The 33rd Annual Conference of the Japanese Society for Artificial Intelligence, 2019

Vision Based Analysis on Trajectories of Notes Representing Ideas Toward Workshop Summarization

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In some workshops, the participants use sticky notes to represent their ideas and the notes are regarded as one of the outputs. When workshop analysts summarize a workshop afterwards, they compare those notes and recorded video and/or audio by hand. We hypothesize that spatial and sequential information of the notes represents how ideas are came up with and how discussions flow. Therefore, we propose a vision based system analyzes trajectories of such notes during workshops. This paper introduces our prototype system that analyzes trajectories of notes representing ideas. During the workshop, the system recognizes and tracks each note separately from camera observation. The recognition and tracking results are saved and used for further offline analysis. From preliminary experiments, we confirmed that the proposed system can potentially reduce the manual tasks.

1. Introduction

Today, the workshop [Geurts 01] departs from the original meaning such as "workplace" or "studio", it means a method to learn or create ideas through experience, work, discussion, emergence among participants, devise solutions for problems. A typical example is people learn to make things by hand or to play music/theater through work participation and physical expression. Also, workshops are using for corporate training in recent years, and it is also frequently used as a means of formulating public policy, citizen participational consensus building or disaster prevention measures.

Considering the discussions in workshops, argument mining [Moens 18] occupies a position to find contextual meanings from the discussions to analyze. Thus, the area of argument mining typically aims to analyze the structure and important words and sentences from text data of utterance.

Discussion mining considers the progress and turning points of discussion [Nagao 04]. Focusing on meetings using slides, their works record the video of the meeting as well as statements and their types of the statements. From those recorded information, we can overlook the structure of discussion [Nagao 04] and presenter's tasks [Nagao 15].

Workshop reflector records a wide variety of activities during workshops to reflect them [Tomobe 08]. A workshop is semi-automatically recorded as pictures, videos, and audios. After the recording, texts or handwritten images are annotated to those recorded data. Once the annotation is done, participants in the workshop can reflect the discussion from those annotated contents with time-line or card style representations.

Contrast to the state-of-the arts, we extract a different type of information from workshop outputs to support workshop analysts. Figure 2 (a) shows our target situation. Workshop participants sit/stand surrounding a table. During the workshop, the participants write their idea and keywords on idea notes, a kind of small sheet of paper, and put them on the table. Following their discussion, the participants move the idea notes to represent their connectivity by their physical distance. When a group of idea notes form a group, the participants put a special idea note to assign a label to the group. Finally, we obtain a set of idea notes and their corresponding groups.

Workshop analysts need to summarize a workshop from its output such as notes representing ideas and their spatial relationship. This task requires them to compare the workshop outputs and recorded video/audio several times by hand, which is time consuming. We hypothesize that spatial and sequential information of the notes represents how ideas are came up with and how discussions flow. Therefore, we propose a vision based system analyzes trajectories of such notes during workshops.

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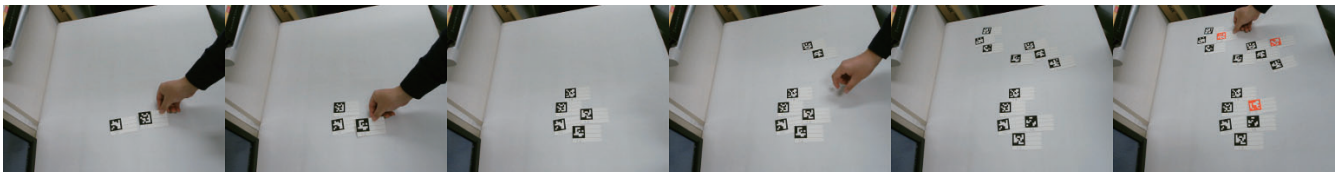
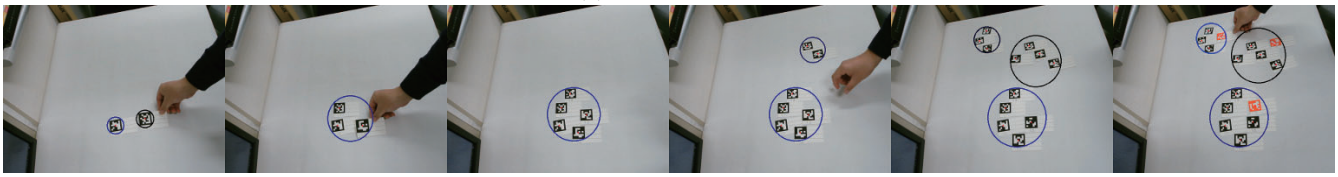
2. Our prototype system

We aim to support workshop analysts summarizing discussions in a workshop to confirm their progression retrospectively. As a first step of this ultimate goal, this paper proposes our prototype system of vision based progress recorder to analyze workshops.

As mentioned above, our aim is to support workshop analysts summarizing the progress of a workshop. In this paper, we introduce our prototype system based on simple computer vision technique. Specifically, we record idea notes put on the table and analyze the recorded sequence in real-time. Using computer vision technique, we can detect idea notes from the recorded picture and recognize their ID in real-time. Hence, we can record (1) when and where each idea note appears on the table, (2) how each idea note moves, and (3) which idea notes form a group. We regard those recorded information as a representation of the discussion progress. So, workshop analysts can retrospect the workshop from the information: idea notes' creation time represents when the idea comes out, idea notes' trajectory represents how the idea interact each other, and groups represent the relationship between the ideas.



(a) Input sequence



(b) Real-time analysis result

Figure 1: The video sequences. (Top) The input video sequence. (Bottom) A sequence visualizing the grouping result.

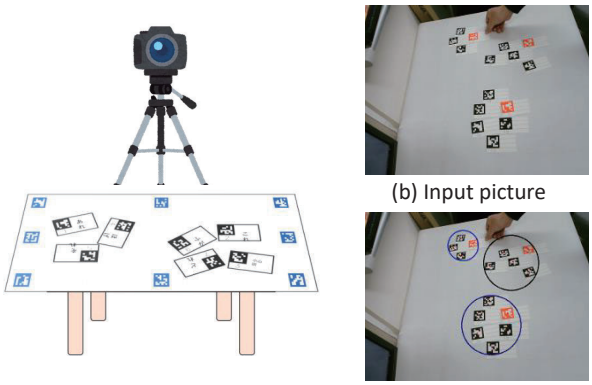


Figure 2: The proposed system.

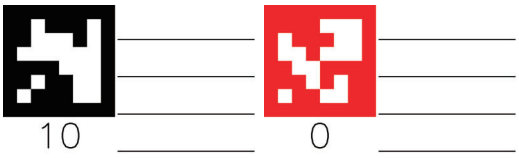
2.1 System Configuration

Figure 2 (a) shows our system setup. We put a camera over a table to observe an entire table. The camera sends a video sequence to a PC. The PC detects and recognizes idea notes put on the table and group them into some groups in real-time. The position of each detected idea note as well as the pgrouping information are stored with recorded time information. Fig. 2 (b) shows a sketch of input picture and analysis result.

To enable idea notes detection and recognition easier, we design a special idea notes as shown in Fig. 3. Each idea note consists of three parts:

1. 2D barcode part on the left top is for the PC to detect and recognize the idea note.
2. ID part on the left bottom is for the participants to recognize the idea note.
3. text part on the right is for the participants to write their idea and keywords.

We design two types of idea notes, one for normal use and the other for labeling. The participants use normal idea notes (Fig. 3 (a)) for writing their ideas. Only when they



(a) Normal (b) Label

Figure 3: Example of the designed idea notes.

label groups, labeling idea notes are used. For ease of understanding, we differentiate these different type idea notes by color.

2.2 Vision based progress analysis

This section briefly explains how our prototype system analyzes the workshop progress.

2.2.1 On-line idea note grouping

On-line idea note grouping is done by two steps. The first step is idea note detection and recognition. We use ArUco [Garrido-Jurado 16, J.Romero-Ramirez 18] for this process. ArUco is an open source library for camera pose estimation using squared markers such as 2D barcodes shown in Fig. 3. As a pre-processing, ArUco builds a database storing the relation between 2D barcode and idea note's ID. During system operation, ArUco takes a picture from the camera and detects and recognizes 2D barcodes appearing on the picture. As results, ArUco outputs a set of idea notes information, each of which consists of its ID and detected spatial position in the 2D picture coordinate.

The second step is to group the idea notes. Assuming that all idea notes assigned to a group must be closer, we solve this grouping problem by the following ad-hoc aggregation.

1. computes a threshold distance for each idea note,
2. computes a pairwise distance between all pair of the idea notes,
3. aggregates multiple idea notes into a single group if their pairwise distance is less than one of their threshold distances.

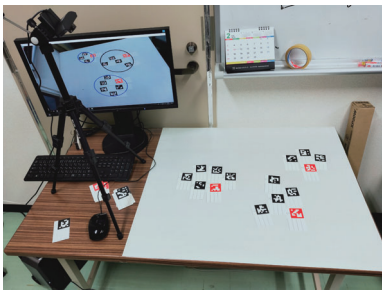


Figure 4: Experimental setup.

2.2.2 Off-line trajectory analysis

Off-line trajectory analysis visualizes trajectories of idea notes so that workshop analysts can reflect the discussions from idea notes' activity. We propose two type of visualization. Both visualization encode time stamp by color. The first visualization draws the trajectories of interests as shown in Fig. 6 (a). A symbol is assigned to each idea note and their position at each frame is plot with associated color. The second visualization draws the trajectories of all idea notes as shown in Fig. 6 (b). Contrast to the above one, this visualization uses same symbol for all idea notes. Thus, this visualization is to see when participants moves the idea notes more.

3. Experiments

We conducted a preliminary experiment to show how our prototype system works and to show its potential. Figure 4 shows the experimental setup. We prepared a half-A0 size white paper on a table. The paper area was used for idea note based discussion. We put a camera at the left hand side of the table to observe the scene. An operator checked the real-time analysis result on a computer monitor behind the tripod.

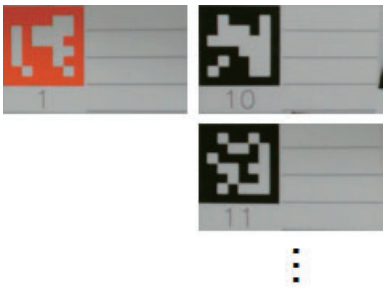
In this experiment, an operator performed fake discussion as shown in Fig. 1 (a). The idea notes history is as follows

1. made a group of five idea notes in the middle,
2. made another group of two idea notes in the top right
3. moved an idea note from the first group to the second one,
4. added one idea note to each group,
5. made the third group of 3 idea notes in the top left,
6. assigned a label idea note to each group.

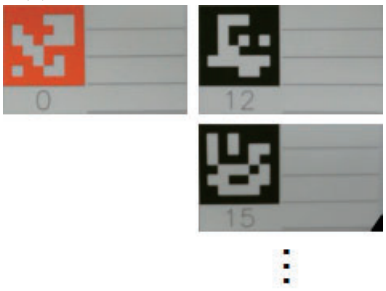
After the fake discussion, the operator captured pictures of idea notes assigned to each group. The computer automatically cropped each of the assigned idea notes and saved them as separate files.

3.1 Real-time grouping results

Figure 1 (b) visualizes the on-line grouping results corresponding to their counterparts in Fig. 1 (a). All markers assigned to a single group is bounded by a unique colored ellipse. As the figure shows, idea notes grouping worked well. For a 24bit picture of 640×480 resolution, the on-line analysis worked in real-time on an ordinary computer.



(a) Idea notes assigned to Group 0



(b) Idea notes assigned to Group 1

Figure 5: Grouping results.

Figure 5 shows the label idea note and some normal idea notes of first two groups. Even though we just saved the cropped notes, we believe that we can extract text written on the notes by OCR and use such information for further reflection.

3.2 Off-line trajectory analysis

Figure 6 shows off-line trajectory analysis result. We can see that the active region moves from the middle to the top and that a single idea note moves from the middle to the top region. These results are consistent with Fig. 1.

4. Conclusion

Considering recent trend style of discussions and workshops, we aim to offer workshop analysts useful tools. As a first step of this ultimate goal, we introduced our prototype system of vision based workshop progress analysis. The preliminary experiments show some potential of our prototype system.

Acknowledgment

This work was partially supported by JSPS KAKENHI Grant Number 18K02834 and Tottori Unversity CBR Grant Program.

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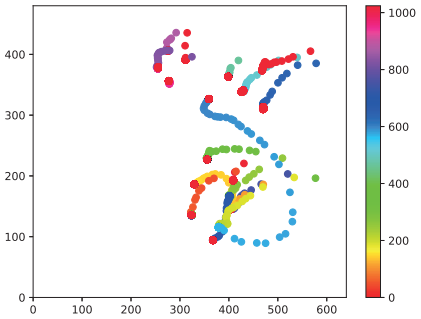
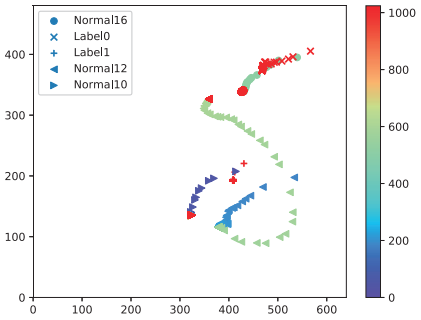


(a) Trajectory of all idea notes.



(b) Trajectory of some idea notes.

Figure 6: Off-line trajectory analysis.

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