Exploring Gaze in Interacting with Everyday Objects with an Interactive Cup

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ABSTRACT
Our eye gaze is important during social interactions. It can generate significant social cues in nonverbal communication. The feeling of being look back when we are gazing at someone influences our social behaviour. In this paper, we propose an interactive coffee cup that is responsive whenever a person is fixating on it. Taking the user's gazing behaviour as our system input modality, we want to create an environment where a person may establish social interaction with an everyday object whenever he/she is looking at it. To make an object *visible* to the user's eyes and for the user to feel connected with the object, it is expected that the object to possess distinctive characteristics that can acknowledge the user that it is aware of being look at. By combining the recent technology of eye trackers, mechanical design and embedded electronics, we want to explore the possibility of nonverbal social interaction between a person and inanimate object that will respond when a person is looking at it to allow social interaction and to create a sense of emotional bond between the two.

Author Keywords
Eye tracking; gaze sensitive object; emotional object; human-object interaction.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

INTRODUCTION
Communication is known as the bedrock of any successful relationship, either personal or professional. It is important to acknowledge that it is our nonverbal communication (our eye contact, gesture, facial expression, the tone of voice and posture) that speaks louder. The ability to interpret and adopt nonverbal communication is the most compelling tool that can help people to relate to one another and to build better relationships.

Nonverbal communication contributes significantly to conversations and interactions. Since visual modality is dominant for most people and the fact that the eyes serve as the focal points of the body, eye contact is an essential type of nonverbal communication. Our eyes reflect our interest, honesty, trust and comfort when communicating with others. Having good eye contacts during conversation is key to creating positive connections with others. When a person tries to initiate interaction with another person, eye contact must come first. Eye contact is known as one of the most compelling social signals which can boost human's physiological arousal [10]. However, humans tend to feel that they are making eye contacts with other humans but not with objects. A website called What The Face: Objects That Look Back, invite people to upload pictures of everyday objects that appear to have human emotions [4]. All of these objects unintentionally show that they have the characteristics of a human face with eyes. Whenever they look at these objects, they felt that the object is staring back at them which influence their behaviour towards the objects. However, since most of the objects do not have eyes, it is hard to define if we can have eye contact with it or not. These objects remain invisible because they are not responsive towards our eye gaze. According to James Elkin, we should not confine our vision to things with eyes. In his opinion, vision should be universal, and every object has its own eyes, full of vision even if they are not [3]. Can a person experience the feeling of being look back from an object even if the object does not have any eyes? What if the object can react and display behaviours when a person is looking at it, will he/she experience the feeling of being look back from the object and influence their behaviour towards the object?

RELATED WORK
EmotoCouch [8] is an emotional couch that could display six emotional states (excited, happy, calm, depressed or sad, and angry). The emotion was identified based on the Circumplex emotion model. It used different colours of lights, irregular patterns of the cushion cover and the sense of touch (haptic feedback) to expressed range of emotions to people surrounding the couch. The couch could show an angry designed when the couch was under pressure hearing people arguing or showed excited designed when a family was sitting together to encourage family time. Sneaky Kettle [6] was a kettle which liked to play and party by rotating around its axis. Its behaviour depended on the type of rotations and

the timing. The kettle knew that it was there to boiled water and not to have fun. However, it will sneakily start to move when there was no human presence. This kettle became more daring and braved enough to move, once it gets to know the user. The user may found this behaviour appealing for a moment but became bothered with it which make the kettle started to isolate itself and just moved when nobody was around. The user felt that this product had a soul. Emotional Objects [7] focused on three modified everyday objects with the purpose to effectively point out their dynamic connection with heat. A tea cup that vibrated when the tea was getting cold, a metal chair uncovered its desired to be warm and comfortable when people sitting in it and a pan with a handle became difficult to hold when it is excessively hot, making it impossible to touch using our bared hand. These unique characteristics allowed these object to promote meaningful interactions with their users by changing their normal state towards surrounding environment which could create an emotional bond between object and the user.

MOTIVATION

This research is motivated to create opportunities for social interaction between a person and an object by utilising the user's eye gaze in the physical world. Previous studies related to gaze interaction were mostly confined to the digital or virtual environment whether as an input modality to interact with an object while playing video games [9] or to point or select an object in human-computer interaction [5]. In this research, an eye tracker is used to detect user's gaze and to help the object to understand how it should react based on the gaze data it has retrieved from the eye tracker. By applying simple mechanical behaviours, we intend to design the object to have its personality traits. Will the user aware that their gaze is making the object react? If the user can realise the characteristic shown by the objects, will the objects affect the user's emotions? Does this experience create an emotional bond between object and the user?

INTERACTIVE COFFEE CUP

Coffee Cup with Dynamic Behaviour towards Human Gaze

We might not have notice that objects do express emotional response when we look at it based on the shape, colour or size [2] but these characteristics are fixed and unchangeable. That is why it is often the case that people are not entirely aware of it. Whether we realise it or not, these objects are communicating to us openly, actively or indirectly, but we were hoping to have a real interaction with them [1].

A coffee cup is the first everyday object chosen for this research because it is a common object we use in our daily life. Since people are already familiar with the cup, we do not have to introduce the function and how to use the cup. Normally, when we arrive at our workplace, the first thing that we do is to have a cup of coffee to start the day. Then, we place the cup within our eyesight. If we want to take another sip of coffee, we look at the cup, pick it up and take another sip. It is a one-sided behaviour between a person and the object. However, what if we implement the coffee cup

with dynamic behaviour that can show movements to express its emotional state, the experience of using the cup can be new and different. A cup that can move up to indicate "are you looking at me?" when the user looks at it, or it will go back to its initial state as shown in Figure 1 if the user turns his/her gaze around and focus on the other things around.

If the user maintains his/her gaze at the cup after it moves up, it will turn itself around and make sure the handle of the cup is pointing towards the user to offer "would you like to have
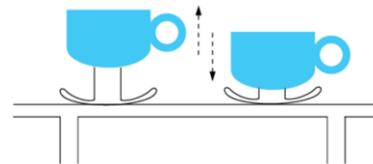
Figure 1. Coffee cup acknowledging the user with the presence of the gaze by moving up and back to its initial state.

a cup of coffee?" as shown in Figure 2.

The cup itself can express its shyness when the user staring at it for a longer time or it might try to distract the user by
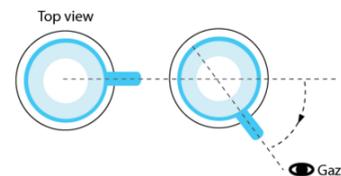
Figure 2. Coffee cup offering the user a cup of coffee to initiate social behaviour.

doing something naughty or ridiculous just to grab the attention so that they can develop visual contact between the two.

Prototype

Figure 3 shows the exploded view of the prototype for the interactive coffee cup. The coffee cup and the cup holder itself were modelled using Rhino3D and fabricated in the Ultimaker 3D printer. The cup holder has a slot to hold the handle. This slot is necessary for the user to know which suitable position to place the coffee cup back after they used it. We used acrylic plastic for the mechanical part and design it by using Adobe Illustrator software for laser cutting. To control the movement of the cup, we decided to use gears as part of the working mechanism. We implement rack and pinion gear systems in the prototype to enable the cup to move up and down. It combines a pair of gears which can convert rotary motion to linear motion. The pinion is a typical round gear, and the rack is a straight bar with jagged teeth in it. When the pinion rotates, it causes the rack to move corresponding to the pinion, thereby makes the cup move up if the pinion rotates clockwise, or move down if the pinion rotates counter clockwise. The cup holder is directly fixed to a flat round surface and attach to a servo horn to control the desired angle of the coffee cup. A servo motor controls this

servo horn to enable the coffee cup to rotate to a precise angular position by transmitting a coded signal to the servo. If the coded signal change, the angular position of the cup will change accordingly.

Hardware and Software
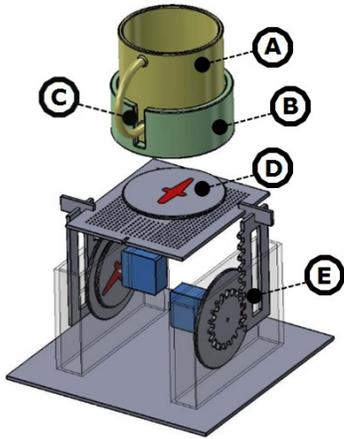
Figure 3. Exploded view of the interactive coffee cup. A: the coffee cup; B: the cup holder to hold the securely on top of the base; C: slot to grip the handle of the cup; D: the base of the coffee cup to control the angle of the cup; E: rack and pinion to control the movement of the cup (up and down).

To track user's gaze in real time, we are required to use an eye tracker to measure the eye positions and eye movements. The Eye Tribe Tracker is one of the affordable devices that can observe and evaluate human attention. It comes with software that can measure the eye gaze defined by a pair of (x,y) coordinate with an average efficiency of 0.5 to 1° of visual angle. This software is based upon an open Application Program Interface (API) design that allows the client applications to interact with the underlying tracker server to obtain gaze data in both raw and smoothed forms. However, this device is meant to be used for desktops, laptops and tablets where we need to fix it the displays. For this research, we use it to measure visual attention on real objects in real environments.

We used Java software to program the system to manipulate the 2D coordinate and make it suitable to be embed in the 3D environment to create an engaging experience by depending on user's eye gazes. We wrote a list of commands in the code, and if the eye gaze point of the user corresponds to the location of the coffee cup, taking into consideration the duration of each visual fixation, the system will transmit the appropriate command wirelessly using Bluetooth.

An Arduino microcontroller is used to control the behaviour of the coffee cup. Three servo motors and a Bluetooth module are connected to the Arduino. Once Arduino receives a certain command via Bluetooth from the system (Java program), it processes the command and controls the servo motor accordingly. The coffee cup will only interact with the user if the user manages to have a visual contact with the cup.

SYSTEM OVERVIEW

This system consists of an Eye Tribe tracker that calculates the location of user's gaze point by extracting information from the person's face and eyes. A computer that acts as a server to extract the data gathered by the Eye Tribe tracker. A Sparkfun Bluetooth mate gold module, an Arduino microcontroller development board, three servo motors and a coffee cup (Figure 4).
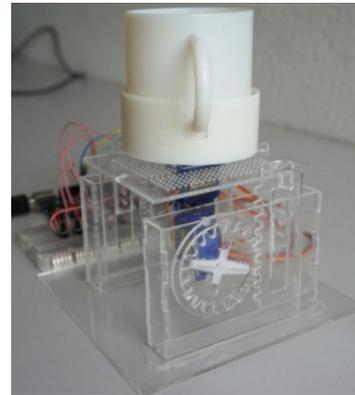
Figure 4. Working prototype of the interactive cup that reacts to human eye gaze.

Figure 5 shown the overview of the system. The location of the interactive coffee cup is pre-determined and must be within the eye tribe tracker's evaluation view. The position of the user is also important and must be in parallel to the tracker's tracking area. It is necessary to centre align the eye tracker and adjust it towards the user's face for the maximum trackability. When the user gazes at the coffee cup, the Eye Tribe will extract the coordinates of the gaze and compare them to the pre-determined position of the coffee cup. If the the point of gaze and the position of the coffee cup matches, the system will sent a command to the Arduino via Bluetooth. Arduino will control the dynamic behaviour of the coffee cup according to the user's gaze to enhance certain desirable characteristics of the interaction.
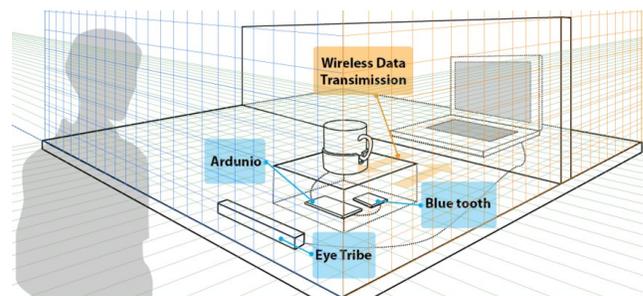
Figure 5. Overview of the system.

SCENARIO

Here we present a scenario that shows how the interactive coffee cup socialises with people in their daily life.

"Nick works for an advertising company, and he loves to drink coffee. Whether it is to wake him up or to keep him focused while being stuck at work, sitting down with a nice cup of coffee helps him get by. The cup he uses is not an

ordinary cup. This cup has its feeling and will react whenever he looks at it. It can acknowledge him by moving up if he look at the cup and if he looks at it long enough, the cup will turn with the handle facing towards him with the purpose to offer him to have a sip of coffee. However, if he stares at the cup without any intention to drink the coffee, the cup will feel disappointed and start to turn away from him slowly. When the temperature of the hot coffee drop and Nick gaze at the cup, the cup will vibrate to let him know that he should drink the coffee before the coffee getting colder. Nick feels that the cup knew that he is looking at it because the cup can react to his gaze and have its personality traits which affect his emotion and behaviour towards the cup."

CONCLUSION

An interactive coffee cup with dynamic behaviour investigates how a simple everyday object can create human-object relationship by reacting to user's eye gaze. Even though the coffee cup does not have any eyes, we expect the behaviour embedded in it somehow can give the users the feeling of being look back as if they have a social interaction with another person. By implementing such experience, this responsive objects can give a different perspective in evoking meaningful social interactions between a person and an everyday object.

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