Introducing Artificial Commensal Companions

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ABSTRACT

The term commensality refers to "sharing food and eating together in a social group". In this paper, we hypothesize that it would be possible to have the same kind of experience in a HCI setting, thanks to a new type of interface that we call Artificial Commensal Companion (ACC), that would be beneficial, for example, to people who voluntarily choose or are constrained to eat alone. To this aim, we introduce an interactive system implementing an ACC in the form of a robot with non-verbal socio-affective capabilities. Future tests are already planned to evaluate its influence on the eating experience of human participants.

CCS CONCEPTS

• **Human-centered computing** → *Human computer interaction (HCI)*; Interaction paradigms.

KEYWORDS

food, eating, hci, robot, companion, multimodal interaction, non-verbal, commensality

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1 INTRODUCTION

Social psychology has shown that "being in a commensality setting", where *commensality* means "the practice of sharing food and eating together in a social group" [9], has a number of positive impacts on humans, influencing food choices, time spent eating, and enjoyment of food, as well as triggering a number of positive emotions.

The benefits of commensality are many, with a study on the effect of ambience on food intake and food choice finding that eating in the presence of other people (i.e. being in a commensality setting) led to eating larger meals for a longer duration when compared to eating meals alone [1], and a study finding that it also led to healthier food choices, reduced "over-eating" (not the same as eating larger meals), and increased the enjoyment of food [11]. A commensality setting may even improve performance within a work group, as a study on firefighters showed a positive association between commensality and work-group performance [3].

Given the current social trends resulting in a lack of commensality, some individuals are increasingly forced to eat alone, for example the elderly, while others suffer from physical and social barriers preventing them from experiencing commensality (distance, work commitments, etc.). It has been shown that eating meals alone is associated with unhappiness. A study in Thailand used data from 39820 individuals over an 8 year period, and found that "the larger the dose of unhappiness the greater the odds of eating alone" [14]. Because these trends are only likely to worsen in the coming decades, there is a definitive need for (more) research into how the field of HCI, particularly around how typically social activities, in this case eating, can be transferred to commensality settings. To address this issue, *Computational Commensality (CC)* was recently defined in [8] as attempts to computationally address various social aspects of food and eating. CC extends commensality in humans by introducing technology as a "social glue" for food-related interaction.

In this paper, we introduce a first prototype of an interactive system specifically designed to implement an Artificial Commensal Companion (ACC). The prototype can be used in the future to run experiments evaluating the impact of interactive technologies during the mealtime, like the one designed in [6]. In the remainder of the paper we describe the ACC hardware and software details. Previous attempts to create the ACCs include [2, 5, 7, 12]: none of them, however, were specifically designed to study the social interaction happening between the ACC and the user during mealtime. As stated in [8], existing "research in AI and HCI and technologies dedicated to food- & eating-related activities often focus on food (or eating) itself (e.g., food recognition and sensory augmentation) rather than on its social dimension." So, our objective is to develop a system in which a social robot can be an active ACC, to, consequently, interact with the human users and improve their eating experience.

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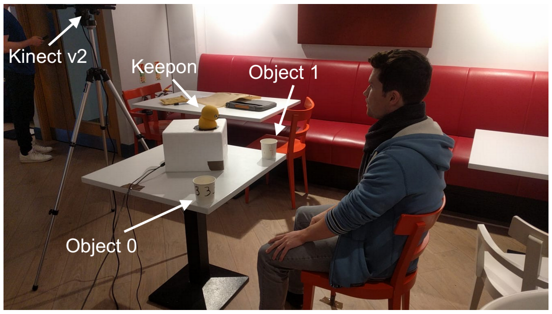

Figure 1: A photo showing the Artificial Commensality Companion (ACC) interacting with a human.

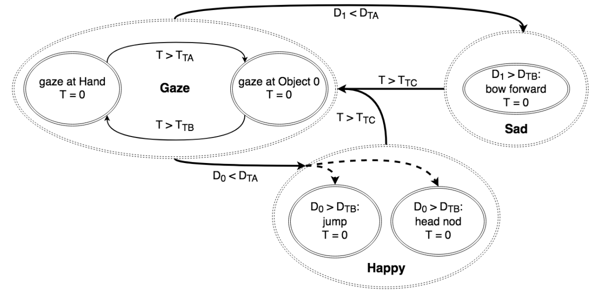

Figure 2: Overview of the non-verbal signals state machine.

2 SYSTEM IMPLEMENTATION

Figure 1 provides an illustration of the ACC we developed. The user is sitting on a chair, and the robot is placed on a dining table together with 2 bowls containing some food. The bowls are placed at 2 pre-defined positions in the scene and labeled *Object 0* (the one on the left of the user) and *Object 1* (the one on the right of the user), so the robot "knows" where they are.

As we will describe in detail in the next sections, the robot continuously generates non-verbal signals to, for example, communicate to the user its food preference and emotional feedback; it periodically gazes at the bowl labeled as *Object 0*), displaying joy ("jumping" and "nodding with its head") when the user picks food from it.

2.1 Hardware

The system is composed of a Kinect v2 and the toy robot called Keepon. The Keepon behavior is controlled via Python code and an Arduino to translate string commands to I2C signals that can be understood by the robot's controller.

Keepon is a simple toy robot, which already has been used for research purposes [4]. It was primarily used while working with children, suggesting that the Keepon's aesthetic design is effective in eliciting a motivation to share mental states.

The robot has 3 degrees of freedom, (left/right rotation, front/back and left/right leaning), and it can perform "jump" movements up and down. The robot is chosen over, for example, a virtual agent as we implement "gaze" behaviors, which are more effective in a robot due to its physical presence [10]. The limited range of non-verbal behaviors that the robot can display is likely enough for the robot to be accepted by a human user [13].

In our ACC, we also exploit a Kinect sensor with the pyKinect2 Python wrapper. A list of body joint names, locations and confidence scores in $[0, 1]$ is returned by the wrapper. The ACC uses the 2D (screen) positions of 3 joints: *Head*, *HandTipRight* and *HandTipLeft*.

2.2 Software

At its core, the robot behavior can be modeled as the state machine illustrated in Figure 2.

2.2.1 States. While being in the *Gaze* state, the robot's gaze continuously shifts between the user's dominant hand, tracked by the Kinect, and the location of *Object 0* in the scene, depending on two time thresholds T_{TA} (8 seconds) and T_{TB} (2 seconds). The *Happy* state triggers the generation of two emotional signals of joy: one in which the robot performs some quick up/down movements and another in which it nods with its head, both accompanied by cheering sounds. The *Sad* state triggers the generation of an emotional signal of sadness: the robot bows forward, accompanying the movement with a low frequency sound.

An example of the system at work, including the production of the emotional feedback described above, can be seen at:

https://youtu.be/sHLhYxwuZ_Y.

2.2.2 Transitions. Transitions between the states are conditioned by checking the value of variables T, D_0 and D_1. Variable T is a timer that is periodically reset to zero to make the robot's gaze shift between the user's hand and *Object 0*, and to make the robot return from the *Happy* and *Sad* states to the *Gaze* state. Variables D_0 and D_1 measure the distances (in pixels on the 2D scene captured by the Kinect) between the user's dominant hand and *Object 0* and *Object 1*, respectively. When D_0 and D_1 become smaller than threshold D_{TA}, the robot changes its state to *Happy* and *Sad*, respectively. Since we want to produce an emotional feedback only when the user's hand is retracted from one of the two objects, in both states we keep comparing D_0 and D_1 with a different threshold D_{TB}, this time to check weather they have become greater than that. The states labeled with emotional signals can be read as in the following example:

$$D_0 > D_{TB}:$$
$$jump$$
$$T = 0$$

which means: "the value of D_0 is continuously compared with threshold D_{TB} and, whenever it becomes greater than the threshold, the *jump* signal is triggered and the timer T is reset to zero to wait a certain amount of time before transitioning back to state *Gaze*".

3 FUTURE WORK

We plan to exploit the ACC system described in this paper to run studies on HCI and commensality. In particular, in a future experiment, we aim to investigate research questions, such as:

- is the presence of an interactive and social ACC preferred over a) eating alone or b) eating with a robot not showing any social behavior?
- can an ACC influence food choice through only its nonverbal behaviors?

REFERENCES

[1] John M De Castro. 1994. Family and friends produce greater social facilitation of food intake than other companions. *Physiology & behavior* 56, 3 (1994), 445–455.

[2] Rohit Ashok Khot, Eshita Sri Arza, Harshitha Kurra, and Yan Wang. 2019. FoBo: Towards Designing a Robotic Companion for Solo Dining. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland Uk) *(CHI EA '19)*. ACM, New York, NY, USA, Article LBW1617, 6 pages. https://doi.org/10.1145/3290607.3313069

[3] Kevin M. Kniffin, Brian Wansink, Carol M. Devine, and Jeffery Sobal. 2015. Eating Together at the Firehouse: How Workplace Commensality Relates to the Performance of Firefighters. *Human Performance* 28, 4 (2015), 281–306. https://doi.org/10.1080/08959285.2015.1021049 PMID: 27226698.

[4] Hideki Kozima, Marek P Michalowski, and Cocoro Nakagawa. 2009. Keepon. *International Journal of Social Robotics* 1, 1 (2009), 3–18.

[5] Rui Liu and Tomoo Inoue. 2014. Application of an Anthropomorphic Dining Agent to Idea Generation. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct Publication* (Seattle, Washington) *(UbiComp '14 Adjunct)*. ACM, New York, NY, USA, 607–612. https://doi.org/10.1145/2638728.2641342

[6] M. Mancini, R. Niewiadomski, G. Huisman, M. Buijnes, and Gallagher C. P. 2020. Room for one more? - Introducing Artificial Commensal Companions. In *CHI 2020 Extended Abstracts*. ACM, Honolulu, USA.

[7] Derek McColl and Goldie Nejat. 2013. Meal-time with a Socially Assistive Robot and Older Adults at a Long-term Care Facility. *J. Hum.-Robot Interact.* 2, 1 (Feb. 2013), 152–171. https://doi.org/10.5898/JHRI.2.1.McColl

[8] Radoslaw Niewiadomski, Eleonora Ceccaldi, Gijs Huisman, Gualtiero Volpe, and Maurizio Mancini. 2019. Computational Commensality: from theories to computational models for social food preparation and consumption in HCI. *Frontiers in Robotics and AI* 6 (2019), 1–19.

[9] Elinor Ochs and Merav Shohet. 2006. The cultural structuring of mealtime socialization. *New directions for child and adolescent development* 2006, 111 (2006), 35–49.

[10] Kerstin Ruhland, Christopher E Peters, Sean Andrist, Jeremy B Badler, Norman I Badler, Michael Gleicher, Bilge Mutlu, and Rachel McDonnell. 2015. A review of eye gaze in virtual agents, social robotics and hci: Behaviour generation, user interaction and perception. In *Computer graphics forum*, Vol. 34. Wiley Online Library, 299–326.

[11] Nanette Stroebele and John M De Castro. 2004. Effect of ambience on food intake and food choice. *Nutrition* 20, 9 (2004), 821–838.

[12] Monami Takahashi, Hiroki Tanaka, Hayato Yamana, and Tatsuo Nakajima. 2017. Virtual Co-Eating: Making Solitary Eating Experience More Enjoyable. In *Entertainment Computing – ICEC 2017*, Nagisa Munekata, Itsuki Kunita, and Junichi Hoshino (Eds.). Springer International Publishing, Cham, 460–464.

[13] KR Thórisson and Justine Cassell. 1996. Why put an agent in a human body: The importance of communicative feedback in human-humanoid dialogue. *Proceedings of Lifelike Computer Characters' 96* (1996), 44–45.

[14] Dr. Vasoontara Yieng-Sbirakos (Yiengprugsawan), Cathy Banwell, Wakako Takeda, Jane Dixon, Sam-Ang Seubsman, and Adrian Sleigh. 2015. Health, Happiness and Eating Together: What Can a Large Thai Cohort Study Tell Us? *Global Journal of Health Science* 7 (12 2015). https://doi.org/10.5539/gjhs.v7n4p270