Study on participatory projection mapping that can be enjoyed by performers

Takahiro Shinoda

Graduate School of Engineering, University of Miyazaki, Japan

Agenda

- Background
- Precedent case
- Purpose
- Proposed method
- Result
- Evaluation experiment
- Consideration
- Future tasks
- Conclusion

Background

- EC

EC (Entertainment Computing)

- In recent years, it has become more and more exciting
- In this study, we focused on projection mapping

Background

- projection mapping

Precedent case

Fig.1. Once upon a time .

Mapping to buildings

- Tokyo Disneyland
  - ✓Mapping to Cinderella Castle

Precedent case

Fig.2. Rio Olympics opening ceremony.

Mapping to buildings

- Rio Olympics
  - ✓ Mainly 20,000 lumen projectors, 333 projectors were used

Precedent case

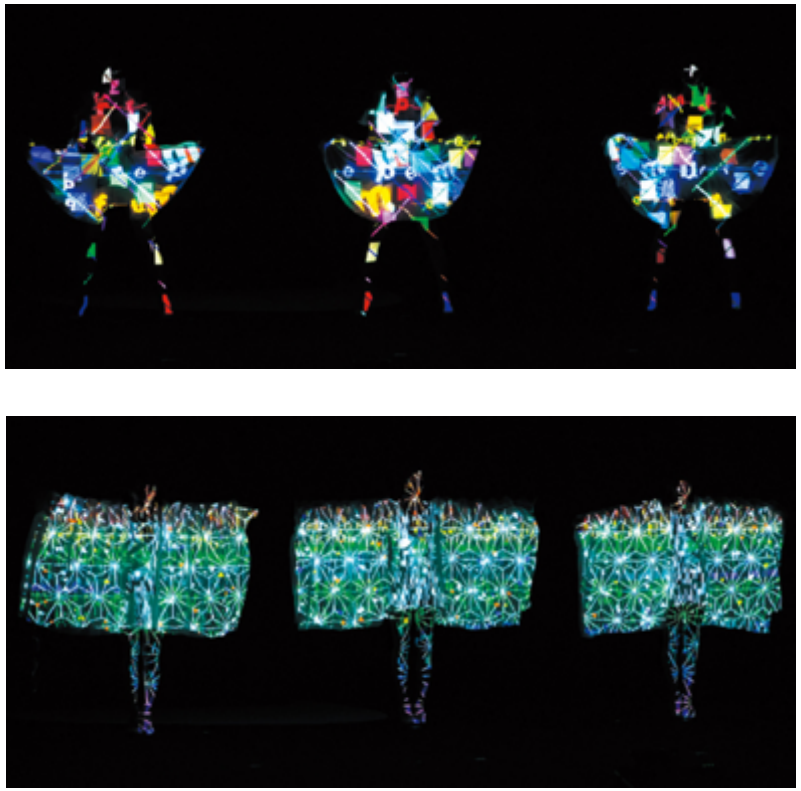


Fig.3. Perfume Cannes Lions "International Creativity Festival".

Events such as live

- Cannes Lions "International Creativity Festival"
  - ✓ There is also an example of projecting to the artist himself

Purpose

- Performers need to accurately align their motion with the coordinates of the image object in the projection mapping

For many, it is difficult

Purpose

Not only people watching projection mapping but also performers enjoy!

Proposed method

- We implemented the projection mapping by the following two methods
  - Method using skeleton coordinates
  - Method using cascade classifier

Proposed method

- Equipment used

Kinect for Windows

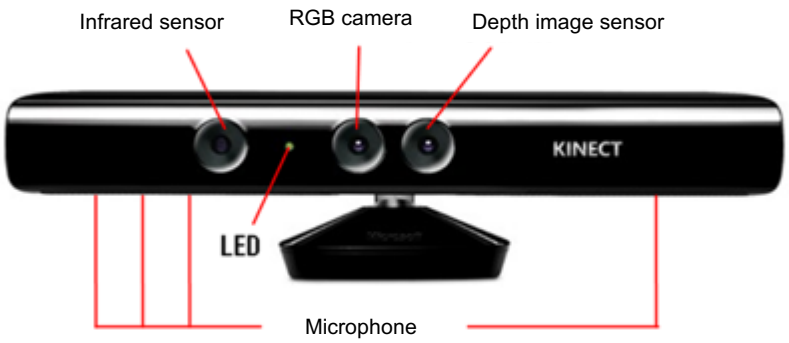


Fig.4. Kinect for Windows.

Projector

Fig.5. Projector (NEC NP50J).

Proposed method

- Development environment

- OS
  - Windows10
- IDE
  - Visual Studio 2017
- Programming language
  - C++
- Library
  - OpenNI2
  - NiTE2
  - OpenCV
  - OpenGL

Proposed method

- System overview

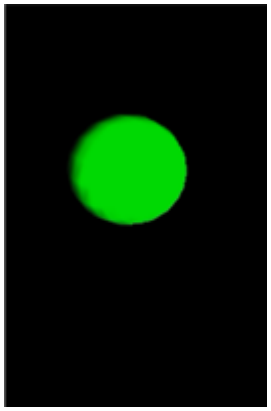


Fig.6. Ball.

Fig.7. Color.

Fig.8. Depth.

Fig.9.
User.

Fig.10. Combination, (_PC).

Fig.11. Skeleton.

Fig.12. Gray.

Fig.13. Cascade.

Proposed method

- Skeleton number

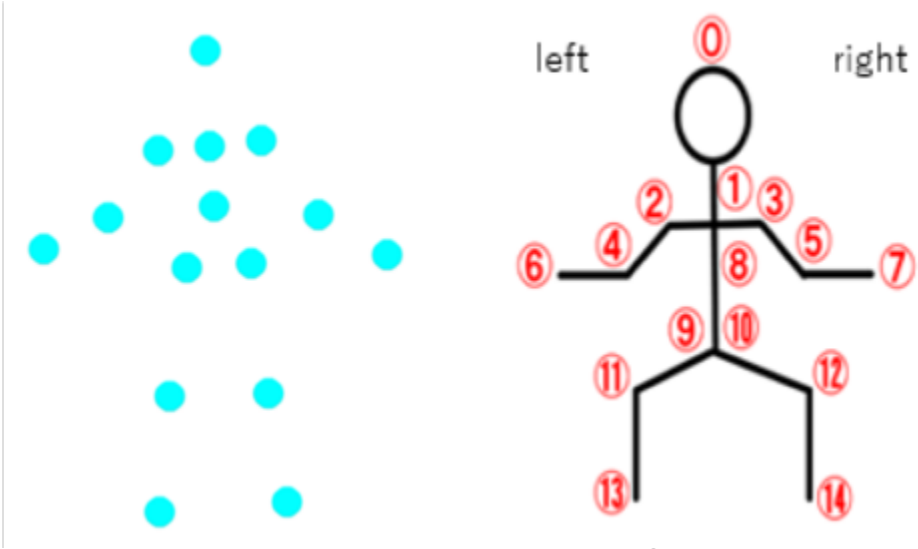


Fig.14. Skeleton number.

num	part name
0	Head
1	Neck
2	Left shoulder
3	Right shoulder
4	Left elbow
5	Right elbow
6	Left hand
7	Right hand
8	Torso
9	Left waist
10	Right waist
11	Left knee
12	Right knee
13	Left foot
14	Right foot

Proposed method

- baseball mode

Fig.15. baseball ground.

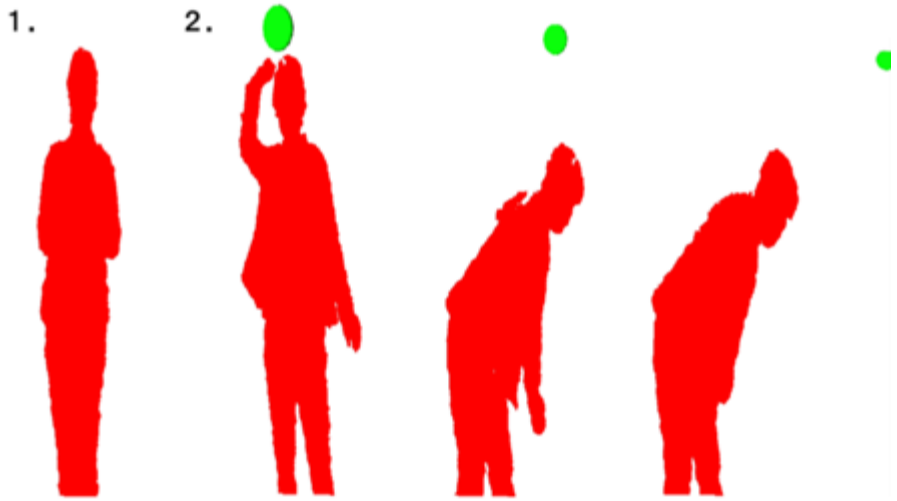


Fig.16. "Combination" screen when running baseball mode.

Proposed method

- baseball mode

1. Align your hands near your chest
   - (x-coordinate of left elbow) − (x-coordinate of torso) $< 200mm$
   - (y-coordinate of left elbow) − (y-coordinate of torso) $< 200mm$
   - (x-coordinate of right elbow) − (x-coordinate of torso) $< 200mm$
   - (y-coordinate of right elbow) − (y-coordinate of torso) $< 200mm$
   - (y-coordinate of neck) − (y-coordinate of left hand) $< 200mm$
   - (y-coordinate of neck) − (y-coordinate of right hand) $< 200mm$
2. Raise your hand so that your hand is above your head
   - (y-coordinates of the right (left) hand) $>$ (y-coordinate of head)

Proposed method

- soccer mode

Fig.17. soccer ground.

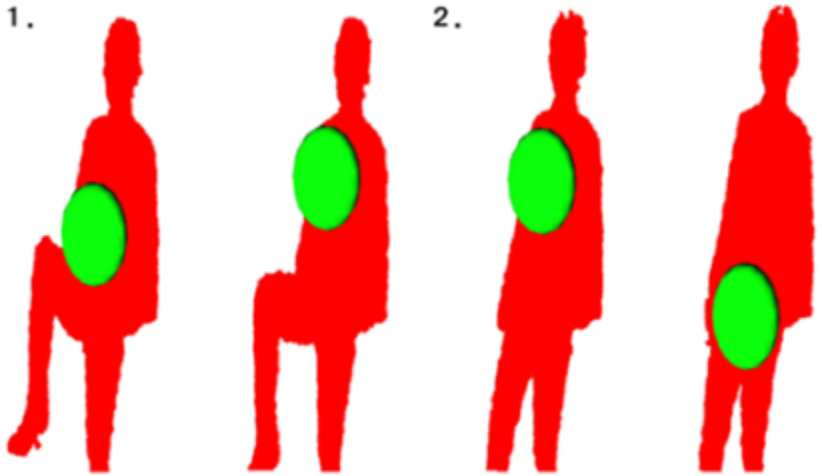


Fig.18. "Combination" screen when running soccer mode.

Proposed method

- soccer mode

1. Raise knee to waist high
   - (y-coordinate of right (left) knee) $>$ (y-coordinate of right (left) waist $- 300mm$)
2. The ball keeps falling when you lower your knees

Proposed method

- soccer mode

- Kinect has a problem of selecting a target person for skeleton tracking randomly from recognized persons. If the user hides in Kinect's field of view and then enters Kinect's field of view again, there is a problem that the re-following of the user's skeleton coordinates may not be executed properly [1].

[1] 濱砂雅人, 伊藤暢浩, 幸塚義之, “人ごみにおけるKinectセンサの誤認追跡の改善について”, 30th Fuzzy System Symposium, Kochi, September 1-3, 2014.

Proposed method

- soccer mode

Fig.19. Positive image.

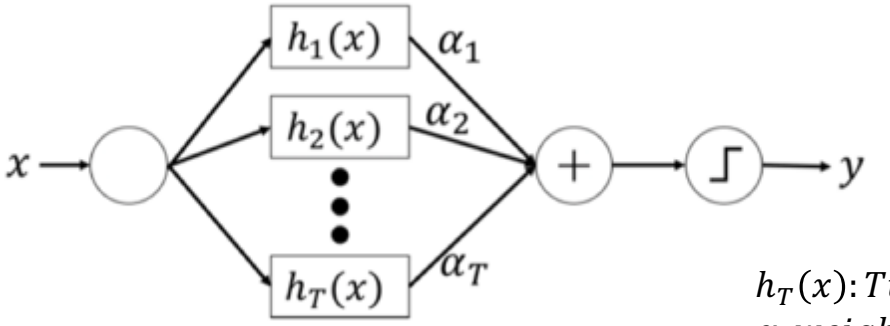
Fig.20. Negative image.

image	The number of samples
Positive image (lifting)	1200
Negative image (not lifting)	345

Proposed method

- soccer mode

- Boosting
  - A learning algorithm that sequentially generates weak classifiers and combines them to create a strong classifier
- AdaBoots
  - One of the boosting methods
  - A method to create a classifier with high accuracy by adaptively weighting and learning the recognition rate of the classifier during the learning process



$h_T(x)$: $Tth\ feature$
α: $weight$

Fig.18. AdaBoots.

Proposed method

- soccer mode

- Image feature extraction
  - Haar-like features
  - Local Binary Pattern (LBP) features
  - Histogram of Oriented Gradients (HOG) features

Proposed method

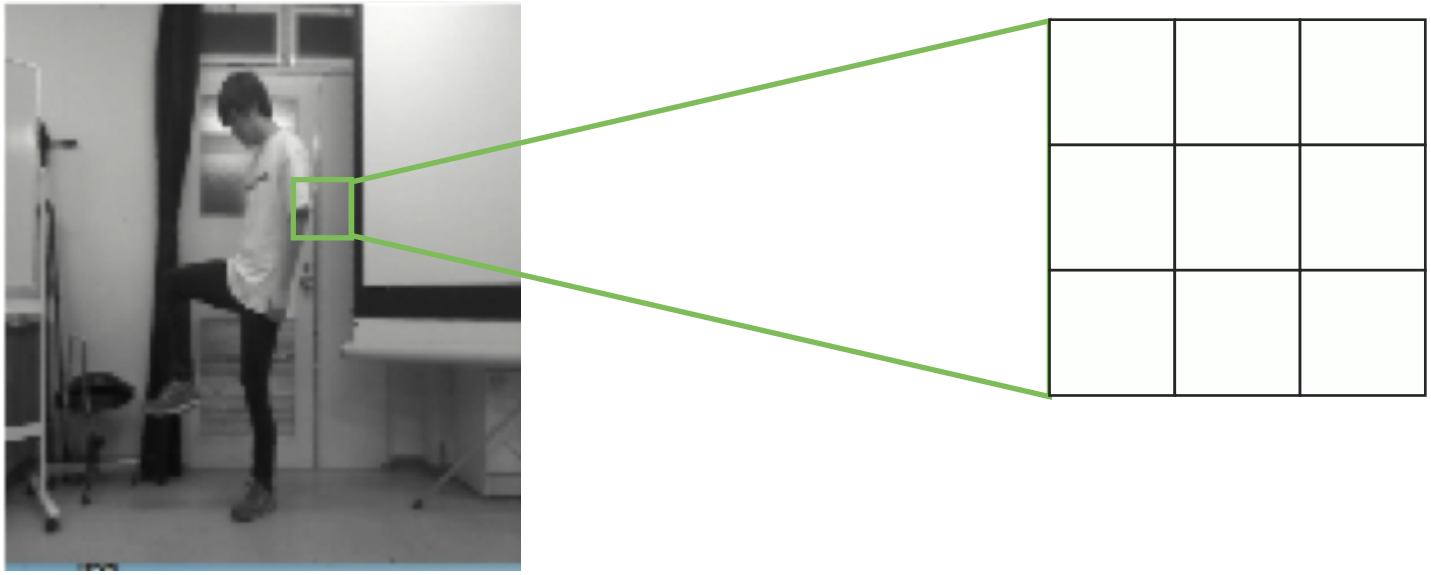
- soccer mode

- Image feature extraction
  - Haar-like features
  - Local Binary Pattern (LBP) features
  - Histogram of Oriented Gradients (HOG) features

Proposed method

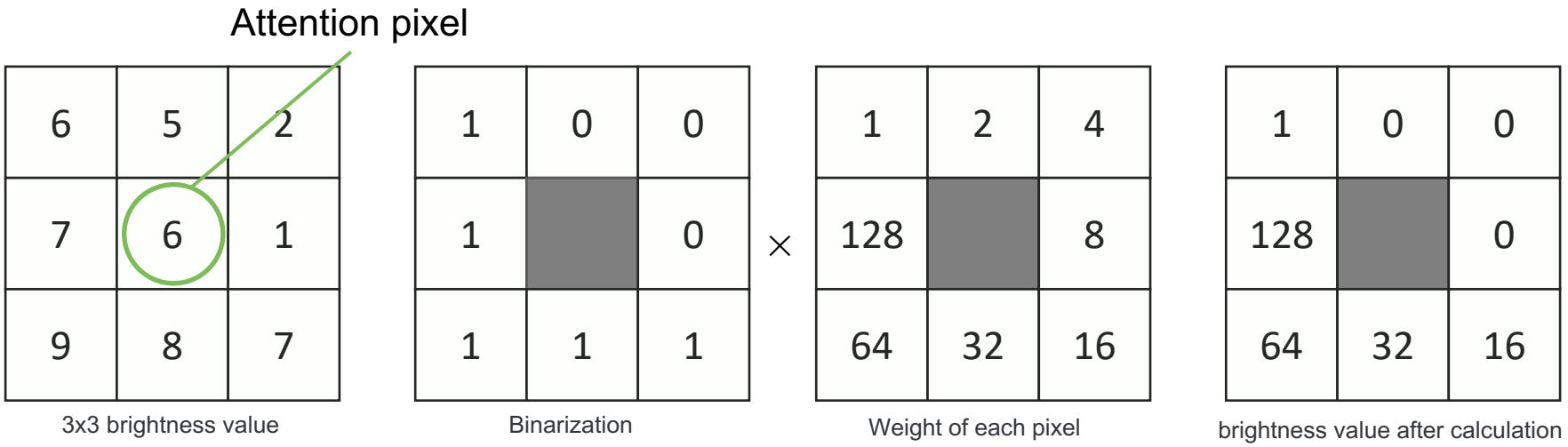
- soccer mode

- Local Binary Pattern (LBP) features



Proposed method

- soccer mode



$$\text{LBP} = 1 + 16 + 32 + 64 + 128 = 241$$

Result

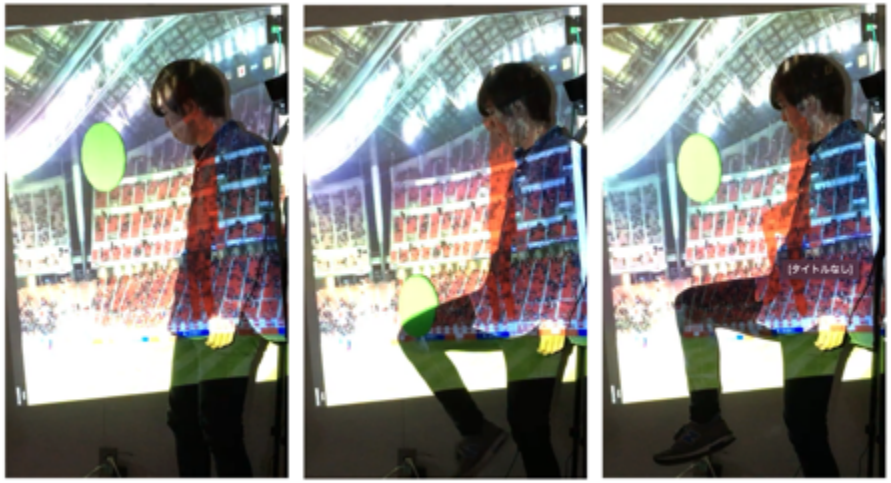


Fig.19. Execution result of soccer mode.

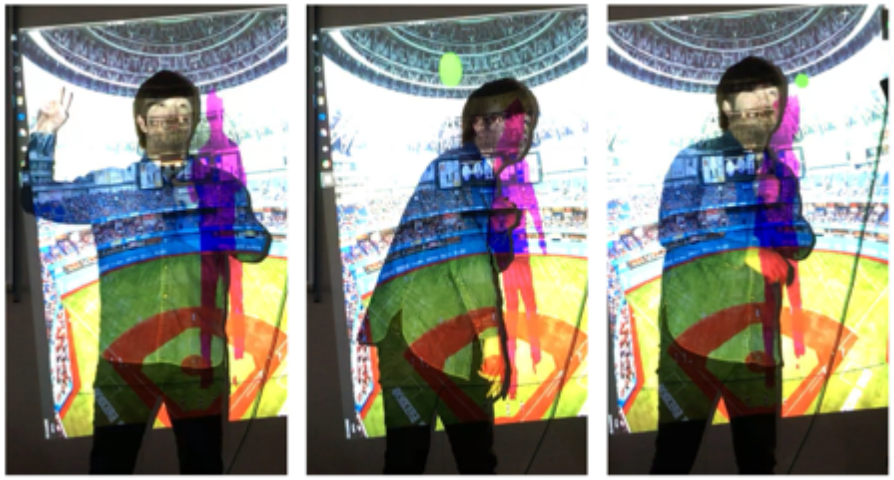


Fig.20. Execution result of baseball mode.

Evaluation experiment

- Evaluation method

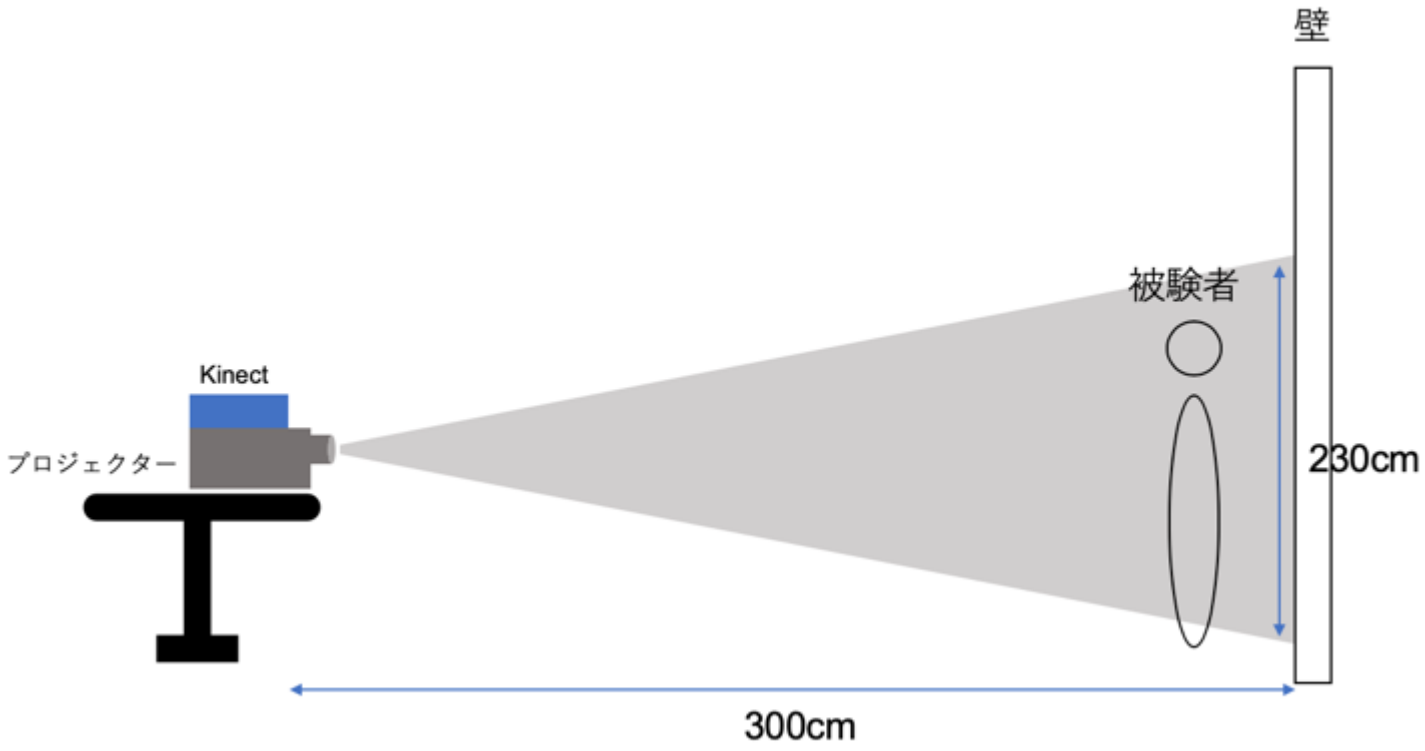


Fig.21. Evaluation experiment environment diagram.

Evaluation experiment

- Evaluation method

In order to obtain the evaluation of the projection mapping proposed in this study, we asked five subjects to experience and conducted a questionnaire.

Q1. Is the operation easy to understand?

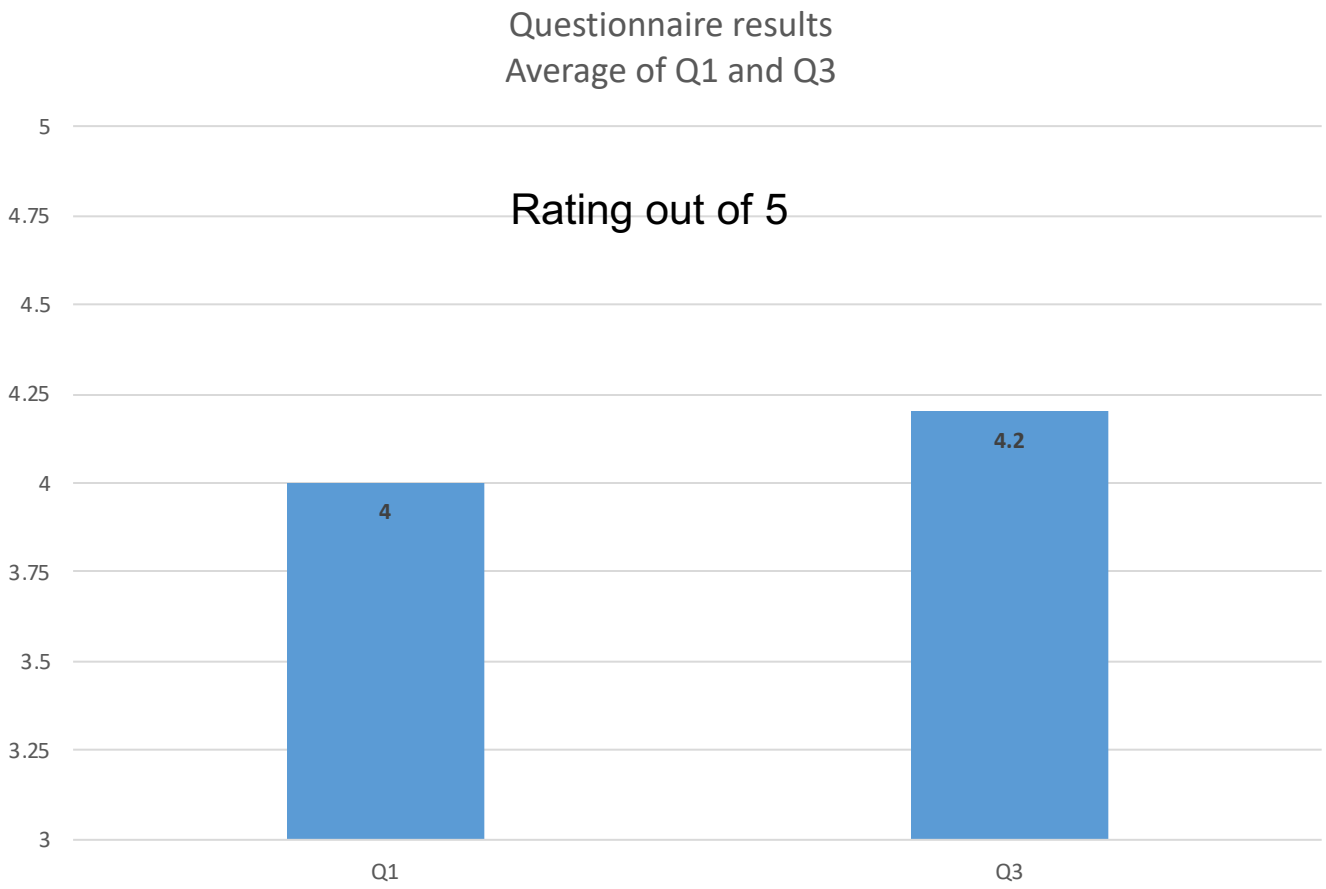
Q2. If not, what was it hard to understand?

Q3. Did you enjoy it?

Q4. Are there any future improvements?

Evaluation experiment

- Evaluation method



Evaluation experiment

- Evaluation method

Q4. Are there any future improvements?

- I want the ball to be realistic
- I want to lift other than my knees
- I want the cheering of the audience
- I want a number display function
- I want a tutorial
- I want the sound to be realistic
- I think you can enjoy more if you meet some kind of charm
- It didn't work
- I was worried about the ball
- I also want to add table tennis version
- I want to raise the FPS a little more

Consideration

- We think that we could get a certain evaluation of whether users can enjoy projection mapping as well as people who see it.
- In the method using the cascade classifier, there are occasional misrecognitions and there is room for improvement.

Future tasks

- Implementation of tutorial screen
- Texture mapping to ball
- Add variation
- Enable use by multiple people

Conclusion

- In order to entertain not only those who view projection mapping but also performers, we proposed a participatory projection mapping that changes according to the movement of the performer.
- Until now, performers need to precisely match the coordinates of image objects in projection mapping, and tasks that were difficult for many people can now be easily performed.
- In the future, by further reducing the deviation of each other's movements, more realistic stage production can be expected