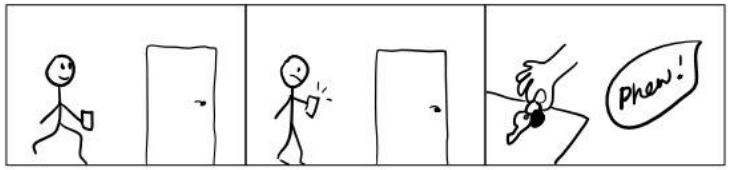

Figure 1: With Sticky Trackers, forgetting your keys is no longer an issue

Sticky Trackers: Customisable Wireless Tracking Devices

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Figure 2: A Sticky Tracker on a laptop charger

ABSTRACT

We present Sticky Trackers, a new system for tracking your possessions. Unlike traditional solutions Sticky Trackers allows the trackers to be programmed by the user so they are fully customisable. We track items through tracking stickers that connect to a mobile phone application and measure their distance from your phone. Our application allows users to invent simple blocks of code to program rules, which define a custom functionality for each sticker. In addition, users will be able to share this functionality by uploading their rules to a store for everyone to use. The results of a formative study show that most users said they would find Sticky Trackers helpful in their daily lives, and they would appreciate and use the option to share rules within their community.

CCS CONCEPTS

• **Human-centered computing** → *Collaborative and social computing devices*; *Mobile devices*;

CHI'19, May 4–9, Glasgow, UK

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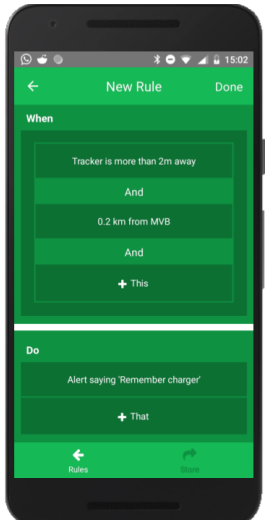

Figure 3: Creating a rule

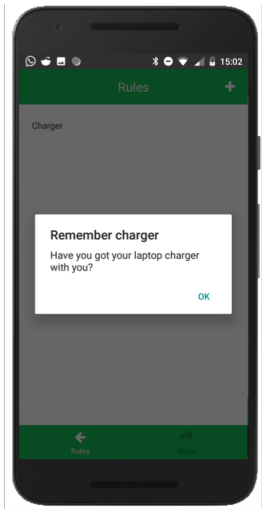

Figure 4: An alert reminds Bob to remember his laptop charger

KEYWORDS

Tracking, Bluetooth, Context aware application, Internet of Things

ACM Reference format:
Albie Baker-Smith, James Daly, Andreas Lazarou, and Izzy Newsham. 2018. Sticky Trackers: Customisable Wireless Tracking Devices. In *Proceedings of ACM CHI Conference on Human Factors in Computing Systems, Glasgow, UK, May 4–9 (CHI'19),* 7 pages.
https://doi.org/10.1145/nnnnnnn.nnnnnnn

INTRODUCTION

An article on the Harvard Health Blog[10] states that there are seven common causes for forgetfulness, one being stress and anxiety. This means people in pressured, stressful environments, like a university or workplace, can mindlessly forget simple routine tasks, such as taking an umbrella to work when it is a rainy day or remembering to take their keys when leaving the house. Our application (built using React Native[6]) provides functionality to allow the user to create fully customised reminders and use our tracking devices to track objects in their daily lives. The user can customise a 'rule' by creating a set of conditions (combined using AND/OR) such as the distance to tracker (using Bluetooth Low Energy), location, time, and weather, and deciding on how the application will act when the set of conditions is met, such as an alert, to send an email, to go to a website, or even change their thermostat.

Our idea is original as we merge pre-existing ideas such as the Google Keep app[8] and Tile[13] to provide users the ability to both track their possessions and customise how they are going to be reminded.

WALKTHROUGH

Bob is a student and he wants to stop forgetting his laptop charger when he leaves university. He attaches a Sticky Tracker to his laptop charger (see figure 2) and creates a rule by navigating to the new rule screen (see figure 3), choosing the conditions "Tracker is more than 2m away" AND "0.2km from MVB" and the action "Alert". The next day, as he is leaving university without his charger, he gets an alert on his phone reminding him to remember his charger (see figure 4).

RELATED WORK

Thousands of applications exist that are designed to help users with their daily lives and many are context aware, meaning they monitor clues about the environment to gain context information. This information is then used to help the user, such as remind them to do a specified activity. This type of application has been analysed by the HCI community and several design recommendations and frameworks have been proposed.

Technology	Advantages	Disadvantages
RFID	- Very cheap - No battery needed	- Short range (~60cm) - Phones cannot read RFID, therefore need additional reader.
Bluetooth Low Energy	- Longer range than RFID - Low power requirements - Small size - Low cost - Compatibility with most smartphones	- More expensive than RFID - Requires battery
GPS	- Can get location rather than distance (display on map)	- Low accuracy - Does not work inside - Not as easy to connect stickers to phone.

Figure 5: A comparison of tracking technologies

Dey et al [5] proposed and implemented a framework for rapid development of context aware applications with 5 separate components (context widgets, interpreters, aggregators, services and discoverers). Our application design implements most of these components with a high customisability level. It does not implement discoverers as the user's services are already stored on the application and if users want to discover other user's services they can use the store.

Stawarz et al [12] focused on analysing applications to support habit formation through contextual cues and implementation intentions (an if-then structured goal used to change habits). This is relevant as habit formation is an obvious use for our application, particularly implementation intentions as they also follow this if-then structure. The design recommendations that they suggested are to: support trigger events (for implementation intentions), remind users of trigger events before the trigger and to not allow users to solely rely on the application.

Pinder et al [11] also proposed design recommendations for implementation intention applications. The recommendations relating to our work (and not the ones focusing specifically on implementation intentions) are to support strong configurability levels, including room and object specific locations, and to let the user tailor notifications to suit them.

A successful context aware system that is rather similar to our idea is IFTTT (IF This Then That) [9]. It allows users to integrate existing devices and applications together to create If This Then That functionality. Our application is different as the tracker stickers can be stuck to anything and so we can track assets that do not normally have IoT capabilities. There are also existing asset tracking devices, namely TrackR [14] and Tile [13] which connect to an application and inform the user of the tracker's location. They are similar to our tracker stickers but are not customisable.

In summary, our application follows the above mentioned design recommendations where possible. We combine the ideas of IFTTT [9] and TrackR [14] and Tile [13] while also introducing a high level of customisation.

DESIGN

To start designing our prototype, we had to make a decision on which technology we were going to use for our hardware. To make an informed decision, we created a table containing the advantages and disadvantages of three technologies available to us at the prototyping stage (see figure 5). Understanding the differences between the technologies, we decided that Bluetooth Low Energy would work best with our application as it is compatible with most smartphones, provides the range our stickers need, and the hardware that provides BLE is relatively small. Ahmad, Lu and Ziaullah [1] also suggest that Bluetooth is the optimal technology for personal asset tracking.

We proceeded by implementing a static prototype of the user interface (see figure 6), which was evaluated in a small study focusing on usability to gather some formative feedback on how to improve the user interface and experience. The general notion of the feedback was positive. Users made

Figure 6: The New Rule screen from our Low-fi prototype

minimal mistakes when using the application and informed us that they understood how to use it without being prompted. Some participants thought that the size of the sticker was too large to be stuck to some items (such as a keyring), while others showed a genuine concern that our application can be used as a human tracking device - our consideration of this can be found below in *Ethics*. An observation of some of the participants was that the language used in the prototype could only be understood by computer scientists. Taking this feedback into consideration, we proceeded to create our application.

The application design follows many proposed design recommendations (see *Related work*). Sticky Trackers use the Adafruit Feather Bluefruit LE as a tracking device, which uses the Bluetooth Low Energy (BLE) technology to communicate with our application (built using React Native [6]). This provides our application with the functionality to calculate the distance between the smartphone and tracking device, by analysing the strength of the received signal strength indication (rssi). Our application also uses the Internet and GPS to allow the user to set conditions based on real time events (such as the weather or location).

EVALUATION

We ran a user study with 5 potential users to find out if they think Sticky Trackers is useful, and if the application is easy to use and understand. We explained the general idea, and presented a situation to them where they needed to remember their keys in the morning. A facilitator prompted the participant to create a rule to alert them when they forgot their keys and afterwards we held a short interview. We used thematic analysis and found two main themes relating to ease of use of the app - building rules and the user interface - and two themes relating to the usefulness of Sticky Trackers - the general concept and the store.

Building rules

All participants quickly understood how to build a rule, with most completing it confidently and quickly. They felt it was "self explanatory" and "pretty explicit, on my first time using it" which shows there is no learning curve to using Sticky Trackers. When asked to give a score out of 10 rating how easy it is to use and figure out, three participants said 7 and two said 8. There was however some mistakes when building a rule, the most common one being only setting one of the two conditions. This shows that users didn't know or think about the availability of compound conditions and one participant from a technical background was also concerned: "different flow to if then? I don't know how, but make it easier for others". However, once again when re-prompted to add a second condition, we found that participants had no issues at all and whilst one user from a non-technical background appeared hesitant they actually had no issues creating the compound rule. Indeed, Apple's inclusion of a similar interface in Siri Shortcuts [4] (following an extensive period of user experience evaluation)

and its success since release, is a reassurance that modern users are capable of comprehending this way of building rules.

User interface
Due to the use of platform-standard components and layout, and the close following of the Material Design guidelines [7] and Apple's Human Interface Guidelines [2], participants enjoyed the "simple, good" user interface which "looks cool, not too cluttered" and found navigation to be intuitive ("the app seems quite easy and natural to navigate through").

Concept
All participants in the user study appeared interested in and enthused by the concept of the product ("I like that, it's pretty cool", "It works! Cool! (big smile)"). Most (4/5) found it to be useful and they would use it in their daily lives, with many noting their forgetfulness ("I forget so much stuff", "Would be useful as I lose and forget things a lot"), implying Sticky Trackers would be a significant and useful addition to people's lives.

Store
Most participants (4/5) said they would use a store, allowing them to download other people's rules and upload their own rules, and one said "I could see that being helpful". This implies users would want to engage with others to help them make the most of Sticky Trackers. Some users had some concerns about the implementation of the store - one said it would be "hard to generalise, as for different houses (like a mansion versus a flat) the distance is different" and another thought it "might be difficult with the current infrastructure, as you would need to assign the downloaded rule to a specific tracker but you do that when you create the rule". These are valid concerns and need to be considered before a store can be fully implemented.

APPLICATIONS AND FUTURE WORK

The prototype of Sticky Trackers aims to demonstrate the capabilities of current tracking technologies and how these can be put in everyday use. A simple example is to be alerted if you forget your umbrella and it is forecast to rain during the day. Other applications include: informing parents about the location of their child when they need to leave them unsupervised; loss prevention, such as being informed if a thief has pickpocketed your wallet; and group notifications, such as automatically emailing a lecturer's students if they are not at their desk during office hours.

New functionality can be easily added due to the modular structure of the codebase. For example the application could be integrated into smart houses, allowing the users possibilities such as turning off the lights if the user is not home.

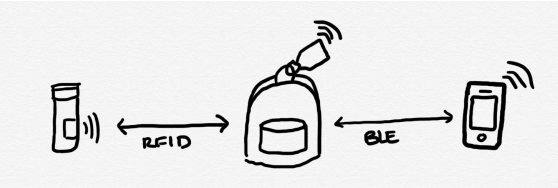

Figure 7: Using RFID stickers with BLE beacons reduces the need for power supplies and the cost.

As mentioned before, we envision the availability for the users to upload their rules, and download and rate other people's rules through a store. This provides the ability for new users to find pre-built rules that might apply to their situation and provide them with a starting point on how to create their own rules. It also provides a place for users to share their rule designs with other users, increasing the accessibility of our product by allowing users to make use of more complex rules without needing the ability to create them themselves.

Groups of users can also share the same rule, creating a sense of community if, for example, the aim was to avoid alcohol, or study more. The rule could be designed to notify everyone in that group when a member achieved something. This will contribute to the interactivity of the application. Another popular idea is when multiple users have a rule based around one shared resource, such as a car or the house keys on night out. This rule could be synchronised among all users, and notify other users when the resource is in use.

As the prototype has been successful, the tracker stickers could now be reduced in size and made more aesthetically appealing. Further functionality could be implemented in the hardware, to allow the user to fully customise the tracker, such as playing selected songs or providing oral directions to the position of the item. In addition, the use of a variety of technologies to provide new form factors for devices, such as flexible and inexpensive RFID stickers without the need for power supplies, which will increase the accessibility of the product both in utility and economically. An envisaged design for this ecosystem would use BLE trackers, on items such as bags, as "beacons" for passive RFID trackers on items which would be expected to stay nearby, such as a water bottle (see figure 7).

ETHICS

Unfortunately, there is potential for abuses with any system, especially those relating to people's locations and personal information. Currently, the product does not collect or store any personally identifiable information, and when the store is implemented this will remain the case.

The potential for misuse for malicious tracking activity is a serious concern. However, by not utilising GPS/A-GPS technology to provide the trackers with the absolute location, we reduce the capability for malicious tracking. Thus there is a much lower possibility for misuse with Sticky Trackers than other mobile applications, such as Find Friends [3].

CONCLUSION

Sticky Trackers provides an interactive solution to improve the daily struggles of individuals by tracking their possessions. Most of the participants in our study provided us with positive user experience feedback and assured us that the need for our application exists in the market. By enhancing both the software and hardware Sticky Trackers could become one of the most useful applications on a user's phone.

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