Design of an Asynchronous Video Sharing Application

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ABSTRACT
While the design of technologies to support family communication is a widely studied topic in developed countries, it remains underexplored for developing nations. To explore this design space, we present the design of the Village Media Space (VMS). The VMS is an Android application that supports asynchronous video transmission between mobile devices. Our design requirements for the VMS are informed by an attempt to design a prototype for testing in a rural Kenyan village. Our hope is that the VMS will support rural families in developing nations to share videos of their daily life activities with remote relatives who live in urban locations so as to maintain connected. In this paper, we describe our design process for the VMS to support communication practices that we gathered from a separate study on family communication patterns in rural Kenya. A description of the research process that was conducted to gather family communication patterns is also provided.

Author Keywords
ICT4D, Kenya, urban slums, rural communities, mobile, Video Sharing

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors; Design

ABSTRACT

INTRODUCTION
Family members often want to share experiences and events in their lives even when they cannot be in the same location at the same time [9,17]. In many cases, at least one family member is always mobile for various reasons such as work or study. Video conferencing systems such as Skype and Google Talk permit synchronous sharing of experiences for distributed families and closely resemble face-to-face communication. However such synchronous video systems cannot be supported with the limited technology that characterizes the settings in most parts of Kenya and other developing nations [25]. We are therefore interested in designing an asynchronous video sharing application that family members can use to share activities between distributed relatives in undeveloped communities. Named the Village Media Space, the application allows a user to record videos of activities that are later relayed to a remote user over the Internet. The VMS therefore enables distributed family members to record videos from separate locations, and then provides them with an opportunity to view videos whenever they access the Internet. This way, distributed family members are able to maintain an awareness of the activities that their relatives are engaged with.

The VMS is an Android application that transmits video asynchronously between two mobile devices over the Internet. We prototyped this set up with a Google Android mobile phone and a touch-sensitive tablet PC. Our idea for using asynchronous video transmission was to provide the closest means possible towards facilitating family communication over video. Our prototype is modeled along the idea of media spaces. Media spaces provide always-on video and/or audio connections [6] between two or more separate locations. We opted to design an asynchronous video application because the limited technology infrastructure in rural Kenya cannot support continuous video streaming between two or more locations.

First, we outline the related work on designing systems that support family routines in developed countries and then look at attempts to design technologies for ICTD communities. Second, we briefly describe the design ethnography study that we conducted in Kenya to collect family communication patterns using technology. Finally, we walk through the design process of developing the VMS prototype.

RELATED WORK
To ground our study, we outline the related literature on studies of technology for family communication in developed countries. There exists a large body of family communication research that looks at the design of technologies that support family routines in developed countries. These systems aim to promote awareness and connectedness between distributed family members [3,16]. The systems typically focus on the exchange of pictures or textual messages between family members via mobile devices [23] or special-purpose digital frames [8,9,23]. Some focus on supporting parent-child interaction over distance [1,8], while others focus on connecting adult children with their elderly parents [13].

There has also been a recent proliferation of systems designed to provide next-generation video connections between family members [10] where video links can be left going for extended periods of time, if desired. This includes video systems designed for digital frames [9] as well as mobile devices [18].

Related Systems

Several systems have been designed to investigate the idea of media spaces within a work environment [9]. Kirk et al. noted that previous video mediated research done for business and organizations focused on how such technologies could support a distributed workforce and not distributed family members [15]. Computer Audio Video Enhanced Collaboration and Teleprescence (CAVECAT) is a media space that enabled small groups of individuals located in separate offices to engage in collaborative work. [15].

Even though there are many video sharing applications that are widely used by family members, the prohibitive cost of devices can also hinder family members' access to such devices in developing countries. Apple's FaceTime application permits live video calling between two iPhone 4s. FaceTime also operates like existing video conferencing systems and requires users to explicitly call one another [15]. Even though this is an excellent video sharing system, the cost of obtaining iPhones in most parts of developing countries where many people live in poverty remains out of reach for many families. Two other systems that have also been designed to support family connectedness include the Family Window and Peek-A-Boo. The (FW) is an always on video media space that aims to create awareness between two families. The Peek-A-Boo consists of a mobile client that is used to share outdoor activities with family members who are in the home through a home client application. Our aim is to design a dedicated video sharing application for family communication in rural parts of developing countries.

Thus, the VMS is designed to provide an asynchronous approach to mobile video sharing over the mobile phone in a limited technology setting [26]. It therefore contrasts systems that aim to provide synchronous video communication between distributed family members such as FaceTime [14]. The major challenge with video sharing in ICTD communities stems from the fact that it is not possible to maintain an always-on video and audio connection because of the poor or nonexistent technology infrastructure. The VMS prototype therefore bridges this gap by providing users with an opportunity to share videos of their activities with distributed family members. It is important to mention that major mobile phone carriers in Kenya, such as Safaricom and Kencell, provide data that users can purchase in bundles from their mobile phones. This would be able to support the transmission of images that have been recorded on a user's phone on to a central server in case such a user lives in a remote village. We have not looked at the costs that would be involved in relaying videos over the Internet. Note that we are only investigating how asynchronous video can be leveraged to support family members in rural communities of developing countries to share activities with distributed relatives.

We will describe our design from the perspective of a rural village user because the family member who lives in the urban region has access and would communicate in a manner similar to an individual in the developed countries. In that case, he would not experience the limitations that exist in the rural environments.

Technology Design for ICTD Communities

Studies on how to apply technology to connect communities in developing countries have also been conducted. Kam et al. conducted a study that focused on the challenges of technology ownership and usage in rural regions of developing countries. They identified poor literacy and low education levels as barriers in the process of designing games that could create a shared social space for Chinese children [11]. Other studies suggest avenues that could be used to support the use of technology in these diverse ICTD communities. Kow et al. suggested that due to illiteracy, online intergenerational game designs should consider features that have low entry barriers, appealing game themes and online interactions that extended real life associations for rural users. The games should also aim to support asynchronous play between families that are distributed across different time zones [12]. In a study conducted in the slums of Cape Town, South Africa, Gitau et al. urges designers to deploy mobile applications with the understanding that most users in slums do not have the knowledge to operate extensive login and authentication steps [4].

Another set of studies has highlighted the desire of populations in the developing countries to use technology to enhance their cultural practices. In this regard, Smyth et al. mentioned that communities in developing countries are capable of embracing advanced information technologies if the appropriate motivation exists [24]. This is echoed through two unrelated projects that were conducted in rural India. First, Patel et al. illustrates how a local audio interactive application enabled farmers in rural India to coordinate farming activities. Farmers were able to navigate menus to receive information regarding profitable farming practices from their successful peers [20]. Second, Petland et al. described DakNet - a low cost digital communication network that uses wireless technology to provide asynchronous digital connectivity to allow remote villages to begin the experience of having a full broadband wireless infrastructure [21].

To understand the dynamics of technology use by Kenyan families (Figure1), we conducted an ethnographic design study that would enable us to capture family communication patterns. In the next section we will

describe our research steps and findings from this investigation.

Figure 1: A home in a rural village in Migori Kenya.

STUDY METHODOLOGY

We conducted a study with 24 participants from Kenya over a two month period to understand how they used technology to share family activities. We initially highlight our interview methodology, and then we describe our data collection and analysis before finally briefly discussing our findings.

Interview Method

We performed a series of semi-structured interviews with participants. Twelve participants from the village were recruited through word-of-mouth, notices, posters that were displayed at the local chief's office and snowball sampling. Nine of the city participants who used technology were recruited using Facebook while the remaining city participants were also recruited through snowball sampling. We explained the aim of our study to our participants so as to ensure that we recruited people who would provide rich information during the actual study.

The interviews took place in the rural homes of the village participants and at the workplaces or businesses of the remaining participants. Each visit lasted between 45 and 60 minutes. The principle investigator conducted an in-depth interview with the participants about their family composition and communication practices using technology. The study was mainly conducted in two stages.

1. Participants were provided with a sheet of paper and asked to draw their family communication networks.
2. After step 1, participants were then asked a series of questions about their communication routines with distributed family members. This included questions about how often a participant contacted each remote family member and the type of technology that was used for such communication.

The questions aimed to obtain information regarding the use of technology to connect with distributed family members across the country on shared family activities.

Participant observation and photographs were also used to monitor the study environments of the participant's life at either their work or home sites. Participant observation helped us to understand the urban and rural infrastructures, routines and technology use of our participants. Notes from these observations were analyzed and then used to further refine the interviews.

Data Collection and Analysis

Open coding was independently conducted on the transcripts to identify salient themes such as convenience of sharing particular family practices using specific technology choices and timing of communications. Initial themes were identified gradually in a manner of convergence, and the remainder of the data was coded iteratively based on the initial themes to relate the communication practices using technology to the activity sharing that they supported best. All the codes and memos were collected and then grouped together in line with the categories they represented.

A follow up visit was conducted approximately one week after the initial study to clarify any unclear observations that were still apparent after transcribing the initial interviews. In both visits, photos and notes were taken during interviews and all data from both interviews was audio recorded and later transcribed.

RESULTS

In general, our results illustrate that family members used techniques such as, beeping, setting up voicemail, and turning off their phone to overcome infrastructure limitation connecting with distributed family members. We also see that through short mobile phone calls and by sharing mobile devices among collocated family members, families were able to share information on activities that required collaboration.

To briefly elaborate on our results, we observed that participants from the rural settings engaged with subsistence farming in conjunction with their relatives who worked in the city. The family members who worked in the city would provide financial support to their remote family's subsistence farming activities. With the advent of relocation of families from rural to urban environments in ICTD communities for economic and study related commitments on the rise, we observed that our participants occasionally needed to keep in touch with their distributed relatives through some medium of communication. In terms of the use of technology to keep in touch with each other, our participants adopted various techniques that allowed them to either call relatively cheaply, or to time their communication so as to align with the availability of remote family members. Our investigations also revealed that an individual's economic situation dictated who bore

the largest cost for communication method used. This was common with all our participants regardless of who had initiated the conversation. Our rural participants reported that they would only beep, briefly call or send please call me texts to their relatives who worked in the urban areas. We now switch our focus to the design process of the VMS.

DESIGN EVOLUTION

Participants' View of the VMS

We then used findings from the described ethnographic study on family communication patterns to inform the design of the VMS. Our study revealed two sets of potential users for the VMS. The first, are individuals who have the knowledge to operate other forms of technology in addition to mobile phones, while the remaining set of users are only capable of using mobile phones with limited knowledge in operating other technology applications. Therefore, designing for both sets of users would require the interpretation of our findings to suit either context. For this paper, we explain how our results support the functional design for the VMS as seen from the village user's perspective.

Our first step to understand how asynchronous video sharing could be used in the village was to design our own system that can be tested and iterated as needed. Next, we describe the initial design followed by suggestions for future work.

Initial Design

Current Design

In this section, we will provide a description of the design process used during the development of the VMS and also describe a scenario of how two family members would use it to share their activities.

Design Description

The VMS supports a one way video transmission, so that each distributed family member who is able to access Internet can choose when to access the server videos. This way, a remote user is able to view recorded videos at their own convenient time.

The Video is transmitted using client-server architecture (Figure 2 over the Internet. The VMS is an Android application that is developed in an Eclipse platform. It is hosted on a Google App Engine SDK (Figure 3) and then exported onto a mobile device as Android Packaging (apk) file. Once the apk file is downloaded and installed in a mobile device, the VMS becomes functional.

The VMS is designed to be an asynchronous video sharing application that could be used to share media between two devices. The VMS app records video on to an Android powered mobile device, and then relays the stored videos on to a server for viewing. The VMS launches on to the phone screen to simulate the idea that the phone is a dedicated device for video sharing. This design also permits the VMS to be highly mobile since it can be used wherever the phone is taken, if desired, which sets its design apart from past media spaces such as the [10].

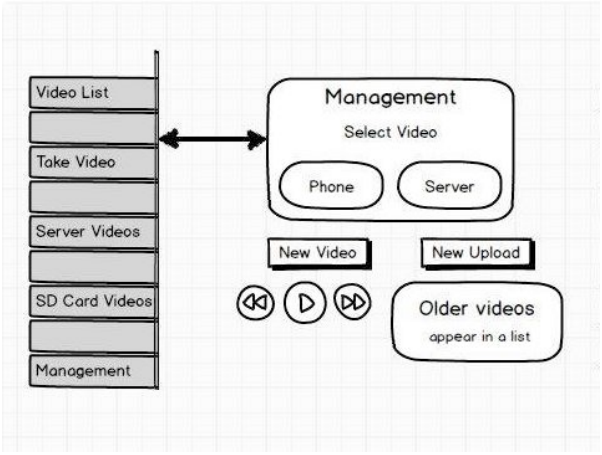

Figure 2: A sketch of classes that are implemented to manage videos in the VMS application.

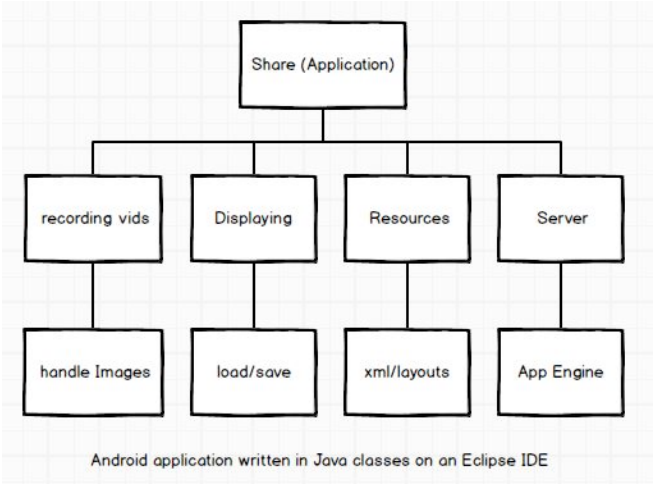

Figure 3: a tree diagram of the VMS software design process

On launching the VMS, videos that have already been recorded on to the phone's storage can be seen listed on the default page of the VMS (Figure 4a). Users interact with the VMS through touch.

Video captions are presented on the left side of the screen so that a user can briefly see an image of the video they would like to view. The list is ordered beginning with the earliest to the latest video recorded. At the bottom right end of the screen there are three dots (Figure 4b) that provide the access to controls that enable individuals to record and access video from both the phone's storage and from the server (Figure 2).

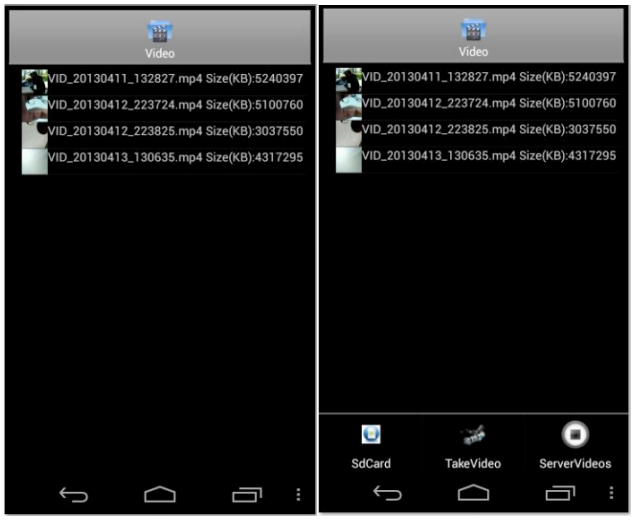

Figure 4 a (left): Videos stored on the phone are seen on the VMS screen after launching the application.

Figure 4 b (right): The VMS controls shown at the bottom of the screen after clicking the buttons on the bottom left of the screen.

Clicking the three dots produces controls for video handling as shown in the bottom part of Figure 4b. When the TakeVideo tab is clicked, a user will be presented with options that allow for the recording or cancelling of video (Figure 5a). On completion, the recording ends after clicking the Stop Video icon that was previously used to begin video recording (Figure 5b). We are then taken to the next screen, where two options to either cancel or save the video to the phone are presented (Figure 6a). Videos that have been saved on to the phone are then relayed over the internet to a server where they can be accessed by a remotely located individual through the ServerVideos tab (Figure 6b).

To access the server videos, a user will press the ServerVideos tab that is shown on the bottom left side of Figure 4b, which then present a list of all the videos that are currently stored on the server (Figure 7a). The newest video is shown last in the list (Figure 7b) of videos currently sitting on the server. Selecting a video from the list will display the video playback controls shown in Figure 6a. Once a video is clicked from the server list, it will begin playing on the whole of the phone screen.

However, should we need to pause a playing video, we would touch the surface of the playing recording which will in turn activate the play controls that will allow for the pausing of a playing video. On the bottom of the playing video's screen, there is a time line that shows how much time has elapsed since the video started playing.

To foreshadow, the asynchronous video transmission nature becomes important for it creates opportunities for information to be transmitted to family members who live away from home. Remotely located family, who are able to access data on their mobile devices, can view videos on activities that they are interested in back in the village. We provide a scenario of how a rural participant reported his technology use to connect with remote family in [19] could use the VMS.

Usage Scenario

John, 20, who is married, unemployed and lacks formal education, uses his mobile phone to coordinate and share information on farming activities with his sister. His sister works and lives in Migori [14] and provides the financial support for a joint sugar cane farming project. John would like to show his sister how much work was performed in the farm during the week. His sister would also like to know how much work was done so that she is aware that finances are being spent well in the project. Previously, John would make brief one minute phone calls in the evenings asking his sister to call back for explanation of completed work. However, we will show how the VMS augments john's communication with his sister in the following scenario.

John Walks to the farm on a Saturday morning holding his cell phone. He turns on the phone and selects the applications Icon. He selects the VMS icon by clicking it among other applications that are installed on the phone. He is then presented with the screen short in Figure 4a. He touches the three tiny dots on the right bottom part of the screen that lead him to the screenshot in Figure 4b. John then selects the camera icon which, in turn presents the video recording interface that is shown in Figure 5a. He clicks the red button and begins recording a video that shows the amount of sugar cane plants that have been put into the already cleared part of the farm. He captures this video from a hilly part of the farm so as to get a clear overview of the work done in relation to the farm's size. After 15 seconds (using the timer on the top left screen of figure 5b), he clicks the white button inside the red circular icon in Figure 5b. The VMS then presents him with the option of saving the video (Figure 6a) and then briefly waits for the screens in Figure 6b, Figure 7a and Figure 7b to confirm that the video has been uploaded on to the server (Figure 7b). Finally, he clicks the house shaped icon at the bottom of Figure 7b which returns him to the phones home page. John then calls his sister, and lets her know that he has just uploaded a video on the amount of farm work that was performed during the week. This scenario assumes that John had already purchased data his phone and therefore was able to transmit the recorded video.

Design Iterations

This iteration of the VMS design will be used as a springboard to future development versions that will capture various needs that will appear after conducting an evaluation with users to address a variety of needs that a larger group of users may want. Thus, we are starting with a

system that will initially support asynchronous video transmission over mobile Android devices.

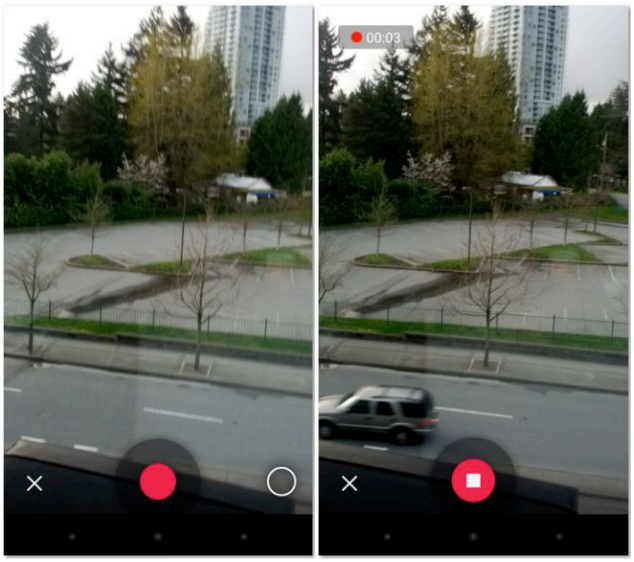

Figure 5 a (left) VMS showing the controls for recording and cancelling of videos

Figure 5b (right) ongoing VMS video recording showing elapsed time at the top left of the screen

Simple User Interface From our investigation of family communication patterns in rural and urban regions of Kenya, we realized that local family members needed a way to notify remote family members that they wanted financial assistance to assist with farming projects in the village. Besides phone communication, video would also show the remote user some sort of progress that would augment phone discussions.

Coupled with the idea that most of our participants from the village reported to have had only limited learning experiences and therefore not very knowledgeable in using computers, we designed a video sharing application to support this need. Users simply touch the video application to launch, and then press one more button to access the VMS video recording and viewing controls (Figure). The illiterate are then required to simply record a video and stop it after a few seconds. The application will then handle the video transmission to the server (Figure 7a).

Beeping and Short messaging systems (SMS) We also recognized a need for family members to share short bits of communication, through beeping or the sending of free SMS that was provided by local phone providers. These short messages were meant to ask a family member living in the urban region to call back for a discussion. Currently we have only implemented video and audio features. We are holding on the temptation of implementing a SMS window on the VMS since most of our participants from the village did not report interest in using SMS to communicate with remote relatives.

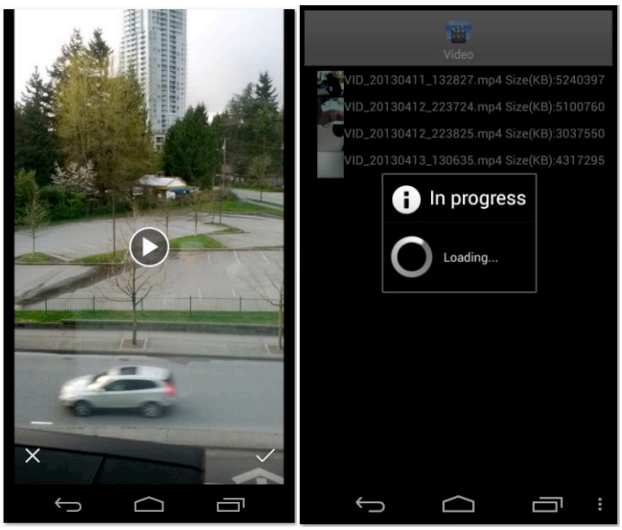

Figure 6a- left: A completed video recording with controls for saving the video on the bottom of the screen.

Figure 6b- right: The VMS saving videos to the phone storage unit (SD Card)

Most of our village participants reported the use of beeping. However, this is a functionality that will be included in future design investigations of the VMS. Short video clips that have been captured using the phone are stored with captions to the left side of the screen and identification of the video given as numerical values.

A future iteration of the VMS will ensure the video description is presented in a text format so that it becomes easy to identify a stored video by name or simple numerical assignments such as the ones shown for the server videos.

1. *Ubiquitous mobile device*. All participants reported to have access to a mobile device that they could use to send or receive information from remotely located family. An application that can be installed in a mobile device is therefore able to build on already existing communication practices. Users will thus be able to use the VMS as if it was part of the applications that are shipped with the mobile device. Deploying the VMS as a phone application will also support people who currently share phones through multiple usage of a single device, in sharing their activities with remote family members. The VMS has therefore been designed as a mobile application that is installed on portable mobile phones. The mobile phone is equipped with a camera on the back thereby making it easier to capture video of the user's environment as opposed to the user's self. The remotely located family member can also view uploaded videos on their mobile devices as long as they have Internet access.

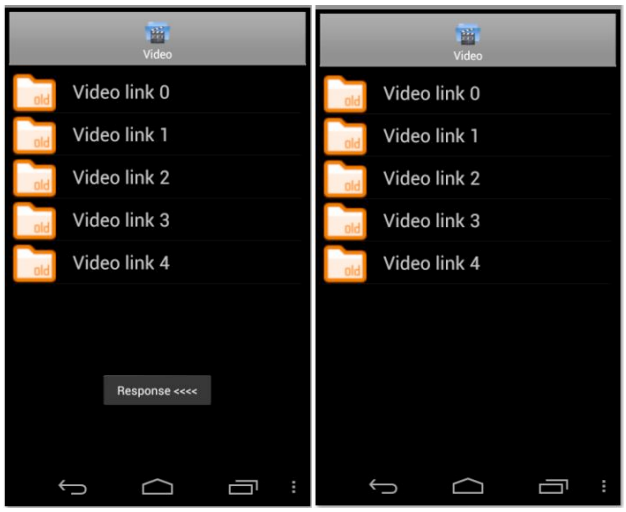

Figure 7a- left VMS showing the saved video (Video link4) being uploaded on to the server

Figure 7b- left shows the new uploaded video ready for viewing from the server

2. *Simple awareness of shared activities*. Since video is the closest technology that resembles face-to-face communication, designing an application that supports the sharing of video among family members in remote parts of developing countries will enable distributed family to augment mobile phone communication with actual images. This functionality will support relatives who would like to oversee projects that they are collaborating on with remote family members and augment mobile communication with videos for the provision of a complete of project progress.

3. *Usage Flexibility*. Through the design of an initially simple interface, the VMS uses only three controls for the recording and access of both the videos both the phone and server videos. Users are presented with the VMS controls after only three clicks from the phone's main menu. The quick access to the video application using the VMS controls greatly reduces the learning curve for illiterate users.

4. *Asynchronous video relay*. The VMS supports the asynchronous relay of short video clips that provide a quick glimpse of the shared activity of interest between family members. This is in line with the widely used practices of beeping and sending of short messages by family members that live in the rural locations to their relatives that live in urban areas. The VMS's asynchronous video support also allows the remote family member, who in many cases provides financial support to village members, the opportunity to access short video clips at his convenience. This is similar to the current use of "please call me" messaging [24].

5. *Automatic relay of images*. Most mobile applications require extensive sign on and settings adjustment procedures that can be challenging for an illiterate rural user. To avoid this challenge affecting our perceived set of users, The VMS is designed to upload videos from the remote user's device automatically. The village user is only required to access internet at times when he or she needs to upload videos to the server. The VMS supports the relaying of videos that are stored on the phone regardless of whether they are recorded by the VMS or the phones inbuilt camera. Reciprocity is purposely not enforced based on our assumption that the urban users do not face challenges with launching and accessing server videos from the VMS menus.

Discussion

We have yet to formally evaluate the VMS but we did use the system ourselves over the course of few days after the completion of the initial design. We know that investigations on media spaces had raised privacy issues with regard to autonomy, solitude and confidentiality [2]. The VMS is designed to be used by the distributed family members amongst themselves. Our design is informed by current practices that we captured in rural Kenya in [19]. Family members reported to share farming and income generating activities with their close relatives who lived and worked in urban regions and were therefore able to provide financial support for such projects. This scenario means that these family members were already comfortable with sharing information with the distributed family members that they were communicating with. Confidentiality is addressed by the rural family member being in control of what is to be shown on video, which mostly relates to common practices that are of interest to the concerned parties. The ability of the urban user to access the server at his own convenience provides him with the opportunity to address solitude concerns that arise from the use of media spaces for family connectedness [2]. The VMS also provides users with the ability to choose when and how to share videos. The village user will only be able to send videos after accessing the Internet and this would give him or her ample time to delete any videos that she would not want to be relayed over to the server. The remotely located family member in the urban areas is also able to access server videos at his own convenience.

In Comparison to Video Conferencing Systems as Skype or Google Talk, the VMS runs as a dedicated application on mobile devices. We envision the VMS to be used through low cost Android phones that might be produced in the future. Our design builds on the experience of using synchronous video conferencing by providing a one way video sharing platform. We are initially investigating the asynchronous sharing of videos because this will allow us to capture missing functionalities that would support our participants in using the VMS. The most fundamental deviation in the VMS design as compared to most other media spaces is a perception shift in the way people see and

think about video conferencing, especially for the parts of the world that experience limited technology.

Currently, the largest limitation with the VMS is that we are only able to delete server videos through the Google App Engine Interface (Figure 8). This requires knowledge with server management that many of our participants are not able to perform. We will address this shortcoming of the VMS in future design iterations.

Figure 8: Video control panel as shown in the Google App Engine server.

For the immediate future, we plan to conduct a pilot study with two families in Kenya that would be interested to be part of our study. We will select these families based on interest that had earlier been expressed in [19]. The next step after conducting the pilot study will involve addressing any design issues that will arise from the use of the VMS by the selected participants. Finally, we will conduct a full study to evaluate the VMS use by a sample of families within their homes, and by interviewing people about our design concept.

Conclusion

We have presented the design of the VMS, a one way system that supports the asynchronous sharing of video for rural users in developing countries. We envision this system being used by rural families in various ways. For example, distributed family members who live away from the villages can acquire awareness of village projects on farming to augment the brief phone calls that are currently used for similar conversations. This way, the remote family members enjoy sharing everyday life with one another. The asynchronous nature of the VMS along with its mobility are critical design factors to support these users' needs especially where outdoor activities are to be shared.

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