WildSnap: Mobile Android application for wildlife/plant identification

Christa Cody (cncody), Chris Brown (dcbrow10), Nicolas Mignotte (nbmignot)

Table of Contents

Introduction and Motivation

From wildlife experts to wildlife hobbyists, anyone exploring nature will eventually run across an animal or plant they can't identify. Currently, there are multiple ways to identify unknown wildlife and plants including books, websites, expert advice, and mobile applications. However, for someone looking to quickly identify an animal or plant, their choices are limited. Mobile applications that exist for wildlife identification and tagging are targeted at people with advanced knowledge about nature and intended to be used under no time constraints. Being directed at expert audiences, the layout requires some level of expertise to use. In this mobile interaction project, we developed a proof of concept for an application called WildSnap that allows users to identify and tag wildlife and plants using pictures taken from within the app while providing a social media aspect. This application expands from existing applications to include fast interactions, a wider audience, and gamification to promote the retention of users. This application will provide insight into HCI issues such as mobile application design for time-constrained interactions as well as user interfaces that encourage retention within the app.

Related Work

Mobile wildlife identification applications and websites currently exist. However, these applications are limited by their features such as:

- very complicated and technical interface,
- requiring the user to identify observations using scientific guides, or
- only providing resources for identifying certain classes, such as flowers, birds, amphibians.

One mobile and web application, iNaturalist (http://www.inaturalist.org/), provides users the ability to log observations using latitude/longitude, time and date of observation, and user entered species name. This requires the user to identify the species observed limiting its application to audiences with advanced knowledge on wildlife and plant life. Also, the design of the application makes it more suitable for less time-constrained identifications and uploads. WildObs (http://wildobs.com/) is a mobile application that allows users to share observations via text-based logs with or without photo, learn new information about species, and view other user's' logs. However, this application relies on the user's ability to identify wildlife or plants and doesn't provide any other interactions between user's besides viewing galleries. Project Noah (http://www.projectnoah.org/) is another mobile application for wildlife and plant observations that allows a user to upload pictures of flora and fauna for identification through field guides. This application includes the ability to join missions and earn patches, which provides a gamification aspect. However, it does not provide any identification services outside of field guides or help by other users, and it doesn't provide social interactions besides allowing users

to view other's observations. Furthermore, there are a wide range of apps that are targeted only at specific observations such as birds, reptiles, or plants and only observations in specific areas such as NYC.

Within HCI literature, there are numerous resources providing guidelines for the design of mobile interfaces [3]. One guideline developed shows how traditional guidelines for user interfaces can be transferred to mobile interfaces and expands on this knowledge to provide mobile-specific guidelines while acknowledging the challenges presented in mobile interface design [5]. Most notably from these guidelines is designing for speed and recovery. Our main focus in this project was to develop a system with a priority of speed. This paper influenced us to include not only fast interactions, but ways to easily recover. For example, after leaving the initial camera screen, the user is always one button click away from being back on the camera screen. This reduces recovery time if a user were to accidentally exit the camera screen. The main goal of the app is to provide quick access for taking pictures so that users can snap photos of wildlife on the go without missing an opportunity due to too many steps to take a picture. However, apart from these guidelines and similar guides, there is limited research focused on the issue of designing a mobile interface in order to carry out an action under time constraints. Thus, our application would provide insight into the mostly unexplored domain of time-constrained interactions in mobile interfaces. Furthermore, this application will address interaction issues including user-friendly interfaces and maintaining user interactions. We designed a user friendly interface by taking the burden of identification off of the user and avoiding being overly technical or scientific so that little knowledge of wildlife/plants is needed to use the system. Furthermore, we capitalize on existing user interfaces in social media apps to provide a familiar design in a new domain.

Also, gamification of the observation process via achievements will provide insight into maintaining user attention in less explored fields such as wilderness identification. We based this design decision on existing research such as research involving the popular website Stack Overflow [4]. This research showed that badges influenced user behavior and in some circumstances increased user activity. In WildSnap, users can earn points and improve their profile achievement status by interacting more with the system and performing activities such as uploading and identifying more pictures, following other users in the WildSnap community, liking and commenting on other users' pictures, etc.

Finally, much research has been conducted involving the importance of the potential connection human beings can create with nature through technology. In papers by Bronwyn, Paay, Kjeldskov et al., methods regarding using technology to promote interactions with nature are explored [2]. The researchers determined key motivators for children to stay engaged with technology and nature included social opportunities and opportunities to learn. We intend WildSnap to add to this work by creating an interface simple enough for beginners, such as children, to use while still encouraging users of all areas to explore their local environment and identify local plant and wildlife near their current location. Therefore, we are decided to include social opportunities in the form of social media features (likes, comments, and friends).

Task Domain, Target Users, Representative Scenarios

Our mobile application is unique in that it will provide auto-detection using an image search, allow quick picture taking, provide a non-technical user-friendly interface, and promote retention through the use of gamification techniques. The application is intended for all audiences and could be used by nature groups and clubs, classrooms, or casual users to engage people in friendly competition while educating them about nature. The application is intended to be used in any situation in which the user may wish to identify an animal or plant including indoors or while hiking. Although identification depends on internet access, the user will be able to wait until they have internet access to identify without interfering with picture taking. Users will be able to gain points and earn achievements that improve the status of their profile by posting and tagging their photos. This application will also be available for both wildlife and plant life rather than limiting the user to only be able to research a specific type of animal, environment, location, etc. Most importantly, we've designed the application to provide fast interactions for users who will want to document observations on the spot. The following scenarios represent usages of our application:

Scenario 1: A group of middle school students go on a hike with their local wildlife club. They decide to use WildSnap to keep track of various wildlife and plant life they see. The group leader creates a competition where the top 3 groups with the highest amount of points will win a prize. The groups split up and begin exploring the trails. One group runs across an insect and takes a picture with the app, which determines the insect is a Luna moth caterpillar. At the end of the hike, the group leader looks at the profile pages of each of the groups to see how many points were earned.

Scenario 2: A woman has advanced knowledge about wildlife identification and pursues this interest by tagging and identifying wildlife on weekends. While she is hiking one afternoon, she spots a unique looking animal and opens WildSnap. She is immediately presented with a camera and is able to take a picture before the animal runs off. She saves the picture and later uses the identify option to identify the animal.

Scenario 3: A family has been having an animal infestation problem in their house and would like to know if the animals were poisonous or venomous. No one in the family has any experience with wildlife identification, but the simple design of WildSnap allows them to take pictures and identify animals (insects, snakes, etc.). One evening a small snake is found in the corner of a closet, the father takes a photo from a safe distance, and identifies the snake to be a species that is non-venomous. He is then able to carefully capture and release the snake back outside.

Evolution of Design

Discovery

Paper Prototypes

To refine our original proposal, we created paper prototypes to use in interviews with randomly selected individuals. The sketches for the paper prototypes can be found in the .zip file under "Initial Sketches." The interviews provided valuable feedback from potential users and generated two overall views from our initial design. One major theme was to make our application more focused on nature. Users wanted an app that would be able to quickly identify animals and plants in nature without much hassle. Therefore, we decided to create a simple, non-technical user interface and automatic image identification within the system.

The other general feedback from our low-fidelity prototypes was to make our tool WildSnap more of a social media experience. Some of the feedback we received to support this included comments such as we should add functionality to match profiles and suggest "friends" based on similar photos tagged and identified between two different users, and come up with a way to group and display all of the pictures with the same tags and identified objects. For example, one participant suggested being able to see all of the cat pictures posted by other WildSnap users. Other comments to improve the social media experience of our app came with how it interacts with other systems such as if it would be possible to share the photos taken using WildSnap with other social media tools (specifically mentioned Facebook, Twitter, and Instagram) and can users create and post short videos (SnapChat and Vine). These changes would make our system similar to popular social media websites to increase interactions between users of WildSnap and other online communities.

We ultimately decided to limit the extra social media content in WildSnap and justified this design decision because we felt that, while it would be a good idea to implement for younger users heavily-involved in social media websites, it would be out of the scope of the quick, effective nature identification app we wanted to create. Nonetheless, we incorporated the ability to have friends, user profiles, likes and comments, and gamification by using status levels and achievements to encourage users to gain more points from using WildSnap.

Survey

Another method we used to decide on features to use in our system was by conducting a survey. This survey contained 5 questions that gauged the knowledge of wilderness the respondents had, their satisfaction levels with current identification applications, and which features they felt were needed or important. Approximately 80 percent of the 58 respondents said that they would definitely like to see easier identification and faster interactions. Multiple respondents reported that a quick photo identification function would be an important feature. One user specifically mentioned that having a way to provide quick feedback on identification rather than waiting for expert advice would be an important feature. The feedback heavily focused on identification methods with only around 20% of respondents interested in gamification, which solidified our decisions to focus on identification. However, the average knowledge of nature indicated by respondents suggest them to have advanced knowledge in this area. Therefore, in interest of making the app appealing to all audiences, especially those with less knowledge, we decided to keep the gamification aspect without making it a focal point of the application. The full survey with results can be found in .zip file.

Design

       Proof of Concept

       Due to the complexity of our project, we decided that doing a proof-of-concept would be the best way to show the usefulness of our application without requiring developing a auto-identification method. Our application shows, in theory, how fast interactions can be achieved and how this would provide useful insight into HCI techniques involving applications that would require the user to make quick decisions.

       Re-Design

       After sketching out designs for the system and choosing important features, we used discovery methods, as previously mentioned, to make re-design the system to focus on photo identification and fast interactions.

       Important features of focus

       All of the design decision and features we focused on while creating WildSnap were for quick and efficient object identification when interacting with nature. Several of these features include limiting WildSnap and deciding not to connect with other social media sites despite feedback from our low-fidelity prototypes, having the application open on the camera as soon as it's open, and taking 3 pictures at a time when using the camera. Connecting with other social media sites such as Facebook, Twitter, Instagram, SnapChat, etc. has some advantages, such as attracting more teenagers that users, however it would turn away a larger part of the population for potential users such as the older adult men and women, younger children, and students in class because teachers and administrators would probably be less likely to let students use WildSnap for school if it could connect with other social media sites. Bronwyn et. al stress the importance of interacting with the environment, writing that it is "vital" that children have regular experiences with nature for their development and encounter elements in nature "without human influence" [2, (189)]. The authors also emphasize the need to have more technologies that encourage direct interaction with the physical environment and engagement with local nature [2, (190-192)]. Linking WildSnap to other social media outlets would take away from users' outdoor exploration and keep them from truly experiencing the natural environment around them.

       We decided to have the application immediately open on the camera because the user will only have a limited time to take a picture in circumstances involving fast moving wildlife. For example, if a user sees an unknown animal they want to identify, they will need to take a picture before it runs or flies away. Directly opening the camera allows users to have direct access to the function they need most. Also, when the user hits the take button, the camera takes 3 consecutive pictures to account for animals moving as the pictures are being taken and prevents the user from having to continually hit the take button to get a good photo. Our overall design is intended to keep the interface simple and social media interactions minimal so that the system could be enjoyed by nature novices and experts during interactions with nature.

Implementation

We decided to create a mobile application because that would be the best way to implement our idea. The mobility of cell phones and tablets provide a quick way to identify sightings. WildSnap was originally developed as an Android application, but in the future it could also be expanded to other mobile platforms such as iPhone, iPad, and Windows phones and tablets.

Written Walkthrough

To use WildSnap, the first interface that appears when opening the application is the camera screen which allows users to take pictures of the object they want to identify:
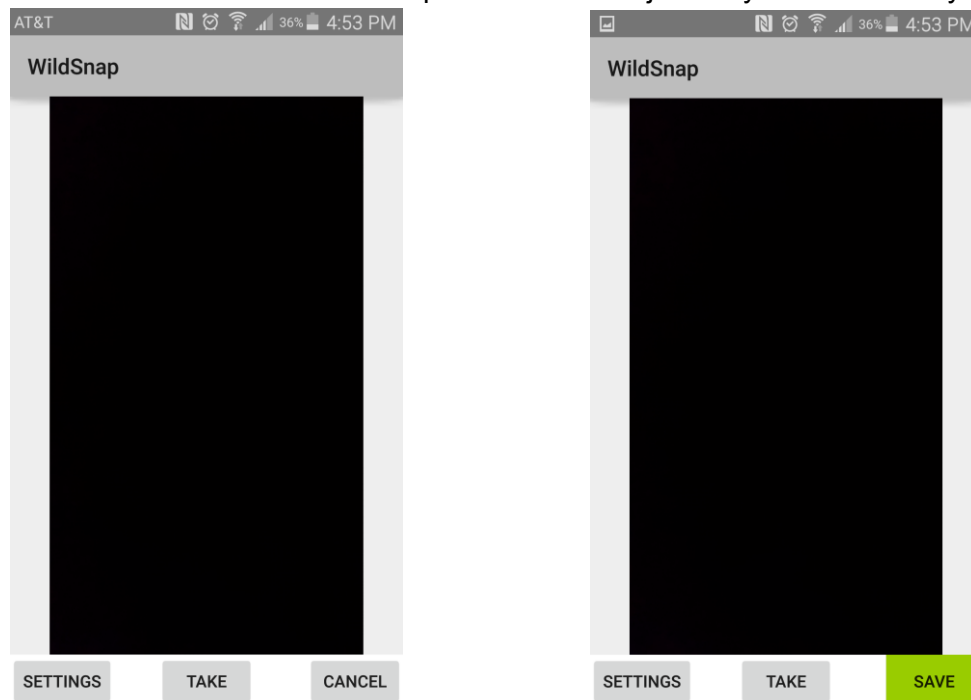
Advanced users and photography experts will also have the option of changing the camera settings to improve the quality of their pictures using the "SETTINGS" button. For users that aren't currently interested in taking pictures and want to go straight to their profile page, the "CANCEL" button in the bottom right-hand corner will skip over taking pictures and go straight to their profile. Otherwise, the user can take pictures with the "TAKE" button in the bottom middle of the screen. Once the "TAKE" button is hit, the camera will take 3 pictures. Then, the "CANCEL" button will switch to a green "SAVE" button. After hitting the "SAVE" button, users will be taken to another screen to save the photos they want.

The next screen that users will encounter after they have taken pictures of the item they would like to identify is a page to save the pictures they want to add to their gallery.
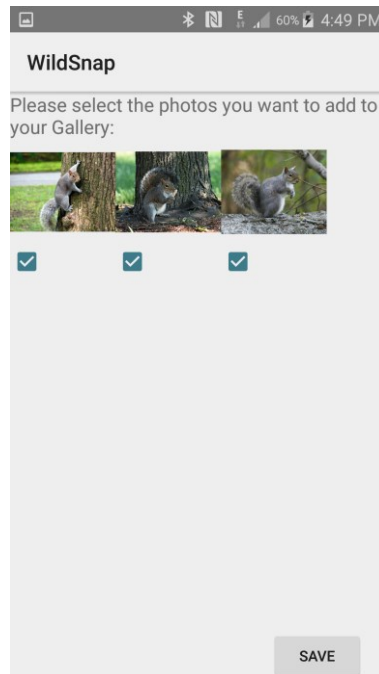
To save pictures, users will simply need to select the checkboxes below each of the photos that they would like to save to their gallery. When they are finished selecting the photos they want to keep, the users can click the "SAVE" button which will save the selected photos and take the user to their WildSnap profile page.

The profile page is the main social media aspect of the application, which allows users to form a community by following other people's profiles, liking and commenting on pictures, etc.
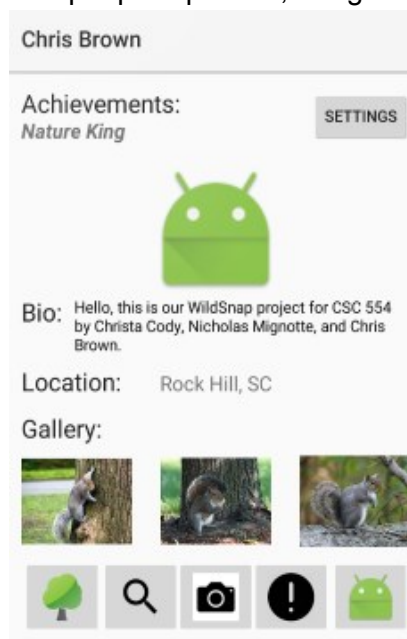
The user profile page is where the identified images in their gallery are stored as well as information on the user themselves. The first time a potential user downloads our mobile

application and opens WildSnap, they will be required to create a new profile using their first and last name, a personal email address, and create a unique username with a password to log in. Every profile page will have the user's name displayed prominently across the top of the screen and users will have the option to add a profile picture to their page. The user profile will also display more information that will be visible by other WildSnap users including a short biography, current location, their picture gallery, and their WildSnap achievements. These achievements are based on the number of pictures added to the gallery as well as interactions within the app. Sample WildSnap achievements include *"Novice Explorer"* for beginners, *"Naturalist", "Eagle", "Wilderness Expert", "Nature King/Queen"*, etc. This form of gamification allows users to compete with each other to reach achievements and gain points by taking more pictures to identify and liking or commenting on their friends' pictures. The "SETTINGS" button in the top right corner allows users to change and modify any of their profile information.

On the profile page, the user can select any picture in their gallery to view. The user can look at the tag, likes, comments, and use the "IDENTIFY" button to identify the sighting.
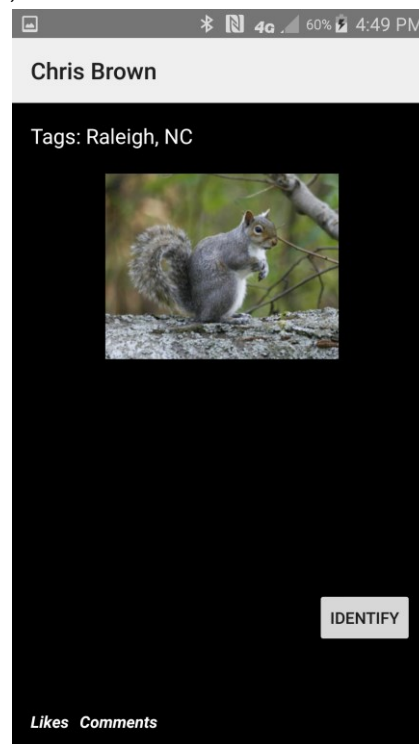
Pictures that have not yet been identified will be displayed with a label for the tagged location of the picture at the top of the screen as well as links to see which other users liked or commented on the photo. The "IDENTIFY button is used to identify the object in the selected picture when clicked by the user. The photo identification works by loading the current picture into an image identification search engine and returns the result to the screen. Once the system has found a match, the screen is updated with text to let the user know that we have identified their object. The example on the screenshot shows a squirrel as the identified wildlife; however, we intend for the real identification to be more specific (e.g. Eastern Grey Squirrel).
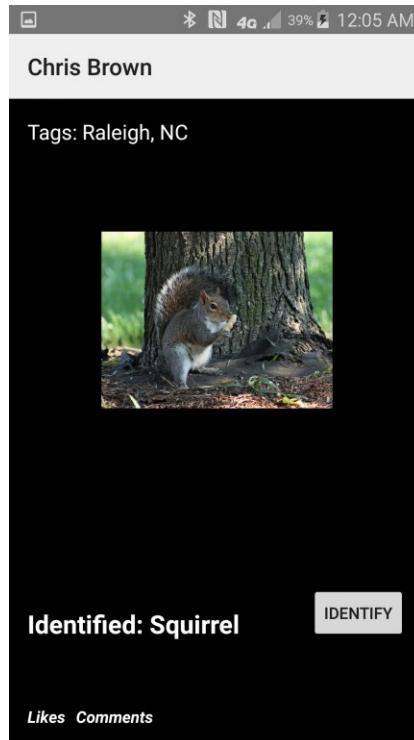
The five buttons in the bottom row of the profile page add to the social media experience of using WildSnap and also provide quick access to other parts of the system:

This button returns the user back to their own personal WildSnap profile page.

The tree icon button links to the WildSnap mobile application homepage. The homepage will connect users with their friends and followers within the app and notify them of new photos those users have updated and identified.
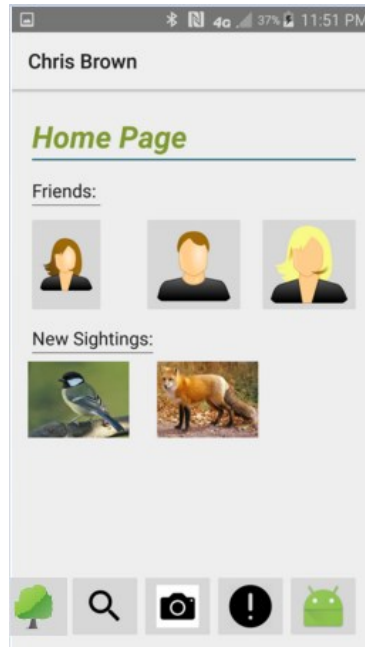
 The search button allows users to search for other users in the system to view their profile. The search page automatically shows top users and new sightings and can sort images based on a given search criteria in the search bar.
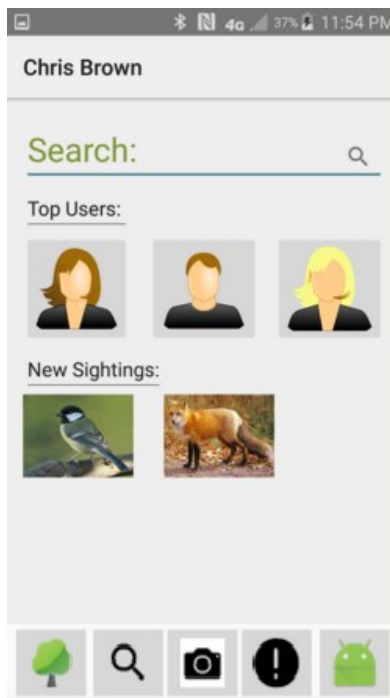
The camera icon button takes users directly back to the camera screen to take more pictures.

This is the Notifications button that will take the user to the notifications page which displays alerts for whenever their profile is updated with a new achievement, another user liking or commenting on a photo in their gallery, etc.
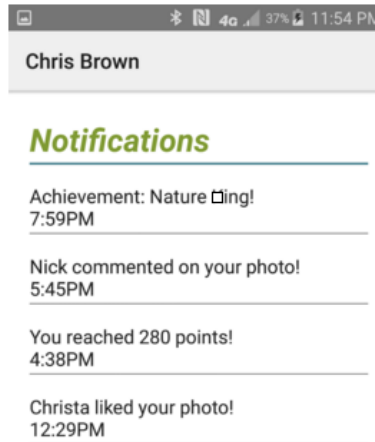
Analytical Evaluation

To analyze our product, we decided to use the Keystroke-Level Model to represent a specific task for our system [1]. We chose to use the keystroke-level model (KLM) because it is helpful for tracking user actions to estimate the efficiency of design by completing a given task by breaking it down into subtasks based on human input and system response within the application. The KLM is also composed of six operators to represent the user's physical motor actions such as keystrokes (K), pointing with the mouse (P), homing hands to the keyboard (H), and drawing line segments (D), cognitive mental actions from the user's perspective (M), and an operator that takes into account the response from the system itself (R). For our study we had to modify several of the operators for computing a task on a mobile device rather than a computer system, for instance the keystrokes were counted as number of taps on the phone screen, pointing with the mouse would be moving your finger to point to the desired area of the app, and we assumed that the user's hands would always be homed on the mobile device.

Our team also created a KLM for completing the same task using the related application iNaturalist, to see how WildSnap would compare with an existing application that has a similar purpose. We performed the keystroke-level model on the same task used in the analytical evaluation for both WildSnap and iNaturalist. After modelling the task on both systems, we found that WildSnap is faster, more efficient, and requires less cognitive and physical operations by the user to complete the given task. The results from the experiment can be seen in Figure 1:

KLM WildSnap:

M[start] **K**[take picture] **R**[system takes and saves 3 pics] **P**[find save button] **K**[tap save button] **M** (Number of Pictures)*(**P**[find pictures to save] **K**[click on desired pictures]) **P**[find save button] **K**[tap save button] **R**[save pics to gallery] **P**[find picture in user gallery] **K**[tap picture] **P**[find identify button] **K**[tap identify button] **R**[system identifies photo]

KLM iNaturalist:

M[start] **P**[find plus sign to add observation] (1)(**K**[tap plus sign] **K**[select "Take Photo" option in menu] **K**[take picture] **R**[system takes picture] **P**[find OK button] **K**[tap OK]) **P**[find Edit/Save Observation] (more K's needed if users want to enter more information such as description, date, name, etc.) **K**[tap Save Observation] **R** **P**[find Sync observations] **K**[tap Sync Observations] **R** [system syncs] (2)(**P**[find picture] **K**[tap on picture] **P**[see feedback] **K**[tap to see feedback])

(1): sequence in brackets has to be repeated to take several pictures
(2): sequence in brackets has to be repeated to wait for an response and get an actual identification

Figure 1: KLM modeling of a meaningful task executed in Wildsnap and iNaturalist

This shows that WildSnap is faster to operate than iNaturalist and more efficient and convenient for users who would like to identify pictures they have taken. Our system needs a minimum of 16 operators required by the user to identify their picture while the competitor needs at least 18. Additionally, our application allows users to take, save, and identify multiple pictures at a time adding only one additional **K** operator for every 3 pictures while iNaturalist only allows users to take and upload one picture at a time with an extra **K K K R P K** operators per new picture. WildSnap also identifies the provided pictures automatically with immediate feedback while iNaturalist users will have to post their observations and wait for other users and experts within the community to identify their photo and respond to the post by adding a comment.

Some of the drawbacks to using the KLM are that it doesn't take into account other types of human-computer performance such as Errors, Learning, Functionality, Recall, Concentration, Fatigue, and Acceptability [1, (396-397)]. However, in this case we were only focused on time and wanted to prove that speed and efficiency to accomplish the goal of photo identification is the main advantage to using WildSnap and is also what makes our proposed system a better design when compared to other existing nature image identification applications such as iNaturalist. Additionally, the KLM study by Card, Moran, and Newell provided estimated execution times to complete each of the operators to project how much time it would take a user to complete a given task, however we felt that these calculations would not be applicable to our system because it is on a mobile device rather than a computer system and the interactions would be different from what the authors originally proposed. For example, the time commonly associated to P is 1.10s. It is the time required for a pointing device to point on the screen. In the case of a mobile device operated through a touchscreen, this operator can not be applied

consistently as it can be hard to track whether do need time to move his pointing device (his finger) or not. Moreover, the computing time R is different on a mobile device due to the limited resources such a device can get access to.

Empirical Evaluation

After completing our proof of concept, we evaluated our mobile application by testing our project implementation of our system to various users. We made sure to check with a wide variety of users from different ages and demographics, technology experience levels, and nature background because we want WildSnap to be user-friendly for any potential users. Our seven participants ranged from age 16 to 55. To test and evaluate the application, we gave our testing subjects a task to complete and measured the time it took them to finish the task with limited instructions and previous knowledge of the system, and performed a quick post-survey to see what they liked about the app, and what they would improve. The provided included:

1. Opening the application on a mobile device.
2. Taking a picture of an object.
3. Saving the picture.
4. Using the app to identify the object in the picture taken.

We decided to use this task for our analytical evaluation because our discovery survey results determined that the most desired use for our system is image identification. We received similar feedback from all of the participants in our study on what they liked about the application and what they would like to see improved. All participants expressed interest in using our system and really liked the concept of our application. Testers believed WildSnap would be useful and helpful in identifying unknown objects in nature and helping them learn about their natural environment. One user commented that this would be "great to have on hikes" and another mentioned it would help her learn animals in the area. The testers also thought the design was good overall, with a specific tester mentioning that he really liked the buttons at the bottom of the profile page to provide quick access to other screens in the app.

The participants also provided some valuable feedback and suggested improvements for our system that we could consider in the future. Several users suggested adding more information about the identified object to help users learn more information about the animal or plant rather than just identifying it. One of these testers also inquired about the detail of identification while using the high-fidelity prototype, since our proof of concept identifies the example as a squirrel but there are many different types of squirrels around the world. We also had another request to be able to connect to other social media (specifically Facebook or Twitter) and able to import and share pictures between the sites. One tester also noted that there should be more emphasis on location and searching for users and identified photos near the current user. Other suggestions included several minor improvements to the user interface including larger font size to make the text easier to read, more images and pictures within the app,

The testers took an average time of 24 seconds to complete the given task. To provide a comparison to our analytical evaluation, we also asked the users' to perform a similar task on

iNaturalist and the average time to complete the task was much worse taking about 48 seconds (and one participant didn't finish)... This solidifies the results from the KLM evaluation that show WildSnap to be faster and more efficient. Furthermore, the users commented that iNaturalist was more technically complex and required a significant amount of additional input to complete the task, which suggests that it would entail a higher cognitive load agreeing with the KLM evaluation.

The full interviews can be found in the "Extra Explanations" document in the .zip file.

Conclusion

In conclusion, we believe that our system WildSnap can encourage people to spend more time interacting with nature by helping users quickly identify animals and plants that they come across in their local environment. Our discovery methods and high fidelity prototype show that our concept is desired by a wide variety of potential users from a large range of backgrounds. Our proposed system provides more efficient identification than most existing related mobile applications as shown by the keystroke-level model. Furthermore, the use of mobile interaction techniques could provide insight into HCI issues such as time-constrained interactions and maintaining user interest.

Bibliography

[1] *Card, S. K., Moran, T. P., and Newell, A. (1980). The keystroke-level model for user performance with interactive systems, Communications of the ACM, 23, 396-410.*

[2] *Cumbo, Bronwyn J., Paay, Jeni, Kjeldskov, Jesper, and Jacobs, Brent C. 2014. Connecting children to nature with technology: sowing the seeds for proenvironmental behaviour. In Proceedings of the 2014 conference on Interaction design and children (IDC '14). ACM, New York, NY, USA, 189-192.*

[3] *Kjeldskov, J., & Dam. (n.d.). Mobile computing. In Mads (Ed.), The Encyclopedia of Human Computer Interaction. Denmark: The interaction Design* and *Rice, A. D., & Lartigue, J. W. (n.d.).*

[4] *S. Grant, and B. Betts, "Encouraging User Behaviour with Achievements: An Empirical Study,", In Proceedings of the 10th Working Conference on Mining Software Repositories, May 18-19, 2013, San Francisco, CA, USA, pp. 65-68.*

[5] *Gong, Jun, and Peter Tarasewich. "Guidelines for handheld mobile device interface design." Proceedings of DSI 2004 Annual Meeting. 2004.*