Dance Your Work Away: Exploring Step User Interfaces

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Abstract
While applications are typically optimized for traditional desktop interfaces using a keyboard and mouse, there are a variety of compelling reasons to consider alternative input mechanisms that require more physical exertion, including promoting fitness, preventing Repetitive Strain Injuries, and encouraging fun. We chose to explore physical interfaces based on foot motion and have built two applications with Step User Interfaces: StepMail and StepPhoto. Both support working with email and photos using the dance pad made popular by the Dance Dance Revolution (DDR) game. Results of a formative evaluation with ten participants suggest that the interactions are intuitive to learn, somewhat enjoyable, and cause participants to increase their level of exertion over sitting at a desk. Our evaluation also revealed design considerations for Step User Interfaces, including balancing effort across the body, avoiding needless exertion, and choosing target applications with care.

Keywords
Step user interfaces, physical interface, fitness.

ACM Classification Keywords
H.5.2 User Interfaces: Input devices and strategies.

Introduction

Rising obesity rates and increasing incidents of Repetitive Strain Injuries (RSI) are among the compelling reasons to consider input mechanisms beyond the desktop. Our goal is to help people continue being productive at their computer-related tasks while incorporating more physical movement and a greater level of enjoyment into their daily activities. While not a substitute for aerobic exercise, we feel that using Step User Interfaces (Step UIs) is similar in benefits to taking the stairs instead of the elevator. In addition, research has found that taking small breaks during the day is one of the most effective means of preventing RSI [1].

To investigate interfaces that encourage physical movement, we have built two applications with Step UIs: StepMail for managing email and StepPhoto for working with photos. We purposely selected applications that we believed might be used in different contexts in order to provide insight into how Step UIs might function in different environments (e.g. office vs. home and by yourself vs. with others). While several research projects have looked at physical interfaces for fitness and exertion, most focus on games [e.g. 2, 7, 8]. Our goal is to take tasks the user already performs and make them more physically exertive.

Foot interactions have previously been used as a way to navigate virtual worlds. For example, LaViola et al's [5] Step WIM tool allowed users wearing augmented slippers to navigate a virtual world by stepping on a map projected on the floor. NEAT researcher Dr. Levine has explored another approach to encouraging physical activity by creating computer workstations where the users are constantly walking while they work [6].

Step UI Applications

While building StepMail and StepPhoto, we explored several types of step commands including a *single step*, where the user hits one button, a *step and hold,* and a *dual step,* where the user simultaneously hits two buttons, typically by jumping. We used the 6-key metal Dance Dance Revolution™ dance pad [4] measuring 34 inches square (Figure 1) as our input device. We included sounds in both applications to indicate command execution.

Figure 2 shows the StepMail interface and commands for scrolling, opening, closing, deleting, flagging and placing messages in folders. StepMail is designed to work in conjunction with Outlook by providing an alternative means for managing messages. The up and down buttons auto repeat when a step and hold command is used. Flagging, deleting and filing are all dual step commands. We selected email because many office workers spend considerable time each day handling messages.

StepPhoto supports sorting and reviewing digital photos. As shown in Figure 3, the interface has a horizontal stream of photos with bins above and below. Using single step commands the user can scroll left or right through the collection of photos, sort the photos into two different bins with configurable labels (labeled People and Animals in Figure 3), and select different bins to work with. Zooming the center image is accomplished via a step and hold command.

Formative Evaluation

We conducted a formative evaluation of our Step UIs with 10 participants (six males and four females). Based on our design goals, we focused on evaluating

Figure 1. Lab Setup

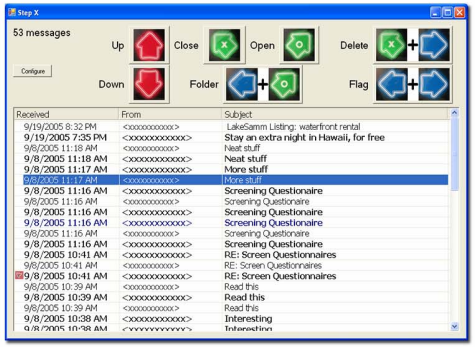

Figure 2. StepMail

Figure 3. StepPhoto

exertion and the level of enjoyment our participants experienced rather than the more traditional metrics of task success and speed. We were also interested in the participants' reactions to Step UIs and whether they could envision using the applications in their daily lives.

Method: Participants were research colleagues, all experienced computer users, ranging in age from their 20's to 50s. Seven of the 10 had some experience with the game Dance Dance Revolution. Upon entering the lab, participants completed a background survey regarding their email behavior, experience with and use of digital photos, and exercise habits. Participants then completed tasks with StepMail and StepPhoto projected on a large screen (Figure 1). The ordering of the applications was counterbalanced among participants. Participants wore a heart rate monitor to record their level of exertion and took a post-survey after using each interface.

When using StepMail, participants worked with their own email inboxes. For some consistency we seeded participants' inboxes with several messages. All participants then completed the same set of 4 tasks that involved reading, deleting, and flagging these messages. Next, to allow participants time to fully experience the interface, we asked them to use StepMail for 5 – 10 minutes on their own.

For StepPhoto we provided a collection of photos, rather than ask users to bring their own. We again began each condition with specific browsing and sorting tasks. For the last task, participants picked their favorite five photos from a collection of 60 photos to encourage them to experiment with the interface.

Results: The responses on the background survey suggested that our participants were a reasonable target population for StepUIs. All participants use a computer for more than 5 hours on a typical work day. Participants agreed that exercise is important to them (med. = 4, scale of 1-Strongly Disagree to 5-Strongly Agree) and that finding time to exercise is challenging (med. = 4.5). Participants also reported some challenges with email and digital photo management. Participants agreed that "email cuts into the time I

want to spend on other tasks" (med. = 4) and that "managing my digital photos takes a lot of time" (med. = 4.5).

Level of Exertion: Based on the wizard of oz studies we conducted in our design phase, we did not expect the Step UIs to cause aerobic exertion, but hoped that participants would feel they were expending some effort. On a scale of 1-Little Exertion to 7-Considerable Exertion, participant's median response on the post-survey was 4 for StepMail and 2 for StepPhoto.

We computed the participants' resting heart rates by averaging their heart rate while they were seated doing our surveys. We determined the application-use heart rate by averaging their heart rate for the duration they were doing trials with each application. Training time was not included in either calculation. On average StepPhoto promoted a 13% increase in heart rate over the resting heart rate and StepMail caused a 19% increase. Participants' average heart rates were significantly higher while using StepMail (paired samples t-test $t(9) = -3.5$, $p < 0.007$), validating the survey responses on level of exertion.

While the Step UIs cause some exertion, the most popular benefit appeared to be a break from the keyboard. Comments from the surveys included "I liked the excuse to hop around – it is nice to stretch out my muscles – they get so sore from sitting all day", "This might be a nice way to reduce RSI problems" and that a favorite thing was "not being hunched over a keyboard to read email [or] while sorting photos."

Some aspects of the exertion were less popular. The tasks in StepPhoto required considerable use of one leg and several participants complained of getting tired. For example, "my left leg got tired because it ended up supporting most of my weight." Two other participants discussed sore ankles in general, mentioning twisting motions and poor shoes for the activity.

Question ("X" = application)	Photo	Mail
1. Using "X" was fun	4.5	5.5
2. I thought using "X" was boring	3	1.5
3. I enjoyed using "X" very much	4	5

Table 1: Median response on 1 – 7 scale: 1 - Not at all true, 4 – Somewhat true and 7 – Very True.

Enjoyment: We assessed enjoyment using questions from the Intrinsic Motivation Inventory Interest and Enjoyment subscale [3]. Table 1 shows that on average people were somewhat positive about how fun and enjoyable it was to use the applications. The response for Q1 is significantly different based on a Wilcoxon signed ranks test ($z = -2.16$, $p < 0.05$), suggesting people enjoyed StepMail a little more. Comments and our observations suggest that some of the additional enjoyment might stem from the use of dual step commands (particularly delete). As one participant said, her favorite thing was "jumping to delete messages. It was like stomping them out." Another said: "It *is* satisfying to do the double-jump thing to get rid of email. Bam!"

Satisfaction and Intent to Use: Participants' agreed that both applications were easy to use and easy to learn (med. = 4, scale of 1-Strongly Disagree to 5-Strongly Agree). However, when asked how satisfied they were with the two applications for their respective tasks the median response was more neutral (3.5 for StepMail

and 3 for StepPhoto, scale of 1-Very Dissatisfied to 5-Very Satisfied). This definitely leaves room for improvement. However, when asked how likely they would be to use StepMail if it was in installed in their offices participants' median response was 5 (scale of 1-Not at all Likely to 7-Very Likely). In addition, their median response for the likelihood of making space in their offices for a dance pad was 4.5.

When asked about use at home the median responses for StepPhoto were less favorable (Likely to use weekly med. = 3, Likely to make space med. = 3.5). However, several of the participants expressed interest in using StepPhoto. We interpret this to mean that while our applications need more work, the general concept of Step UI shows promise. Encouraging comments included: "it's cool, can I play with it in my office" and "I think this has a lot of potential."

Clearly only a limited subset of a full application can be made available using a dance pad. Participants' agreed that both applications had enough functionality to be useful (med. = 4, scale of 1-Strongly Disagree to 5-Strongly Agree). However, for each application we observed that some users desired more functionality, for example, the ability to perform short replies in StepMail and red-eye reduction in StepPhoto.

Discussion

Comparing users' experiences with both applications has raised some general design considerations for step interfaces. The study emphasized the need to keep the body centered in the middle of the dance pad and design the interface to balance the movement between the left and right sides of the body. Maintaining balance further limits the available commands since some commands, like a dual step on the middle right button and the top right button, are awkward.

Mapping of commands to buttons requires an understanding of the command frequency and the likely command combinations. Despite the similarities in command mappings in each application, the photo collection browsing tasks led to prolonged use of buttons primarily on the right side of the dance pad. Most users complained that this was uncomfortable and made their supporting leg tired. We conclude that, in order to be successful, Step UIs must be designed to balance work and allow the user to stay centered. This may mean the most literal visuospatial-based mapping of application features to commands is not the most appropriate; in fact, this may require that the application have a custom interface for Step UI.

We originally assigned a dual step motion to the StepMail delete command in order to reduce the chance of accidental activation. However, study comments showed, even though it led to more exertion and the users had trouble hitting both buttons without an occasional misstep; the satisfaction from jumping and stomping on a completed message was considered worth the effort and more enjoyable.

Despite having a goal of intentionally doing more physical work, people still expressed the desire to be efficient. Features such as auto-repeat scrolling were used consistently and when they did not perform well users expressed dissatisfaction. Other performance enhancements such as multi-select and sorting commands were requested, even though having them would have reduced the amount of exercise. This

suggests users are resistant to command mappings that needlessly increase effort.

As work progressed we observed that some classes of applications were more compatible with Step UIs than others. Email management is a necessary task for many office workers and can be done in short bursts. We believe this allowed the StepMail application to be seen as reasonable, providing both some exertion and breaks at well spaced intervals. Photo management may not be as necessary for our participants and is generally done less frequently, potentially raising the bar for how enjoyable StepPhoto needs to be in order to motivate use. It is clear that the size of the command set, the frequency of use, and the duration of use all must be considered when selecting an application for a Step UI.

Conclusion

Interfaces that promote and support physical activity offer an exciting opportunity to build applications that have a positive impact on people's daily lives. StepMail and StepPhoto represent our initial foray into allowing users to complete work tasks while incorporating more physical movement. Participants received some exertion benefits from standing and moving about and initial results show that users were receptive to the notion of using physical devices to accomplish their tasks.

We are planning to deploy the Step UIs into people's offices and homes, which will give us the opportunity to better understand the social implications of StepUIs. We would also like to explore equipment that can be used anywhere, perhaps using tracking devices that are strapped on feet or embedded in shoes. Finally, we are considering improvements ranging from voice-assisted text entry to more game like interfaces that require timed reactions to events happening in the application (e.g. stepping quickly to decide which moving photo to send into a particular bin).

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