3D Documentation of Nursery Activity using Photographs with Location and Sound Information

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We propose an easy-to-use 3D documentation system for nursery activity that visualizes photos with embedded location and sound information, taken by childcare workers while they are taking care of the children. Most existing nursery documentation is made by hand as a piece of paper with printed photos and hand-written comments, which has high readability and freedom of layout and also is good in expressing the emotion of workers. On the other hand, this method has several drawbacks: 1. it requires time and effort of workers 2. it is hard to store for a long time and pick up later 3. it does not scale in sharing with other people, such as parents. Among several standard documentation formats, we chose the so-called "nursery mapping" style since it is suitable for visualizing positional information (which usually corresponds to the type of activity) and other forthcoming nursery sensing data. With the power of Wi-Fi-based indoor localization technique and voice recording/recognition while photo taking, our system allows a much easier generation of documentation of nursery activities with 3D visualization. Our system also has some typical advantages of online documentation systems such as large, almost permanent storage and easy sharing since the data is stored in cloud storage (Google Drive), and visualization is performed in common browsers.

1. Background

The documentation of nursery activities that collect photos and comments of childcare workers gains increasing interest in nursery schools. Such documentation is useful not only in sharing childcare information with parents and children themselves but also in reflection of workers' activities, which can potentially contribute to supply better quality care [1].

Figure 1: An example of nursery documentation
Source: Takagi Minami Nursery School HP: 'Documentation corner' http://nursery.ict-takagi.com/minami/documentation.html

Figure 1 shows is a typical example of nursery documentation. As clear from the figure, this efficiently shows the children's activity and childcare workers' interpretation with the help of lots of photos and texts. Nursery documentation usually takes this handwritten style. This style has many advantages. Since the elements are manually arranged and drawn on an empty sheet of paper, it has a large degree of freedom for design, which results in high readability and potential for expressing the emotion of workers. On the other hand, this method is largely manual labor-intensive. The workers take pictures while they are taking care of children and then spare time separately to print the pictures, glue them to a paper, and draw the texts, arrows, and other elements. The product of this process is a physical paper, which is hard to keep for a long time, thereby hinders future references. This is also unsuitable for sharing with other people such as parents.

These drawbacks are partly overcome by digital documentation. Digital data does not physically occupy spaces and lasts for a long time. If it is available online, sharing it is also easy. On the other hand, digital data creation is usually less intuitive than physical content creation. Therefore, we need to design an efficient user interface to support digitalizing the data. We propose to embed additional metadata to the photos that support nursery documentation. We decided to embed positional information using the Wi-Fi localization technique because activities strongly correspond to their location (e.g. dietary activity happens at the dining room.) We also added a sound recording functionality to our camera app, because text information is an essential part of the documentation in describing what is going on in the photo and to what the nursery worker intends.

There are several kinds of nursery documentation. We take a "nursery mapping" style that plots photos and other information onto the floor plan of the school because it is suitable to visualize positional information[2]. We also adopt the 3D visualization, because it provides a highly intuitive perception for a spatial relationship between photos and the environment, as well as the possibility to resolve occlusion between photos and texts by changing the viewpoint.

2. Our System

The overview of our system is shown in Fig.2. The screenshot of our visualization is depicted in Fig.3.

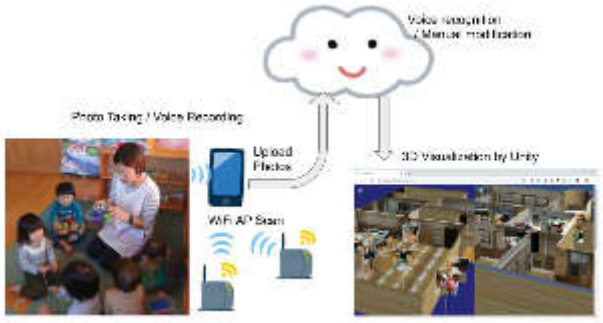

Figure 2: Overview of our system

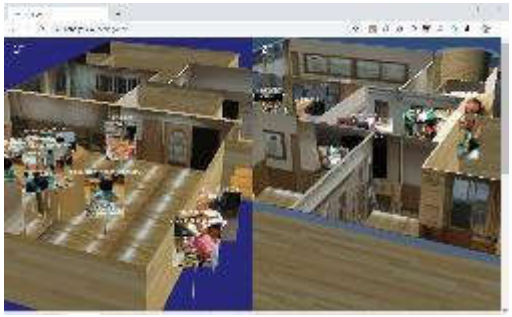

Figure 3: A screenshot of our documentation

Our system visualizes photos with text information on top of the 3D models of the nursery school of which we are planning to perform field tests. Since the school has two floors, our visualization shows both floors at once. If the user drags on the window, both models are rotated at once. The photos and texts always face to the viewpoint (billboarding).

The photos are taken by childcare workers at work. We developed an Android camera application called “Tag Camera” that allows sound recording at 16k, 16bit, monaural, by holding the shutter button after taking a photo. The sound information is converted to a string using base64 encoding and embedded into the image file as the EXIF comment. The image file is automatically uploaded to the cloud (Google Drive), the EXIF field is extracted and analyzed, and the sound information is sent to Google Cloud Speech API. Since the transcripted text is not always correct, we developed the frontend web application to manually modify the transcripted text.

Figure 4: The frontend of our cloud system

Wi-Fi-based localization is a common technique for quickly obtaining positional information of mobile phones, especially for environments where GPS is not available [3]. Our camera app also scans the Wi-Fi signals when a photo is taken (Fig.5). The scanned result is also stringified and embedded into the EXIF comment field of the image file.

KURAKINAGATAWIFI	74:0	-48
Extender-C-BACA	74:0	-54
	0c:8	-72
KURAKINAGATAWIFI	0c:8	-73
ngw-room1	b8:2	-81
	06:8	-85

Figure 5: Wi-Fi AP scan result example

In our cloud, the scan information is separately extracted from photos and stored as a JSON file in Google Drive. The file is periodically processed by our optimization software to estimate locations. The algorithm is basically a constrained nonlinear optimization technique using a log-normal signal propagation model [4]. Our software is implemented as Python and Node.js scripts and run inside the Google server through Google Colaboratory. The estimated locations are again stored as a JSON file in Google Drive.

The 3D model of the nursery school is created by SketchUp [5]. We take interior photos of the target nursery school and attached to the 3D model as textures (Fig.6).

Figure 6: Three-dimensional data in SketchUp (left). We take photos of the interior of the nursery school to be used as a texture of the model (right).

The finished model is imported to Unity [6], which is a popular game engine. We added the navigation interface within Unity and exported the application to WebGL. The HTML contents are hosted by GitHub pages that communicate with our cloud frontend system through inter-frame communication.

3. Conclusions and Future Work

We proposed an easy-to-use online 3D documentation system of nursery activities with the help of Wi-Fi indoor localization and sound recording/transcription techniques. We developed a tailored camera application for smartphones and corresponding clouds system. Our system semi-automatically generates efficient 3D documentation with a little additional work of the childcare workers to record their voices at taking pictures. Our direct future work is to perform the field test in the real childcare environment.

References

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