered the secondary keyword. The participants were also asked to read the intensity of the emotions.

Condition	Exhausted (Dopey, Sad, Sleepy)	Anti-Social (Grumpy, Shy)	Adventurer (Happy, Brave)
Primary keyword	45	45	90
Primary keyword + Secondary keyword	80	75	100

RESULTS

A. Forced choice questions (Primary Key)

The responses of the subjects to the questions are been tabulated. 90%of the participants successfully identify one of the related emotional states in adventure hero model with the exception of Exhausted and Antisocial models having 45% accuracy.

The recognition rate of the personality models based on the corresponding emotional state is 60% whereas the HRI Model using coarse facial features [23]was only 55% amongst adults. This however is not as good as Kismet's emotional expression comparatively which has 77.6 % accuracy [2].

B .SECONDARY KEYWORDS

When both primary and secondary keys were used the accuracy increased gradually to 100%among the participants and the Exhausted Drone had 80% accuracy and Antisocial Drone had 75% accuracy.

C . QUALITATIVE DATA

When the participants selected a specific primary key they could interpret the activities of the drone but it was not always corresponding to the emotional states. When secondary key was added to the primary key their interpretation was more accurate.

Emotion		Personality Models	
	Exhausted	Anti-Social	Adventurer
	(Dopey, Sleepy, Sad)	(Grumpy, Shy)	(Happy, Brave)
Dopey	**25**	10	10
Sad		5	
Sleepy	**20**	15	
Grumpy	30	**25**	
Shy	5	**20**	
Happy	10	10	**70**
Brave			**20**
Afraid	10	10	

FUTURE WORK

In the concept of HDI,drones have been assumed to have characteristics as that of pets, as it could be made into a more interactive object to stereotype of personality models that helps in making the interaction more relastic.Other features of drone (i.e. other than the personal traits) can also be acquired. For instance it can imitate ones emotional state. The users will be able to measure the accuracy of their actions by the drones emotion like the drone would express sadness if it is not exercised for a long time or be happy if it is going for a run. Future work includes enhancing the models such that the behavior or drone is correlated with that of the personality models.

CONCLUSION

The paper explains in detail the personality ,models of the drones behaviour and the concept of emotinal encoding into the drone,by using their flight path.As drones have applications in various fields we consider it to be inevitable to use it even in social platforms .We have proved that people could effectively identify the drones emotions by observing their flight path and its response to the order of the instructor based on the observations made from the drone, the participants could identify the emotions sates and associate them with the personality model. The drone's purpose will be determined and the interactions with them could be made potent ahead in the future.

References

[1] R. W. Picard, "Affective computing: challenges", International Journal of Human-Computer Studies, 1st ed., vol. 59, 2003, pp. 55–64.

[2] C. Breazeal, "Emotion and sociable humanoid robots", International Journal of Human-Computer Studies, 1st–2nd ed., vol. 59, 2003, pp. 119–155.

[3] D. He, H. Ren, W. Hua, G. Pan, S. Li, and Z. Wu, "FlyingBuddy: augment human mobility and perceptibility". Proc. 13th International Conference on Ubiquitous Computing, 2011, pp. 615–616.

[4] S. Schneegass, F. Alt, J. Scheible, and A. Schmidt, "Midair displays: concept and first experiences with free-floating pervasive displays". Proc. International Symposium on Pervasive Displays, 2014, pp. 27–31.

[5] H. Yoshimoto, K. Jo, and K. Hori, "Designing interactive blimps as puppets", in Entertainment Computing, S. Natkin and J. Dupire, Eds. Springer Berlin Heidelberg, 2009, pp. 204–209.

[6] J. Nagi, A. Giusti, G. A. D. Caro, and L. M. Gambardella, "Human control of UAVs using face pose estimates and hand gestures". Proc. ACM/IEEE International Conference on Human-Robot Interaction, 2014, pp. 252–253.

[7] T. Naseer, J. Sturm, and D. Cremers, "FollowMe: person following and gesture recognition with a quadrocopter". Proc. IEEE/RSJ International Conference on Intelligent

Robots and Systems, 2013, pp. 624–630.

[8] D. Szafir, B. Mutlu, and T. Fong, "Communicating directionality in flying robots". Proc. ACM/IEEE International Conference on HumanRobot Interaction, 2015, pp. 19–26.

[9] D. Szafir, B. Mutlu, and T. Fong, "Communication of intent in assistive free flyers". Proc. ACM/IEEE International Conference on HumanRobot Interaction, 2014, pp. 358–365.

[10] D. Arroyo, C. Lucho, S. J. Roncal, and F. Cuellar, "Daedalus: a sUAV for human-robot interaction". Proc. ACM/IEEE International Conference on Human-Robot Interaction, 2014, pp. 116–117.

[11] M. Sharma, D. Hildebrandt, G. Newman, J. E. Young, and R. Eskicioglu, "Communicating affect via flight path: exploring use of the laban effort system for designing affective locomotion paths". Proc. ACM/IEEE International Conference on Human-Robot Interaction, 2013, pp. 293–300.

[12] J. Newlove and J. Dalby, "Laban for all", Taylor & Francis US, 2004. [13] N. Mavridis, "A review of verbal and non-verbal human–robot interactive communication", Robotics and Autonomous Systems, vol. 63, part 1, 2015, pp. 22–35.

[14] C. Breazeal, "Toward sociable robots", Robotics and autonomous systems, 3rd ed., vol. 42, 2003, pp. 167–175. [15] S. Dubal, A. Foucher, R. Jouvent, and J. Nadel, "Human brain spots emotion in non humanoid robots", Social Cognitive and Affective Neuroscience, 1st ed., vol. 6, 2011, pp. 90–97.

[16] G. Hoffman and W. Ju, "Designing robots with movement in mind", Journal of Human-Robot Interaction, 1st ed., vol. 3, 2014, pp. 89–122.

[17] J. Fink, S. Lemaignan, P. Dillenbourg, P. Rétornaz, F. Vaussard, A. Berthoud, F. Mondada, F. Wille, and K. Franinović, "Which robot behavior can motivate children to tidy up their toys?: Design and evaluation of ranger". Proc. ACM/IEEE International Conference on Human-Robot Interaction, 2014, pp. 439–446.

[18] D. Sirkin, B. Mok, S. Yang, and W. Ju, "Mechanical ottoman: how robotic furniture offers and withdraws support". Proc. ACM/IEEE International Conference on Human-Robot Interaction, 2015, pp. 11–18.

[19] M. Saerbeck, and C. Bartneck: "Perception of affect elicited by robot motion". Proc. ACM/IEEE International Conference on Human-Robot Interaction, 2010, pp. 53–60. [20] J. Novikova, and L. Watts, "A design model of emotional body expressions in non-humanoid robots". Proc. International Conference on Human-Agent Interaction, 2014, pp. 353–360.

[21] P. Ekman, and W. V. Friesen, "Unmasking the face: A guide to recognizing emotions from facial clues", Ishk., 2003.

[22] T. Baltrušaitis, L. D. Riek, and P. Robinson, "Synthesizing expressions using facial feature point tracking: how emotion is conveyed". Proc. International Workshop on Affective Interaction in Natural Environments, 2010, pp. 27–32.

[23] L. Canamero, and J. Fredslund, "I show you how I like you - can you read it in my face?", IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans, 5th ed., vol. 31, 2001, pp. 454–459.

[24] J. A. Russell, "A circumplex model of affect", Journal of Personality and Social Psychology, 6th ed., vol. 39, 1980, pp. 1161.

[25] L. Tiberio, A. Cesta, and M. Olivetti Belardinelli, "Psychophysiological methods to evaluate user's response in human robot interaction: a review and feasibility Study", Robotics, 2nd ed., vol. 2, 2013, pp. 92–121.

[26] T. Fong, I. Nourbakhsh, and K. Dautenhahn, "A survey of socially interactive robots", Robotics and Autonomous Systems, 3rd–4th ed., vol. 42, 2003, pp. 143–166.

[27] J. R. Cauchard, J. L. E., K. Y. Zhai, and J. A. Landay, "Drone & Me: an exploration into natural human-drone interaction". Proc. ACM International Joint Conference on Pervasive and Ubiquitous Computing, 2015, pp. 361–365. [28] M. Spadafora, D. Sirkin, V. Chahuneau, N. Martelaro,

and W. Ju: "Designing the behavior of interactive objects". ACM Tangible Embedded and Embodied Interactions, in press.

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