

Support Tool for Game Storming with Vision Sensor

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Abstract

A support tool for game storming is proposed in the paper. The tool is composed of a vision sensor with depth camera and projectors. The tool supports both conducting games and analyzing results of games by monitoring and recording deployments of sticky notes and players' hands on a game board. A prototype of the support tool has been developed and feasibility is evaluated through examinations.

1. Introduction

Game storming [1] is frequently applied to product and system design, where goals of the system are difficult to set by top-down approaches, e.g. innovative product or system design. Most of game storming methods utilizes sticky notes and flip charts as physical artifacts for making ideas explicit and tangible, and for discovering embedded relationships between ideas.

For example, in the Affinity Map [1], that is one of popular game storming tools, players call out their ideas on sticky notes and post them on a flip chart (a game board) for making their thought visible to everyone. A facilitator utilizes simple diagrams, which consist of circles and lines, for clustering or structuring ideas described in sticky notes on the flip chart. These simple procedures help players discover their embedded patterns of thinking and promote creating new ideas on these patterns. The sticky note and flip chart are seemed to be useful artifacts for most of game storming, but have issues as the followings:

- Most game storming needs iterative processes between divergent and convergent of thinking. These iterative processes leave too many traces and lead the board difficult to return the board to previous conditions.
- Retracing these iterative processes is a useful way to discover embedded patterns of thinking and promote new ideas on them. However, there is no assistance for retracing the iterative process.

Game storming is getting more sophisticated in order to apply more complicated goal settings. For example, in the Innovators Marketplace on Data Jackets (IMDJ) [2], a map generated by a machine learning technique are drawn on the game board and plural kinds of sticky notes, which have independent roles in the game, are

added or removed in the progress of game. A support tool for game storming to retrace the iterative process and to add information on the game board is required.

2. Basic concept of the support tool for game storming methods

Physical artifacts required for game storming are elicited through surveying popular game storming methods [1] (Table 1). Longhand and handiwork on sticky notes and a flip chart are expected to promote innovative ideas and help discover implicit relations among ideas, in comparison with the uses of electronic equivalents, e.g. electric white board and electric sticky [3].

Artifacts	Usage
Sticky note	Extract a certain thought in a head as explicit and tangible
Flip chart	Discover embedded relationships between thoughts by locating in a space
Marker pen	Draw lines and circles, which indicate relations among thoughts
Dot seals for voting	Use for selecting favorable thoughts by voting
Information card	Provide information required for conducting games

Table 1. Artifacts required for game storming

We assume that the support tool is used in situations shown in Figure 1. Game players stand around a game board and play a game according to facilitator's instructions. For supporting both the game players and the facilitator, the tool provides the following two major functions: sticky notes detection (add or remove, and deployment of these on the board), and players' hand gesture detection. All the activities on the game board and aural communication among players are recorded with images in the tool.

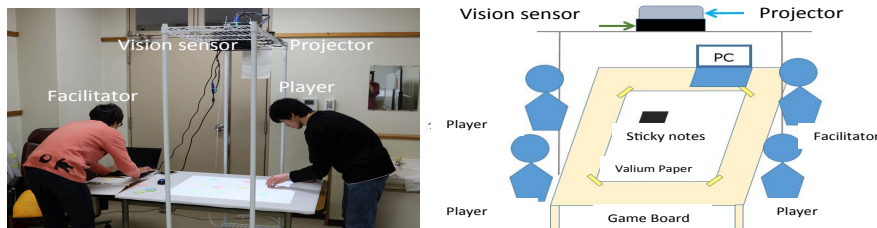


Figure 1. Overview of the support tool for game storming

3. Implementation of the tool

The prototype of the tool was implemented on the concept. The tool is composed of a vision sensor (Color image: 1920 x 1080 pixels, depth image: 512 x 424 pixels), which detect sticky nodes and players' hand gesture on the game board, and two projectors, which project images and information required for

conducting the game onto the board, and personal computer for controlling the vision sensor and the projectors and for recording activities through the game.

3.1. Algorithm for detecting sticky notes

Detection for sticky notes on the board is realized with color images captured by the vision sensor. Each sticky note is identified with their colors: pink, blue, yellow and light green. The algorithm for detecting sticky notes is:

1. Get color images of the board at every 30 msec and Convert RGB color images into HSV coordinate system with the computer
2. Extract regions, which have similarity of colors of the sticky notes, as candidates of locations for each sticky note
3. Recognize regions, which satisfy the size of sticky note ($42\text{mm}^2 - 134\text{mm}^2$), as deployment of each sticky note, and give each sticky note a unique number for identification

The color images of sticky notes on the board are heavily influenced from conditions of ambient lighting and shadows of the game players themselves. To reduce these influences, the tool controls the intensity of illumination on the board constantly with the projector.

3.2. Algorithm for detecting hand gesture

The tool detects players' hand gesture for drawing lines or circles on the board. The tool also identifies actions for picking up the sticky notes and putting down for replacement on the board. The detection is realized with images with the depth camera [4]. The algorithm for detecting hand gesture is:

1. Get depth images of the game board at every 30 msec and Extract regions, which have differences between the current depth image and the former one.
2. Recognize regions, which satisfy differences of the depth ($d'-d$) from 15mm to 115mm (Figure 2. (a)), as a hand, and give a unique number for identification of each hand

It is difficult to detect positions of fingertips due to the limitation of the resolution of the depth camera (depth image: 512×424 pixels) (Figure 2. (b)). To break through the limitation, the tool utilizes color images for identifying fingertips of hands as an auxiliary measure. The tool searches neighborhoods, which have same color recognized as a hand on the color images, and regards the most far-off regions with the same color as a position of the fingertip (Figure 2. (c)).

Drawings of lines or circles with hands' gesture are realized by tracing positions of hands consecutively. Menu buttons for each operation are provided at a corner of the board by the projector.

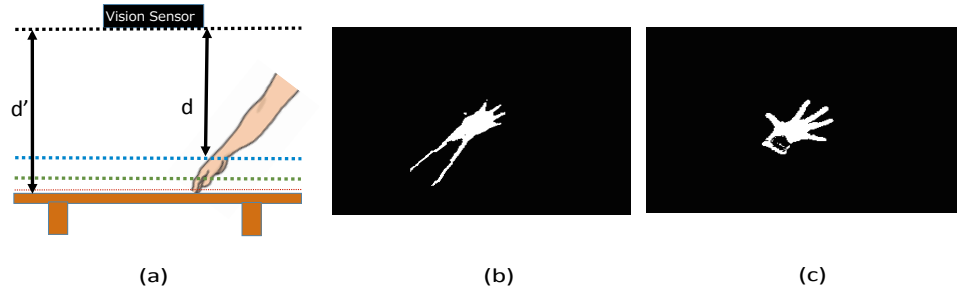


Figure 2. Detection of hand gesture

4. Evaluation

The prototype of the support tool was implemented. Accuracies for detecting sticky notes and hand gestures are evaluated. Feasibility of the tool was also confirmed by applying the tool for idea meeting with brain storming and affinity map.

4.1. Accuracies for sticky notes detection

5 sticky notes were set at 5 positions on the board for evaluation (Figure 3). Accuracy for detecting each position of sticky notes and time for identifying all sticky notes are evaluated. The examinations were repeated 10 times for each color (pink, blue, yellow and light green).

As a result, we confirmed the accuracy of position detection is enough for the size of the sticky notes (within 10mm) and time for identifying sticky notes is seemed to be practical (around 100 msec).

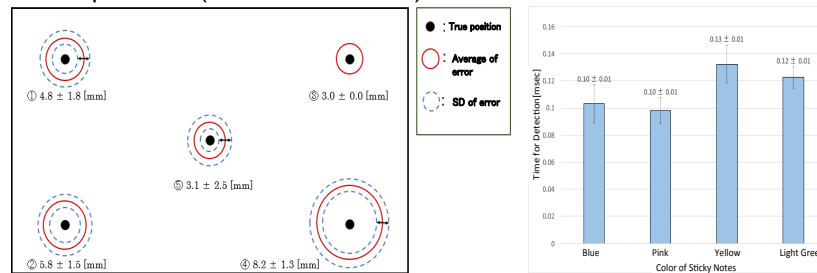


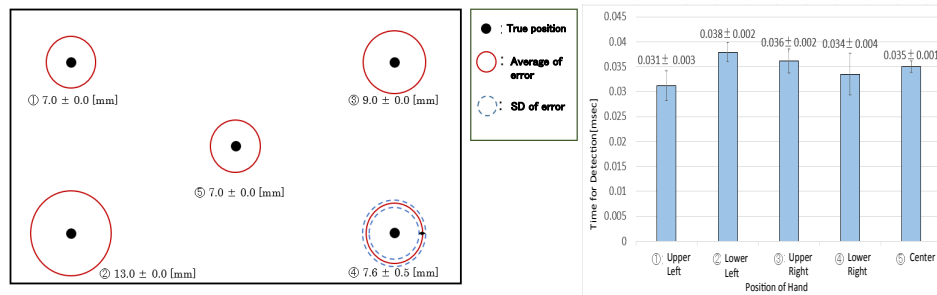
Figure 3. Accuracy of sticky note detection

4.2. Accuracies for hand gesture detection

5 positions on the board are pointed at with hands for evaluating accuracies of the hand gesture (Figure 4). The accuracy of detecting positions and time for identification of hands are evaluated. The examinations were repeated 10 times for each point. As a result, we confirmed that the accuracy of position detection with

hand gestures is enough (within 13 mm) and time for identifying hands is practical (about 0.040 msec).

Figure 4. Accuracy of hands detection



4.3. Apply the support tool to popular game storming

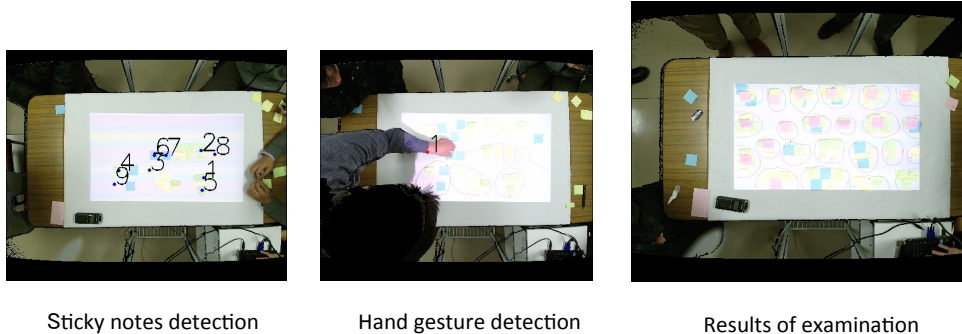
We applied the tool for popular game storming methods: brain storming and affinity map [1]. The examination was conducted with three game players and one facilitator.

1. At the first step, players call out their ideas on sticky notes and post them on the game board
2. Then, players arrange sticky notes on the board and draw circles or lines for each cluster with hand gesture
3. Players make a label of each cluster, and search implicit relations between clusters
4. Players add new ideas, that are created through the above procedure, on the board, and regroup the ideas

As a result, we have confirmed the followings (Figure 5);

1. Sticky notes and hands are identified well with color images and depth images of the vision sensor
2. The tool failed to detect hands and sticky notes, when players leaned over the game board, because, the tool lose color and depth images of the board.
3. The tool sometimes failed to detect the fingertip, when players rolled up their sleeves. The most far-off regions of hands' color are identified in the arm. It is necessary to improve algorithm that utilizes both color and height of the regions as criteria for identifying the fingertips.
4. Increase of number of hands and sticky notes impact time for identification. Time for identification is increasing from 30 msec to 250 msec when four hands are moving continuously on the board. Time delay is seemed not to interference the feasibility of the tool significantly, because 250 msec is enough short for identifying hands' gesture. However, it is necessary to optimize the algorithm in case of applying the tool for the game with large number of players.

Figure 5 Results of applying the tool for popular game storming method



5. Conclusions

The support tool for game storming is proposed in the paper. The tool is composed of one vision sensor with depth camera and two projectors. The tool supports games by monitoring and recording deployment of sticky notes and players' hands on the game board. The prototype was implemented, and accuracy for detecting sticky notes and hand gesture are confirmed. Feasibility of the tool was evaluated by applying the tool for idea meeting with brain storming and affinity map. However, few improvement points in the algorithm, e.g. time for hand gesture detection, were observed for sophisticating the tool in practical level. We have already started improvement of the algorithm, and have a plan to apply the tool to the practical application.

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References

- [1] Gray D., Brown S., Macanufo J. *Gamestorming A play book for Innovators, Rulebreakers, and Changemakers*, O'REILLY; 2011.
- [2] Liu C., Ohsawa Y., Suda Y., *Valuation of Data through Use-Scenarios in Innovators's Marketplace on Data Jackets*, IEEE Data Mining Workshop; 2013.
- [3] Muellell P.A., Oppenheimer D.M., *The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking*, *Psychological Science*, vol. 25, No. 6; 2014.
- [4] Murugappan S. and Elmqvist V.N., Ramani K., *Extended Multitouch: Recovering Touch Posture, Hanedness, and User Identify using a Depth Camera*, ACM UIST; 2012.