EmoEcho: A Tangible Interface to Convey and Communicate Emotions

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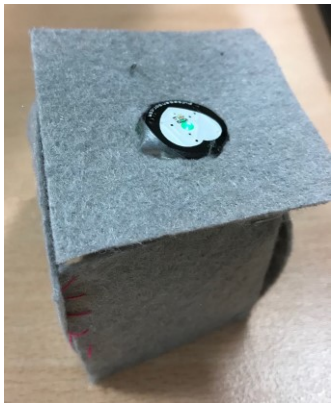
Abstract
An interactive tangible interface has been developed to capture and communicate emotions between people who are missing and longing for loved ones. EmoEcho measures the wearer's pulse, touch and movement to provide varying vibration patterns on the partner device. During an informal evaluation of two prototype devices users acknowledged how EmoEcho could help counter the negative feeling of missing someone through the range of haptic feedback offered. In general, we believe, tangible interfaces appear to offer a non-obtrusive means towards interpreting and communicating emotions to others.

Author Keywords
Tangible Interaction; Emotion Recognition; Affective Computing; Haptic Feedback.

ACM Classification Keywords
J.4 Social and Behavioural Sciences

Introduction
With the advancement of transport systems and modern lifestyle, many people nowadays are living apart from their loved ones, whether an elderly relative, who is living in a care home or a lover who is living away from his or her partner.



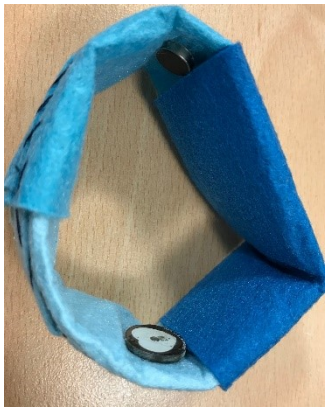


Figure 1: EmoEcho prototype devices, a) EmoEcho Cube, b) EmoEcho wristband

There are many forms of communication that aim to ease the feeling of longing for distant loved ones but they don't enable people to feel physically connected to one another. People are accustomed to interacting via tactile stimuli as touch is critical for physical and mental wellbeing [7].

With recent developments in Internet of Things (IoT), Tangible User Interfaces (TUI) and emotion sensing technologies [1, 6, 8, 10, 13], it is possible to develop tangible interfaces that can infer emotional wellbeing and wirelessly communicate this. This project aims to use these technological advancements to enable people to maintain a remote physical connection.

RELATED WORK

Previous work shows tangible interfaces solely for communication purposes have been developed including Squeezy Bracelet [11]; a device that allows the wearer to send predefined messages by squeezing at various pressure levels. However, pressure based interaction was found to be simple but unintuitive.

A range of tangible interfaces have been developed to further communication interfaces in promoting remote intimacy. LumiTouch communicates the action of touching a picture frame as once a picture frame is touched the remote partner's frame lights up [4]. Similarly, the Interactive Pillows [12] allow a remote pillow to light up with when the partner pillow is touched or hugged enabling simulated pillow talk.

Another example is Lover's Cups [5] these are light-up glasses that remotely activate when a partner uses their cup to simulate drinking together showing communication can be extended to daily interactions.

Researchers have also developed methods to help people communicate their emotions. Subtle Stone [2] is a tangible device that allows users to express their emotions through unique colours. The use of colours to represent emotions was well received, with students liking the anonymity and simplicity it provided.

Emoball [3] is another device that allows users to record their emotions by squeezing. This device only allows users to report a limited number of emotions but is useful for self-reflection. These research directions show the interest in developing tangible interfaces to express emotions but communicating these emotions to improve mental wellbeing has not yet been explored.

System Architecture

EmoEcho is a portable device that allows people to share tactile interactions remotely to express their current emotion and improve mental wellbeing by allowing partners to feel connected. Initially different methods of interaction were analysed resulting in three transducers being selected; pulse, touch and motion as shown in Table 1.

EmoEcho has been designed to comprise of two portable devices containing the required sensors and haptic feedback. The devices connect to an Android app using Bluetooth which then sends the data to the trusted partner's app enabling 2-way communication.

Once one device is used the partner device responds with different vibrotactile feedback patterns ranging from gentle taps to sharp buzzes dependant on the inferred emotion. The two small vibration motors within EmoEcho create a very powerful impression to ensure a sense of tactile interaction is achieved.

Variables captured
Heart rate
Pressure / touch
Accelerometer / motion
Time
Date

Table 2: Variables captured by the system

Relaxation	Enjoyment	Anger	Boredom
Low frequency, low intensity	Low frequency, dual (two)	High frequency, high intensity	Low to Med frequency

Table 3: Encoded vibration patterns of emotions for playback

Different designs have been considered for EmoEcho (see Figure 1). One prototype is a soft cube that allows for easier touching but makes taking pulse readings more difficult. The second prototype is a wearable device resulting in more accurate pulse readings due to the position of the sensor but less area to touch.

Data processing

Once force, motion and pulse data has been read from EmoEcho fuzzy logic is used to classify the data to high, medium or low. Previous research [14] shows the possibility to detect emotions from motion and whilst it's difficult to encode compound emotions such as yearning, we have successfully encoded four high level emotions as shown in Table 2.

Variable	Relaxation	Enjoyment	Anger	Boredom
Pulse	Low	Med	High	Irregular
Touch	Low to Med intensity, no sudden changes	Med intensity, sudden changes allowed but generally short	Fluctuations more pronounced returns to shifting baseline erratically.	Irregular fluctuations. Inconsistent frequency changes and amplitude
Motion	Low activity Activity fairly smooth	Low to Med and occasionally high intensity. Signal changes often but returns quickly	High activity. Occasionally in bursts. Baseline is irregular	Consistently Low to Med level of fluctuations and frequency of changes. Amplitude mostly Low to Med

Table 2: Encoding sensor readings into emotions

The four emotions encoded are based upon previous research [8, 9, 10] and limited tests using the device. Table 3 shows the encoding of emotions into haptic feedback. Once an emotion has been detected it is encoded as an actuation pattern and the signal is transmitted. Upon receipt of the signal the remote device plays the pattern informing them of the emotional wellbeing of their partner.

Discussion

To test the concept the 2 prototypes developed were shown to 5 placement students (aged 19-22, 3 male and 1 female) enabling them to gain an understanding of EmoEcho's functionality. The prototypes allowed the users to experience the different interaction methods and different designs being considered but not use the devices with family or loved ones.

The initial feedback provided shows EmoEcho has high potential as most participants stated they would use such a device to connect with distant family members. Users also liked the concept of having a range of feedback patterns as it would allow them to know how their partner was feeling in real-time.

The user feedback also showed that a wearable device would be preferred to a handheld device as it is less obtrusive enabling people to privately communicate anywhere and feel closer connected at all times. Overall users liked the concept and wanted to use the device to connect with their partner or family members.

Conclusion

This work has presented a tangible interface to communicate emotions in real-time, called EmoEcho. EmoEcho measures pulse, touch and motion, processes this data and then outputs varying vibrotactile feedback

on the partner device. This enables people to improve their mental wellbeing by remotely connecting with another through tactile stimuli and haptic feedback.

EmoEcho has been shown to 5 people to gain initial feedback. Most people believed the vibrotactile feedback would be successful in helping them feel closer to a partner and are interested in continued use showing EmoEcho can help people remain physically connected when geographically apart.

As future work, it is important to study whether another form of interaction is better suited to communicate emotions. Also, given the small sample size of our study, it is difficult to speak of generalisable results, so further evaluation is required. We will also apply this evaluation in specific contexts, e.g. elderly people, people in relationships and the blind or deaf.

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