Message Bag: Can Assistive Technology Combat Forgetfulness?

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ABSTRACT
Forgetfulness can be a cause for concern when it begins affecting our daily lives. Forgetfulness is associated with feelings of embarrassment and shame [1] and yet there is little attention given to forgetfulness in a healthy population. Forgetfulness is a lived experience and something that happens in our day to day. Therefore we propose the "message bag", which will be carried throughout regular daily activities, with an aim to alleviate the cognitive load, in an effort to eliminate forgetfulness. We describe a prototype for a device that will be tested in the wild.

Categories and Subject Descriptors
H.5.2 [**Information interfaces and presentation**]: User Interfaces – *prototyping, user-centered design.*

General Terms
Management, Design, Human Factors.

Keywords
memory, forgetfulness, cognitive load, assistive technology, wearables, user-centered, ubiquitous

1. INTRODUCTION
Forgetfulness has been shown to have negative consequences in people's everyday lives: "Forgetting led to failures in social interactions and influenced their proper performance of everyday tasks. As such they reported that forgetfulness changed their lives, producing worries and feelings of shame and embarrassment, and creating the need to establish new practices in everyday life. At the same time, forgetfulness decreased their ability to establish new practices."[1]. Our primary aim here is to design smart technology to alleviate these consequences.

Containers such as bags have been used to enable people to carry more items than our hands will allow. In modern society, we see bags of varying specialist nature from backpacks, to wheeled luggage, to sports bags and designer purses. Ultimately they allow us to bring items we consider necessary from one location to another. However, one common denominator with all these bags, is that they don't have a way to communicate to us what is inside them, and through the lack of information the bags offer us, we frequently forget items we need or should have packed. This is where *message bag* aims to improve the way we currently use bags, we look to implement assistive technology to combat forgetfulness.

Our bag will use recognition over recall in order to reduce the load on the users memory [2]. Additionally, ubiquitous computing allows us to look at the traditional bag in a new way, by embedding technology to support the user through giving it the ability to notify them that things that they find necessary for their day, are in fact packed within the bag (as communicated by the bag).

1.1 Forgetfulness
In the case of our *message bag*, we are targeting individuals who do not have a diagnosed medical condition for their forgetfulness, but users who *perceive* themselves as being forgetful. There is a need for solutions for healthy individuals: [3]'s study of 1871 volunteers demonstrated that 40% had perceived forgetfulness and 70% of those were worried about their forgetfulness, with 25% being interested in ways to improve their memory. It was these users who believed they were forgetful that found it the most impacting in their daily lives. The more they perceived their forgetfulness, the more emphatically they insisted it was a problem in their lives. The greater belief that they were forgetful, the more they described their feelings of stress and embarrassment.

2. RELATED WORKS
Although the concept of devices to improve memory is not new, most relevant work in the field of assistive technology is divided into (a) aids for people affected by dementia, brain injury etc. and (b) information management approaches typically embodied as hardware or software systems added to or separate from the user's everyday life. In contrast, our approach is focused on healthy adult individuals, and on technology which fits in seamlessly with their everyday routine, requiring no additional cognitive load or learning. Most related research revolves around devices that can be used in the house; again, these devices are all noted for individuals who have diagnosed dementia, Alzheimer's, or brain injury [4]. They tend to be clunky in nature and require some degree of learning; they are often bulky items (PDAs, Item

AH'13, March 7–8, 2013, Stuttgart, Germany.

locators or voice prompters), software solutions such as To Dos and Reminders or small physical reminder systems that are in and around the home. The devices also tend to be very large, for example, large button phones, or pill bottles [5] that dispense the correct pills for that day through wireless signals that potentially activate a glowing light, text messages or other forms of communication to alert the patient to taking their medicine.

Our initial prototype *message bag*, is different from these devices as it will be an item they typically already carry (and use) on a daily basis, with the aim of removing any visible interface to eliminate any learning curve or disruption to their daily lives.

3. SYSTEM DESIGN

Our main concept is a message bag: in contrast to e.g. voice prompters, a large proportion of individuals carry bags already. We will be designing several stages of a prototype message bag, building upon the first, to discover which is the most successful configuration in combating forgetfulness. Our first initial prototype extends a standard shoulder bag with Radio Frequency Identification (RFID) reader (connected to a circuit board) and tags (see figures 1 & 2), to alert the wearer if a certain item was packed in the bag or not.

Its interface consists simply of light-emitting diodes (LEDs) as a communication lighting system, and creates no additional learning curve or cognitive load for the user. Users simply place items in the bag as usual, which light an LED notification as the item goes in. They could then see on the *outside of the bag* which items were packed through the LEDs that were corresponding with a lit LED or not lit. The component list for *message bag* initially contains a Teensy Board, D-12 RFID reader, tags, LEDs, Piezo (for auditory feedback), Screen, 9v battery, wires and a bag of some choice, be it a backpack, hand bag, purse or other. The tags are placed on their real world item, in our case it was items including a mobile phone, key fob, lipstick, notebook and wallet. The piezo is used as an audio cue to alert the user when an item (tag) is successfully scanned. The design of this system also has a small screen on the front of the bag, which lists the recent item scanned, and this will be given further functionality in subsequent systems. Subsequent versions will build upon this rough, early phase concept prototype.

3.1 Identification Technology

Our initial prototype requires items to be programmed ahead of time and tagged before the bag "knows about" them as potential contents to be tracked. However, there are other circuit boards and RFID readers available that would enable additional flexibility within the system, such as being able to wirelessly send the tag id's of the items to the bag so that it would not need pre-programming (a possible limitation due to a finite number of items entered into the system). This would enable a user to update their own tagged items to be included and would make for a more lifestyle compatible system, though it would have initial set up time and learning phase of how to enter the tags successfully.

RFID technology as a tagging identification framework [6] is relatively new. When compared with Barcode technology, RFID systems have an advantage when using it in this environment (*message bag*), which is that tags can be scanned in any orientation, and the reading is not dependent on a specific light condition. (Barcode technology utilizes a system of printed horizontal strips containing vertical bars, which has been long established for identifying an object – however it requires line-of-sight reading across a scanner at a certain reflective lighting condition. This is not a practical solution, as it is likely to be dark in the bag and the user does not want to have to hold an object in an unnatural way.) An additional advantage of the RFID reader is that the tag can be some distance away or even obscured by clothing or plastic or other materials. The tags used to read the code from have adopted the non-volatile memory characteristics of Barcode labels; meaning that the tags retain stored information even when they are not powered.

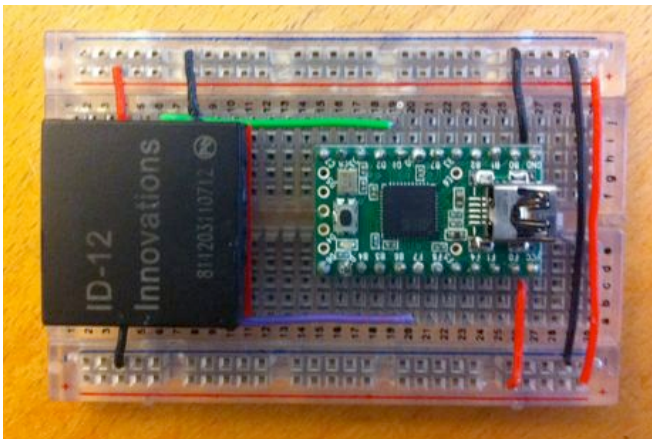

Figure 1. ID-12 RFID reader on the breadboard, alongside the Teensy circuit board to run the code.

The RFID system of *message bag* is equipped with an Innovation ID12 reader and passive tags that are prewritten with a 12-byte unique identification number (id). The ID12 reader has a coiled antenna embedded inside the case (this has a claimed distance reading of +12). The tag has a microchip storing the 12-byte unique id and coiled antenna that is used to communicate with the reader via radio frequencies. The antenna from the reader forms a magnetic field allowing the tag to obtain power from the reader – supplied with 5V power from a microcontroller, in this case a Teensy USB Development Board (with a 9V battery connection to allow portability). In addition, the chosen reader (25 x 26 x 6 mm) and tag(s) are small enough to be housed in the bag (reader) and on the users objects (tags).

In addition to the functionality and compactness of this reader, it is also an affordable solution. The ID12 does have limitations in that it can only read one tag at a time, so there is a short pause between readings, additionally there is a working range of less than four inches which isn't a problem for our prototype but may limit functionality if it was embedded into a large backpack for example. In conjunction with the identification technology, there is a small LED visible externally for a visual clue and a piezo for an audio notification within the bag to inform the wearer about the RFID tag reading taking place and whether it was successful, or not. There is also a button placed in the interior of the bag to enable the user to switch off the notification LEDs once they are ready to go on their journey so they wouldn't be actively displaying the contents of their bag to the outside world. They do not need to reactivate the bag as by default the button switches off the LEDs and then reactivates the RFID reader for further scanning, should it be necessary.

3.2 Circuitry

The Teensy USB Development Board is used for it's discreet, lightweight and compact size, which becomes important when integrated into a bag that the user will be carrying. The wires used to connect the elements are multicore to enable more flexibility and movement than a single core wire offers, which is more prone to snapping in movement. Using a Teensy means that both the circuit board and the reader can be placed in close proximity (see figure 1), eliminating possible wiring issues (wires coming loose or unattached).

3.3 User-Centered Design

Using user-centered design [7] is important for *message bag*, as it must become part of the users' everyday routine. The user-centered approach has real users and their goals as a driving force, and it should support, not constrain the user, therefore the early focus is on users and their tasks. Additionally, as per user-centered design approaches, it will encompass iterative design [8] throughout several stages and over time as the users have the bag with them. Our design process includes inquiries, face to face interviews, video conversations and questionnaires. This is then used to construct a requirement analysis for the bag. A user may not be able to engage with a device they have any concerns with or about, so it is important that through discussions and feedback, that anything which may prevent them from using it, or from the *message bag* helping them in their daily lives, needs highlighting and amending.

3.4 System Function

Our approach to design is inspired by research in distributed cognition [9]: we aim to ease the cognitive burden on the user by distributing memory to smart artifacts, in an aim to dissolve boundaries of the individual. We can see bag + individual user as a single distributed cognitive system, spreading cognitive load from user to the bag, enabling them to pack the bag as usual. Only in the case that they forget an important item, do they then need to act upon it. Alternatively, the message bag could be extended to incorporate communication from many individuals, making a one-to-many model of use, where there are several users communicating to one bag, which is specifically for one user. This distribution of information, possibly utilizing social media, messaging and similar other forms of communication, could mean further relief of cognitive load with users then effectively becoming less forgetful.

In this first prototype, due to the external LEDs the user can see which items are contained within the bag, through that recognition they do not need to take time to recall which items are present or that they have packed and they do not need to take time to go through the bag to hunt a specific item to see if they have packed it or not. Due to the prolific use of bags of some sort throughout our daily lives, the message bag would replace the users typical bag, and the design of the system would not require the user to understand it's inner workings. "*A good designer makes sure that appropriate actions are perceptible and inappropriate ones invisible*" [7]

4. DISCUSSION/FUTURE WORK

As this is an initial prototype, there are a few discussion points that have surfaced. One area noted was that more use could be made of the audio / visual aspect and cues for the user. Currently an audio cue tells them that an item (tag) has been scanned and registered by the reader and it is just a simple beep. This could be enhanced in a way to give the user and perhaps users who are visually impaired a clearer idea of what is missing. Another change that could be implemented in the next prototype would be the use of RFID as well as near field communication (NFC) which could have the added benefit of being integrated with the users mobile phone for example or a more complex reading / writing system for the users objects.

Figure 2. Early prototype of *message bag*.

Additionally, the intention is to ultimately link a further prototype *message bag* with a network connection making use of their personal network. Can their friends on Twitter help by sending appropriate messages? Could a community on Flickr trigger things through photographs? Can a text message from family keep them from forgetting an important item? Can existing data services / GPS be used to send reminders and visual cues? Do these messages become helpful or hindrance? Would there be any privacy issues to be addressed if the message bag becomes an extension of them? This network connection could not only accept the incoming messages as noted above, but could itself communicate to the user items of importance. Perhaps in a twist on messages sent to the bag, could the bag send a tweet or notify the user in some way when they have forgotten an item or something of note.

5. ACKNOWLEDGMENTS

Many thanks to Dr. Matthew Purver and Dr Tony Stockman for their on going support and guidance. This work was funded by the Engineering and Physical Sciences Research Council (EPSRC) as part of the Centre for Doctoral Training in Media and Arts Technology at Queen Mary University of London.

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