

People in Books: Using a FlashCam to Become Part of an Interactive Book for Connected Reading

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ABSTRACT

We introduce People in Books with FlashCam technology, a system that supports children and long-distance family members to act as characters in children's storybooks while they read stories together over a distance. By segmenting the video chat streams of the child and remote family member from their background surroundings, we create the illusion that the child and adult reader are immersed among the storybook illustrations. The illusion of inhabiting a shared story environment helps remote family members feel a sense of togetherness and encourages active reading behaviors for children ages three to five. People In Books is designed to fit into families' traditional reading practices, such as reading ebooks on couches or in bed via netbook or tablet computers. To accommodate this goal we implemented FlashCam, a computationally cost effective and physically small background subtraction system for mobile devices that allows users to move locations and change lighting conditions while they engage in background-subtracted video communications. A lab evaluation compared People in Books with a conventional remote reading application. Results show that People in Books motivates parents and children to be more performative readers and encourages open-ended play beyond the story, while creating a strong sense of togetherness.

Author Keywords

Reading, children, literacy, video conferencing, background subtraction, family communication

ACM Classification Keywords

H5.3. Information interfaces and presentation (e.g., HCI):
Group and Organization Interfaces: Synchronous Interfaces

General Terms

Human Factors; Design.

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INTRODUCTION

Today's families are increasingly diasporic, and are turning to the Internet to help bridge distances and maintain ties [15]. Cheap long distance phone calls and free video conferencing have made it easier for adults to keep in contact with other adult family members. However, communication with children remains quite difficult both over phone and over videoconference for a number of reasons [2].

One problem the community has identified in engaging children in teleconferencing or phone calls, especially those under the age of five, is the implicit assumption that the best way to support relationships is through conversation. However, young children – even in person – are not yet the best conversationalists, and co-located family members often engage children through activities such as play, games and reading [3].

A number of recent systems have demonstrated that better communication and long-term relationships with children can be achieved by structuring video conferencing interfaces around shared activities, such as structured play [12, 30], unstructured play [29, 13, 30], and reading books [2, 12, 30]. Central to all of these systems is the idea of



Figure 1. A sketch of proposed mobile tablets running the People In Books software. Here a Child and Remote family member play on a boat together.



Figure 2. A screenshot of a child and parent playing in the trees of *Where the Wild Things Are* using the People In Books System.

playfulness as a means for engagement in distant communication. Our work builds on these ideas and presents a novel implementation of a shared reading experience that invites remote parties to become part of the story alongside characters in the book.

Interactive electronic children's books have been gaining popularity with the rise of affordable mobile devices and tablet computers coupled with an easy distribution system for books and applications. However many of these commercial offerings focus on interactive features that enable the 'pass-back effect' [8] where the parents pass their device to the child as a way to keep them occupied, thus removing the need for adult participation. Although this certainly has its time and place, we wanted to create interactive books that could harness adults as teachers, mentors, and play partners for children. We wanted to focus on the social interactivity of reading, the experience and activity of shared reading beyond the printed word. Parents can pretend to be different characters and read out loud with different voices, they can ask children questions to engage them in the story, they can even change the story completely, highlighting parts they know their children like [19, 32]. Likewise the child plays an important part in the interactivity of the book, in that the story often lives in their imagination rather than on the pages. Children who act out stories are able to better understand the books [11, 22]. Parents or family members can do a better job of estimating the zone of proximal development for a child than computer software [27].

In our work we aim to focus on encouraging character voices, play acting, and play beyond the written words in the book. Our goal was to create interactive book reading that could bring humans back into the loop. But instead of merely putting books online, we wanted to explore how to use technology to give even more freedom to parents and children to be part of the stories. In the People in Books system, background subtracted live video of children and

family members are placed into the storybook setting along with the characters of the book, encouraging play (Figure 2). We intend this design to help break down barriers of distance and separation implicit in the GUI window metaphor. Instead of seeing each other in their real world distant locations, children and remote family members can both go together into the world of the story. We hypothesize that orienting geographically separate video streams in a shared virtual story environment can create a stronger sense of togetherness than traditional video conferencing approaches. We assume that visual togetherness will support a feeling of emotional togetherness, and that the stories can help structure families' shared play in the imaginary environments.

We previously introduced an early version of the People in Books concept as part of a series of four exploratory design concepts for shared activities over video conferencing [12]. Following that formative work, this paper demonstrates an evolved design with a novel high-fidelity technical implementation that works towards our vision of creating a mobile tablet based device that fits in with existing reading practices, see Figure 1. Although we have still not reached the final implementation, we have developed robust active background subtraction cameras that allow for movement and a stable video conferencing pipeline to transmit alpha encoded video. This enables us to more holistically study how families engage around the fantasy world of the book, and we present laboratory results that compare the system to traditional distance-reading tools.

RELATED WORK

Our work contributes to research in interactive books, video conferencing, and shared activities for Family Communication. Books have been explored as both a foundation and inspiration for interactive systems over the years. The XFR group explored how digital interactive paper books could immerse users in the spaces and experiences afforded by stories [14]. Listen Reader

explored how users' orientations to books might change, and also inspired a category of talking children's books which have been popular in the marketplace for the past decade.

The growth of video technologies in mobile touch devices points to a need for children's video chat applications. Classic video experiments in CSCW inform the needs of children and family. ClearBoard explored the importance of eye gaze and facial awareness in shared video activities like drawing, painting, or the arts [17]. Mediaspaces [1] gives insight into roles of presence over a distance, and work such as Exertion Interfaces shows how non-conversational activities like sports and playfulness can support a sense of togetherness over a distance [20].

Work in the role of always-on video in the family environment [18, 16] forecasts children's emerging use of video to play with peers over a distance [29, 30]. Communication toys such as dollhouses [13] may also scaffold children to play together over a distance, rather than "conversing" in manners traditional for video chat.

Games and stories can help structure and scaffold interactions between children and remote adult family members. Our research builds directly on formative experiments in remote Video Play [12], and connected reading. Family Story Play [3] and StoryVisit [23] showed that systems for shared book reading can increase video chat times 5-7x over ordinary video chat, and can engage children as young as 3 years old in a sense of connectedness with distant adults. Those systems used a pedagogical agent to help children and adults engage in book content. Our work builds on the concept of "connected reading" for family togetherness, with our approach exploring how the books themselves might support more immersive experiences if children and adults can imagine being part of the story worlds created by the children's books' authors.

Our concept of play with books is informed by research in child development [4], insights into children's pretend play [22, 7] and pre-literacy activities like dialogic reading [11, 19, 32].

PEOPLE IN BOOKS

The People in Books prototype was developed to support reading and open-ended play with young children ages 3 to 5 years old and remote family members. The design focuses on supporting dialogic reading practices that involve children and adults beyond the printed words and illustrations to provide a more interactive experience. Readers can act out parts and ask questions to engage children in a richer reading experience. In addition we focused on minimizing the feeling of distance between the two remote parties. We attempted to address these two issues through inserting segmented video feeds of the remote users into the storybooks. Video segmentation allows for full-body gestures and poses of users to be captured and inserted into the illustrations, allowing for

more performative reading. The system was designed through an iterative design process, and motivated by our prior experience with designing video conferencing applications for children and distant family members [12].

From our prior experiences designing interactive video conferencing systems for children we established these design goals for the People in Books system.

1. Create a sense of togetherness through shared context
2. Encourage active and performative reading
3. Allow for play beyond the printed words in the book
4. Fit into existing reading rituals

System Description

A simple UI minimizes distractions from the reading experience. The users are presented with a storybook, which takes up the full horizontal screen. Video of the users is segmented and composited into the illustrations of the book as live video avatars. The locations, sizes, and rotation of the live video avatars are modified for each page such that the images of users are placed into contextual locations in the illustrations and scaled appropriately to match the scale of other characters in the book. Foreground elements such as rocks, other characters or other props are used to obscure the bottom half of the user's live video avatars to create the illusion that their full body is in the illustration as opposed to a floating head or torso.

Layers of foreground and background elements can be grouped programmatically and animated along with the video layers to create the sense of movement. For example the live video avatars of two users are placed on a boat, and the boat is animated to sail along the sea, see Figure 3.

Interaction with mouse cursors is minimized. Users can change pages by clicking on the sides of the pages, and the segmented video of users is moved according to the page index. Beyond changing pages the only interaction is through video, where parents and children can move around and act as different characters.



Figure 3. An animation of a boat sailing moves both parent, child and book characters with it.

Designing Content for People in Books

Content for People in Books has to be selected and manually modified. Each page has to be manually segmented into foreground and background layers, and the location, scale and rotation for each live video avatar must be encoded for each page.

Not every storybook works well as a People in Books story. Through early prototyping with a number of different children's story books, we found that important qualities were a location based story, fairly consistent sizing of characters and many different locations. Although these are not hard and fast rules, our most successful stories had these qualities. Currently, we use existing storybooks and modify them to fit into the People in Books format. However in the future we hope to develop custom storybooks for the People in Books format that could be tailored to maximize the strengths of the People in Books system.

Technical Implementation

Our interaction design focused heavily on designing this reading experience around families' existing reading practices. For many families that often means in bed or on the couch with parent and children close together and book held between them.

We designed the technology so that it could be easily ported to mobile devices running on Linux. Our eventual goal is to make this system in a tablet form factor, so physical size and computational limits were of high concern.

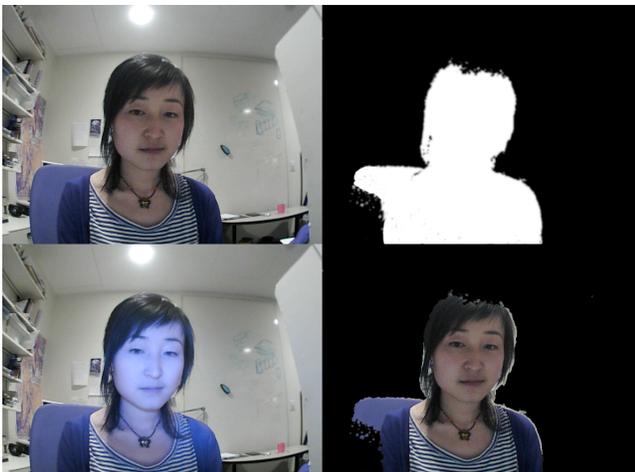


Figure 4. FlashCam Pipeline: Top Left, unlit image of user. Bottom Left, IR Flash illuminates user. Top Right, Subtracted and threshold mask derived from difference of two previous images. Bottom Right, unlit image of user matted.

FlashCam: Active background subtraction

We chose background subtraction, over other methods such as face tracking, as a means for inserting users into illustration because of its flexibility to capture full body poses or arbitrary objects. But because parents and children are holding the laptop or tablet running People in Books, our segmentation method needed to be robust enough to work while the device was in motion. In addition children and parents are very close to the book interface and often move closer to inspect pictures more carefully, so the system needed to work at close distances.

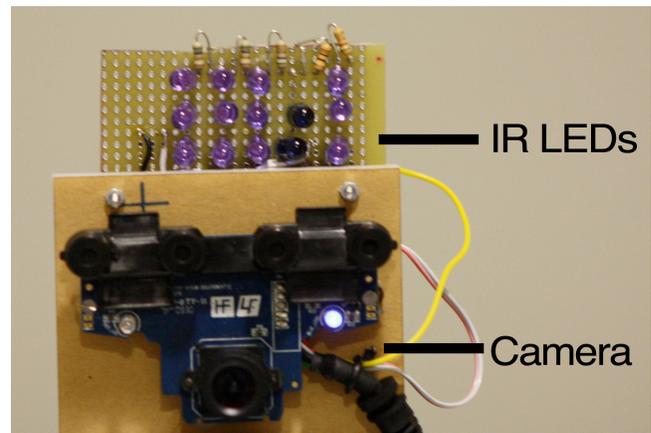


Figure 5. FlashCam prototype hardware. Above: IR LEDs which flash on every other frame. Below: modified PS3 camera.

Existing techniques for foreground/background separation often rely on a background model, where the background is known and image elements that differ are considered foreground. These techniques often require the camera not to move. There are other adaptive approaches that relearn the background, however these systems cannot operate robustly while in motion or when the changes are abrupt. Other systems rely on machine learning, which can be very robust but are difficult to implement and computationally intensive and cannot run on many mobile devices [31].

Another approach is active background subtraction, where some sort of structured light is added into the environment to make it much easier to determine background and foreground. We chose to implement a simple active background subtraction camera, that uses flashing IR lights to help segment the video which we call FlashCam [6, 25]. Although similar flash camera techniques have been developed before, they have not been applied to mobile devices or for video conferencing. We believe that because FlashCam is small, inexpensive, computationally cheap and robust to changes in orientation it makes a great candidate for mobile devices.

An array of IR LEDs are placed close to the lens of a camera. A small microcontroller listens to the trigger sync signal and flashes the LEDs on for one frame and off for the next. Our implementation uses a modified Sony PS3 Camera, see Figure 5. The computer software compares the pairs of images, and looks for areas that are brighter in the flash frame than the frame without flash, and labels those areas as foreground, see Figure 4. We use an adaptive threshold based on the amount of brightness in the flash frame, as the differences between the two images are changed slightly based on the amount of sunlight in the frame, which contains IR light. The camera system does not work in full sunlight as the IR LEDs are completely washed out.

The background subtraction algorithm was written in C as a Gstreamer plugin, allowing us to feed the background

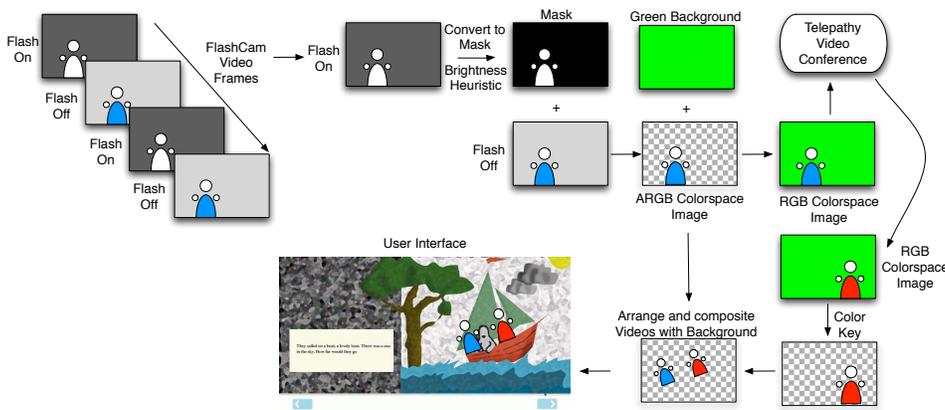


Figure 6. Video Conferencing Pipeline. FlashCam Segmented video is sent both to onscreen graphics and matted with green background and transmitted over Telepathy Video Conference. On the remote side the video is Chroma Keyed out and sent to on screen graphics.

subtracted video easily into our video conferencing pipeline.

Video Conferencing Pipeline

The video conferencing functionality for this prototype is built using the Telepathy-Farsight¹ open source software stack. The stack leverages the open source Gstreamer² multimedia library for video processing and codec support. In our video conferencing client implementation, we leverage the XMPP and Jabber protocols to stay compatible with a range of open videoconference client implementations including the Nokia N900 phone and Google’s browser-based video chat client.

Our design requires the transmission of alpha matted video (e.g. ARGB color space). However, most video conferencing clients use H.264 video codec implementations that do not support color spaces with an alpha channel. In order to send alpha matted video easily over existing video channels and protocols we chose to add a green background and later chroma key out the background once received, see Figure 6.

Front End User Interface

The front-end user interface was implemented using Qt Quick³ with QML. Our prototype ran on laptops running Ubuntu 9.10. Using Qt Quick allowed us to easily animate parts of the book to bring the book to life.

USER STUDY

To evaluate the People in Books system’s influence on engagement, dialogic reading and feelings of togetherness, we chose to compare it to a more traditional shared book reading experience. We created a prototype control system

based on a commercial shared reading product, Readeo.com. The control system, shown in Figure 7, has two equal sized video windows above the book content to view the local and remote video feeds.

We chose to evaluate the system in a controlled lab based study to allow for in-depth qualitative analysis on the use of People in Books for reading at a distance, to highlight differences in reading practices between the two systems, and to provide feedback into our design process for later iterations.

Methodology

We recruited 12 families with children aged three to five years old (5F, 12M), and their parents (11F,3M) to use both the People in Books system and our control reading system. Seven of the families had a parent and a child present, and three families had one parent and two children present, and two families had two parents and two children present. Ten families reported using video conferencing previously with their children, four of those ten families monthly used video conferencing, and two families of those ten reported weekly use. Predominately the prior video conferencing with children was with grandparents or other close relatives. None of the families had previously read a book over video conferencing with a service like Readeo or by sharing the images of a paper book through traditional video conferencing.

Each session with a family was split in to two parts, a People In Books session and a control session, with a short break between. Two Books were used to evaluate the system, *Where the Wild Things Are* by Maurice Sendak and *We’re Going on a Bear Hunt* by Michael Rosen and Helen Oxenbury. The order of the sessions was counter balanced, as were the books, resulting in four conditions. Participant families were randomly assigned one of the conditions.

The children and parents were separated into two rooms, except for 5 sessions when a single room with a wall

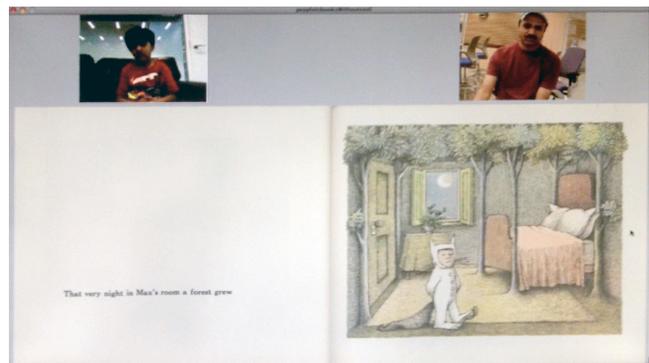


Figure 7. The control system remote reading interface.

¹ <http://telepathy.freedesktop.org/wiki/>

² <http://gstreamer.freedesktop.org/>

³ <http://qt.nokia.com/qtquick/>

divider was used. Parents and children could see each other's video feeds on the screen and hear each others voices through a polycom speaker phone system. To enable easy set up for the multiple conditions we chose to forgo the network infrastructure and instead build a lab only prototype. This prototype consisted of one laptop with its screen mirrored on another monitor. Long VGA and USB cables connected the monitor and FlashCam of the parent's system to the main laptop computer. Children used the 15.4inch laptop screen and sat on a couch, where as parents in the adjacent room sat at a desk and viewed the same content on a 23 inch LCD monitor. We chose this set up to mirror how we thought the systems would be used by people in their homes, with distant relatives, remote parents, or grandparents using the system on a desktop computer and children using a smaller mobile device that could be used where reading normally happens, such as on the couch or in bed. Both the parents and the children were able to use a mouse to control the book interface.

The sessions were screen captured and an additional video camera was used to capture the children's movement in the room (Figure 8).

Following the session, parents filled out a questionnaire and were then interviewed, to help us understand how the systems differed from traditional video conferencing, how the systems differed from normal reading, how the two systems differed, and any other information they wished to provide.

After all evaluations were conducted we analyzed the recorded sessions for qualitative evidence of participants

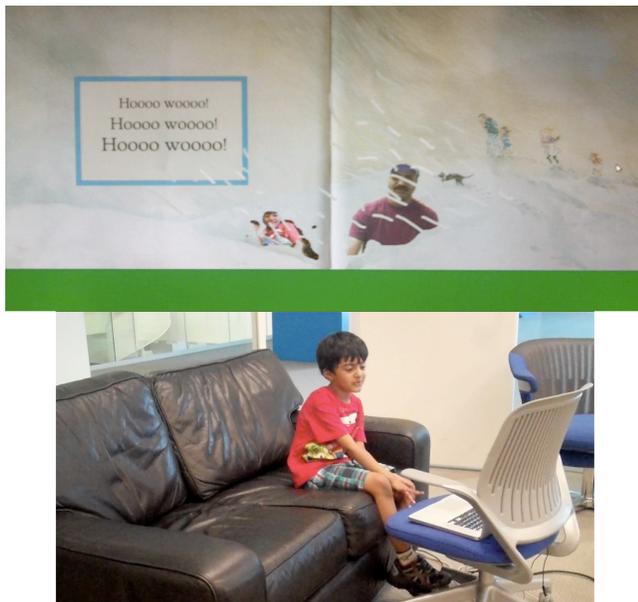


Figure 8. Above a screen recording of a study session where a father and son use *People in Books* to read *We're Going on a Bear Hunt*. Below, a secondary camera captures children's actions in the room for later analysis. The Child rests the laptop running *People in Books* on a Chair.

exhibiting a sense of togetherness, examples of dialogic reading, extended play beyond the book, and engagement.

Findings

Closeness to remote participants

In many of the studies we observed a lot of evidence of children and parents expressing a sense of togetherness through dialog and through their actions. For example closeness was conveyed to console children who were scared by certain sections of the books. One child in a scary part of the story said, "I can see a monster! Mama, Are you still next to me?," and once they were next to each other in the next page layout "Now I am next to you, Mama." The mother responded "I'm going to protect you [from the monsters]" and the child said "Thank you mama!" [F4]. In this case it seemed as though the spatial proximity of the images of the children and parents affected their sense of togetherness.

Parents and children would also try to touch each other inside the *People in Books* session. In one example a mother reached out to touch the child's video she said "I'm touching your head" [F2]. We also saw children and parents performing compassionate gestures, for example hugging and kissing each other's video inside the *People in Books* system. For example the son in session 4 leaned towards his mother's video and gave his mother a kiss, which was followed by an audible "Aww" from the mother [F4]. However, younger children also tried to touch or interact with the remote participants video outside of the system, often by touching the screen, which the remote parents could not see. This type of touching the screen was prevalent both with *People in Books* and the control system.

Often in the *People in Books* system participants would refer more to locations where participants were, such as "You are over by the monster" [F2]. And there was also a higher incidence of children and parents describing that they were at a location together. "Are we in Max's [the character from the book] room?" [F4]. Or "We are in the river" or "We are on a boat". The language used by parents and children seemed to highlight more of a shared, proximal experience. In the control system there wasn't as much evidence of this "closeness," instead children seemed to focus on the fact that they could see their parent. "I can see you," a daughter proclaimed to her father [F7].

Closeness to characters

Beyond feeling close to their long distance reading partners, parents and children using the *People in Books* system often expressed a sense of closeness to characters that their images were proximal to in the *People in Books* system. While reading *Going on a Bear Hunt* a child remarked, "This is the scary part... He's right behind you, papa," his father replied "Yes that's why we have to go home!" [F10]. The child was referring to the large bear that was next to the image of his father. This expression of fear or pretend fear, was very common when there were scary characters around

in both books. “I can feel the monsters!” a child exclaims while reading *Where the Wild Things Are* using the People in Books system [F4].

We also saw a great deal more interaction with the other characters using the People in Books system. “I’m cuddling with Max”, a child proclaims as they both mime cuddle with the illustrated character Max. The mom then grabs past Max to her son explaining, “I can feel you.”[F4]. Another mother tickled the Monster’s toes as a child laughed [F2]. Parents and children would also try to communicate with some of the characters. One child tried to tell the character Max, “Look, Max, there’s food on your table” as his mother in the video pointed towards the food to show Max [F4].

Play Acting In the Story

In addition to interacting with characters in the book we also saw a great deal more play acting inside the People In Books System than the control system. Particularly there was more play referring to the different settings or locations in the book. *We’re Going on a Bear Hunt* features many out door locations, such as rivers, grassy fields, muddy ponds or forests. By placing the video of the children and parents inside these locations they were more likely to pretend play that they were in these locations.

For example one father and son reading *Going on a Bear Hunt* with People in Books were on the river page. “See, if you want to go to the other side you have to swim.” As they turn the page to the river the child says “I’m going to swim, swim, swim swim” as he lies on the couch and pretends to swim [F10]. There were other sorts of these activities such as pretending to run, jump, or play in the mud.

Parents also remarked that they felt like People in Books brought out “more acting for parents and children” [F9]. Some parents explained that it was a more theatrical experience; “I would use more dramatic facial expressions” [F5].

However, People in Books seemed to limit the amount that children pretended to be other characters. Children even made this explicit, for example one Mother asked “Should I say Max [the character in the book] or Ciallas [the child’s name].” The child replied quickly and forcefully “Max!” [F7]. But with the control system parents and children were more likely to mimic the other characters’ visible actions.

There were also certain words that triggered action in both systems. For example words pertaining to particular actions, like “growl,” “show their terrible claws,” or “roar” tended to be acted out in both our system and the control.

Play Beyond the Story

After they had finished the story a number of participants continued to play with the People in Books system. Often families would try to find their favorite page and then play in that page. “I like the one where you are upside down” the mother says as the child flips the pages back to that one and they continue to play and dance [F1].

	Video Conferencing	Control System	People in Books
Mean	4.45	4.91	5.54
Standard Deviation	1.33	0.93	1.42

Table 1. Results from post-test questionnaire asking participants to rate their sense of togetherness with their children while using three different interfaces. The parents rated them on a 7 point Likert scale with 1 being distant and 7 if they felt like they were in the same room.

Another common observed play act beyond reading that People in Books seemed to encourage were hiding games. Because of People in Book’s foreground elements there are objects to hide behind, and a large number of children ended up hiding. Parents would say things like “Where did you go?” and then children would respond “I’m Hiding” and that would begin a game for them where the child would kneel down or move out of the frame, and then come back again [F4]. That family played hide and seek on a single page for more than one minute.

Engagement

As previously reported [2] parents often said in post test interviews and questionnaires that they had a hard time keeping children engaged with traditional video conferencing. “[While talking to] grandparents the kids get bored [with] Skype quickly, so this would certainly help with that” [F7]. All but two families thought this was an improvement over normal Skyping for keeping children’s attention while video conferencing.

Most of the parents after the session responded that children were more engaged with the People in Books system compared to the control system. “[People in Books] holds the kids interest more” responded one mother [F9]. A number of parents thought children were more engaged with People in Books, even if they didn’t prefer the system [F5, F6, F7]. However reading times for both systems tended to be similar. For *Where the Wild Things Are*, the average reading time with People in Books was 7 minutes 33 Seconds, and for the control system the average was 5 minutes 32 seconds. But for *Going on a Bear Hunt* the average reading time for People in Books was shorter than the control system and none of the results were statistically significant.

Problems with Field of View

Parents reported having problems seeing the children while using People in Books more than the control system. One parent explained that she had “less sense of what is going on in the room with people in books” [F5]. It was very clear to parents when using the control system if the child was in the field of view or not, but because of background subtraction and foreground elements in People in Books it

was often hard for them to know if the child was out of view, hiding, or that the system was not working.

DISCUSSION

Increasing a sense of togetherness

Our qualitative data points to more active engagement with book content using People in Books. While we assumed this would correlate to a “sense of togetherness,” these findings are not statistically correlated with post-survey data in which adults reported their “sense of togetherness” using both of our test systems, as well as previous experiences with Skype (Table 1).

However, many of the children of the families who said they didn’t feel closer using People in Books tended to stay outside of the field of view of the FlashCAM. Although this certainly represents a shortcoming with the system, there may be ways to change this behavior through technological solutions. Wider field of view cameras in addition to larger video placement could go a long way towards helping this. Some of the parents in post test interviews complained saying that they only saw their children as “small heads” [F6] probably because the children sat further away from the camera or because they were outside the region of the background subtraction. Other research reiterates the importance of framing on emotional connections over video conferencing [21], so finding ways to get around these issues with the People in Books system is important.

Changes in reading practices

For parents reading to young children, often the words on the page are not the most important part of the experience in terms of learning. Research in dialogic reading [32] highlights the importance of tying the events back to experiences in children’s life, asking children to answer questions about the story, and creating an engaging reading experience by using character voices or other types of more theatrical reading styles. On the whole parents who were practicing good dialogic reading with their children tended to do so in both sessions. In some cases we did see dramatic changes in reading styles, such as drastically increased dialogic reading when using the People in Books as opposed to the control system, but most of the readers who did not practice dialogic reading heavily in one system did not in the other. However, People in Books increased participants’ dramatic presentation of the story and allowed for more open play pertaining to aspects of the stories. This is an important improvement that could impact how children learn to read [22]. In addition, to achieve a goal of making reading and learning a fun and enjoyable experience for children, it is important to engage parents in the experience because parental engagement in learning early on has great affects on the child’s educational performance later in life [4].

Beyond the type of reading used by parents we could also see a change in the way children responded to the stories. Children using People in Books on average seemed to show

a higher level of empathy for the characters in the stories. They often pretended to be scared, or excited, when the other characters in the story were more often than in the control case. This could be because they felt as though they were physically in the same situation, because their visual representation was. Parents and children also exhibited a larger shift from referring to the collective characters in the book as “They” to “We,” than in the control case. This could also have had an effect on the level of empathy the children experienced.

However, there were some changes in reading practices with People in Books compared to the control system that may not be desirable. We noticed a lot more use of the mouse cursor in the control system to highlight important words or for parents to point out characters that were referred to. Parents also noticed this trend. “I Found it was hard to read as I normally do, asking kids to point or touch body parts as we read about them...ears, eyes, etc” [F6]. This may be because parents were more busy acting as embodied characters in the stories and have to split their attention between acting, reading and pointing. Further study should address how being an embodied character as opposed to a traditional reader changes reading practices.

This is also related to the issues of acting like characters vs. acting with characters. People In Books seemed to lessen the prevalence of acting as or mimicking other characters in the book, which was observed to a greater degree in the control systems. Instead, while using People in Books, children and parents focused on being their own embodied characters in the story who were going along with them too. This could have effects on children’s development of empathy, an important social skill that is helped by early reading practices. But children often shared similar emotions with the characters because they seemed to be more involved in the book’s story. By seeing their image proximal to the scary monsters and animals that the characters were close to, they seemed to express similar fear to the characters.

In addition, many parents have different types of reading styles and maintain different levels of control, and People in Books clearly catered to some of those styles more than others. Some parents did not encourage their children to act like characters from the stories. One parent told child a child who was acting like a dog in the story, “You don’t have to act like the characters. Sit down” [F6]. The mother later explained “If I wanted to do some tricky things then I would use People in Books” but that for normal reading it did not meet her expectations. [F6]

Two parents explained that People in Books seemed like a lot more work. Particularly they found difficult the fact that there were large meta issues while reading with People in Books (for example “why are we in the story?”), and some parents felt they had to explain the context to the children. “[People in Books] makes it more work to focus on the

story, because you also have to comment on your own physical presence in its illustration” [F2].

Fitting in with Existing Reading Rituals

Although we designed the People in Books system to be flexible and portable enough for families to use the system where they normally read, the playful nature of the system may be a poor match for many parents’ use of stories as a “calming ritual” [F7] before bedtime. Because People in Books gives children the ability to see themselves as characters in the book and encourages them to act like characters in the book it tended to create a very high energy reading session. One parent explained, “really when you read you want them to calm down, settle down. So then you don’t want to do things to get them more excited [F7].” However, parents did say that there were times during the day time when reading with People in Books could work especially well. A number of participants even suggested using People in Books on their own at home without a long distance partner. It seems that there are many different types and styles of reading for young children. Instead of designing one system for all types, designers should more closely choose aspects of reading to design for, such as time of day, number of participants, learning goals and attention spans. Just as there are different kinds of books, there can be different kinds of book reading applications.

FUTURE WORK

The positive results from our in lab user study have shown the potential for children and remote parents to read as characters inside of story books. The findings from our lab evaluation suggest a number of areas in which immersive ebook experiences could be improved.

A number of parents were concerned with the lack of vision of peripheral areas when viewing the background subtracted video of their child. Children would often move in and out of the view of the camera, however remote parents tended to stay inside the view of the camera at all times. We suggest presenting the remote participants with both the People in Books interface as the children sees it, but also with the raw video feed of the child to better understand what is going on. Similarly parents responded better when children’s images were much larger in the story. A feature to allow users to zoom in on certain areas of the book with video images in them may help alleviate these problems.

We would also like to explore allowing users to interact with content in the book in a more direct way. Currently the books pages are fixed except for animated layers that run continuously. The outline of users silhouettes could be used to interact with on screen elements, for example if it is raining or snowing, particles could be simulated around the users to make it feel more immersive. Further investigation should help to find an acceptable level of interaction that still makes the experience feel like reading a “book.”

The user evaluation presented here only covers a single session and the impact of novelty is still unanswered, although no users had used either People in Books or the control system previously. We plan to conduct longitudinal studies using smaller tablet based computers in users homes with remote family members to better understand how systems like People in Books are used, how they fit in with existing practices, and how they change reading behavior. Our robust video conferencing pipeline and active-background subtraction FlashCam will help support these longer studies.

Beyond tablet based systems we would like to explore other form factors or settings for the People in Books system. The living room, equipped with a large television screen and a depth camera like the XBox Kinect, could provide an interesting space for this kind of remote play. Instead of being limited to fixed positions in books, you could move around a 3D book scene by moving around in the room, while being tracked by the Kinect. We would like to explore how this design would influence full body interaction, as the current system focuses more on upper body movement. In addition larger settings like connecting two preschool classrooms for shared reading could be an exciting new area to explore. Different classes could take turns performing and observing, or they could collaborate together.

CONCLUSION

People in Books introduces a new type of reading that involves and integrates remote readers’ video chat streams directly into children’s story book illustrations, supporting children and adults to play alongside the story characters. Being together in the story world allows children and distant family members to read books together in a way that goes beyond traditional videoconference, and beyond traditional reading. Reading with People in Books is a more active experience; we have shown that for many families it can promote more theatrical reading and encourage other pre-literacy activities, helping families move towards certain dialogic and educational reading practices. By making traditional video conferencing and reading more interactive, where parents and children can still be creative and imaginative, we have shown that children’s book illustrations can provide a playful shared point of entry for young children and their long-distance reading partners to become connected with one another.

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REFERENCES

1. Agamanolis, S., Westner, A. and Bove, V. M., “Reflection of Presence: Toward More Natural and Responsive Telecollaboration,” Proc. SPIE Multimedia Networks, 3228A, 1997.

2. Ames, M., Go, J., Kaye, J. 'J.', Spasojevic, M. "Making love in the network closet: the benefits and work of family videochat." Proc. CSCW 2010, 145-154.
3. Ballagas, R., Raffle, H., Go, J., Revelle, G., Kaye, J., Ames, A., Horii, H., Mori, K., and Spasojevic, M. "Story time for the 21st century." IEEE Pervasive Computing, 9:28-36, 2010.
4. Barnard, W. M. Parent involvement in elementary school and educational attainment, Children and Youth Services Review, Volume 26, Issue 1, Promoting Well Being in Children and Youth: Findings from the Chicago Longitudinal Study, January 2004, Pages 39-6
5. Bly, S., Harrison, S.R., Irwin, S. Media spaces: bringing people together in a video, audio, and computing environment, Communications of the ACM, v.36 n.1, p.28-46, Jan. 1993.
6. R. M. Bolle, J. H. Connell, N. Haas, R. Mohan, and G. Taubin. Object imaging system. U. S. Patent 5,631,976, 1994.
7. J. Cassell and K. Ryokai. Making Space for Voice: Technologies to Support Children's Fantasy and Storytelling
8. Chiong, C., and Shuler, C. Learning: Is there an app for that? <http://www.joanganzcooneycenter.org/Reports-27.html>
9. DeVincenzi, A., Yao, L., Ishii, H., and Raskar, R. 2011. Kinected conference: augmenting video imaging with calibrated depth and audio. In Proceedings of the ACM CSCW '11. ACM, New York, NY, USA, 621-624.
10. Fails, J., Druin, A., Bederson, B., Weeks, A., and Rose, A. A child's mobile digital library: Collaboration, community, and change. In Mobile technology for children: designing for interaction and learning. Morgan Kaufmann, 2009
11. Fisch, S. M., Shulman, J., Ackerman, A., Levin, G. "Reading between the pixels: Parent-child interaction while reading online storybooks." Early Education and Development, 13(4), 435-451, 2002.
12. Follmer, S. Raffle, H., Go, J., Ballagas, R., and Ishii, H. 2010. Video play: playful interactions in video conferencing for long-distance families with young children. In Proceedings IDC '10. ACM, New York, NY, USA, 49-58.
13. Freed, N., Burleson, W., Raffle, H., Ballagas, R., Newman, N. "User interfaces for tangible characters: can children connect remotely through toy perspectives?" Proc. IDC 2010, 69-78.
14. Harrison, S., Minneman, S., Back, M., Balsamo, A., Chow, M., Gold, R., Gorbet, M., Mac Donald, D., Ehrlich, K., Henderson, A., Design: the what of XFR: eXperiments in the future of reading, interactions, v.8 n.3, p.21-30, May/June 2001
15. Hiller, H., and Franz, T. New ties, old ties and lost ties: the use of the internet in diaspora. New Media & Society 6, 6 (2004).
16. Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., Conversy, S., Evans, H., Hansen, H., Roussel, N., Eiderbäck, B., Technology probes: inspiring design for and with families, Proceedings of the SIGCHI 2003.
17. Ishii, H., Kobayashi, M., Arita, K. Iterative design of seamless collaboration media, Communications of the ACM, v.37 n.8, p.83-97, Aug. 1994
18. Judge, T. K. and Neustaedter, C. Sharing conversation and sharing life: video conferencing in the home. Proc. CHI 2010.
19. Mol, Bus, de Jong & Smeets (2008). "Added Value of Dialogic Parent-Child Book Readings: A Meta-Analysis," Early Education & Development, 19(1), 7--26.
20. Mueller, F., Agamanolis, S., and Picard, R. Exertion interfaces: sports over a distance for social bonding and fun, Proceedings of the SIGCHI 2003.
21. Nguyen, D. and Canny, J. 2009. More than face-to-face: empathy effects of video framing. In Proc. CHI '09. ACM.
22. Page, A. Children's Story Comprehension as a Result of Storytelling and Story Dramatization: A Study of the Child as Spectator and as Participant. Diss. University of Massachusetts, Amherst, 1983.
23. Raffle, H., Revelle, G., Mori, K., Ballagas, R., Buza, K., Horii, H., Kaye, J., Cook, K., Freed, N., Go, J., and Spasojevic, M. Hello, Is Grandma There? StoryVisit: Family Video Chat and Connected E-Books. ACM CHI 2011.
24. Sherman, L., Druin, A., Montemayor, J., Farber, A., Platner, M., Simms, S., Porteous, J., Alborzi, H., Best, J., Hammer, J. Kruskal, A., Matthews, J., Rhodes, E., Cosans, C., and Lal, A. 2001. StoryKit: tools for children to build room-sized interactive experiences. In Extended Abstracts of CHI EA '01.
25. Sun, J., Li, Y., Kang, S. and Shum, H. 2006. Flash matting. ACM Trans. Graph. 25, 3 (July 2006)
26. Vutborg, R., Pedell, S., and Vetere, F. 2010. Family storytelling for grandparents and grandchildren living apart. In Proceedings of the 6th NordiCHI '10 531-540.
27. Vygotsky, L. S. (1978). Mind in Society. Cambridge: Harvard University Press.
28. Whitehurst, G. J., Falco, F. L., Lonigan, C. J., Fischel, J. E., DeBaryshe, B. D., et al. (1988). "Accelerating language development through picture book reading." Developmental Psychology, 24(4), 552-559.
29. Yarosh, S, Inkpen, K.M., Brush, A.J. "Video playdate: toward free play across distance." Proc. CHI 2010, 1251-1260.
30. Yarosh, S. Cuzzort, S. Müller, H., Abowd, G.D. "Developing a media space for remote synchronous parent-child interaction" Proc. IDC 2009, 97-105.
31. Pei Yin, Antonio Criminisi, John Winn, and Irfan Essa, Bilayer Segmentation of Webcam Videos Using Tree-based Classifiers, in Trans. Pattern Analysis and Machine Intelligence (PAMI), IEEE, 2010
32. Zevenbergen, A.A. & Whitehurst, G.J. (2003). "Dialogic reading: A shared picture book reading intervention for preschoolers." In A. van Kleeck, S.A. Stahl and E.B. Bauer (Eds.), On reading books to children: Parents and teachers. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 177-20