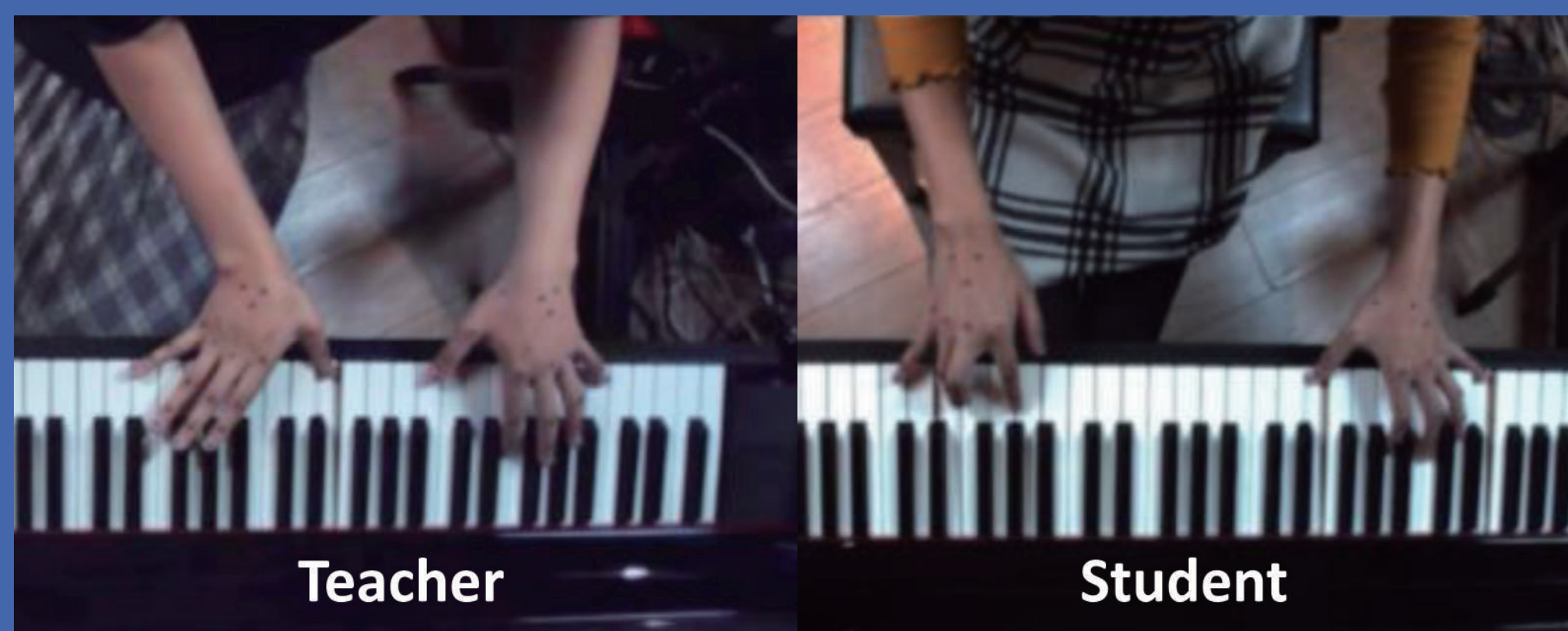


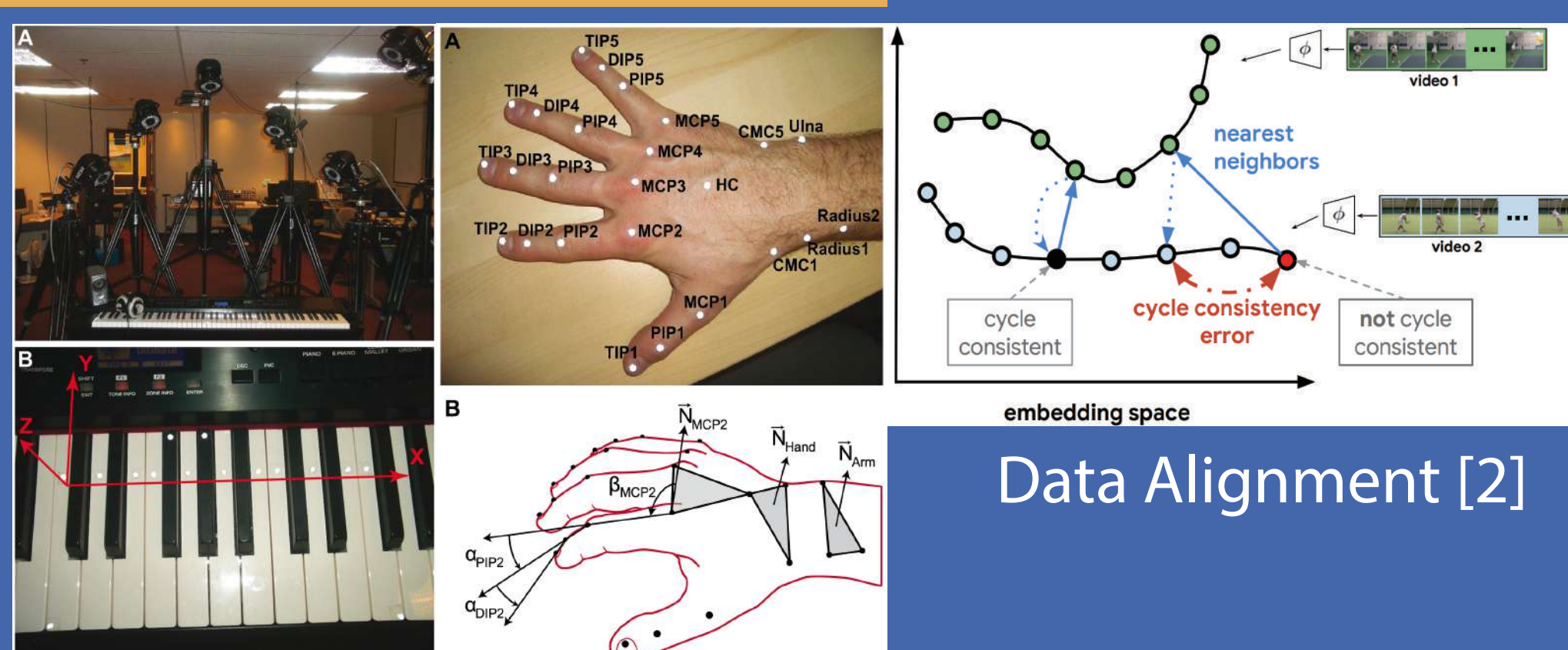
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PROBLEM



- | | |
|------------------|-----------------------------|
| Music Educations | Conventional piano learning |
| • Video-based | • Different playing speeds |
| • Online lessons | • Few teaching functions |

RELATED WORK



Data Collection [1]



Visual Feedback [3]

Timeline Visualization [4]

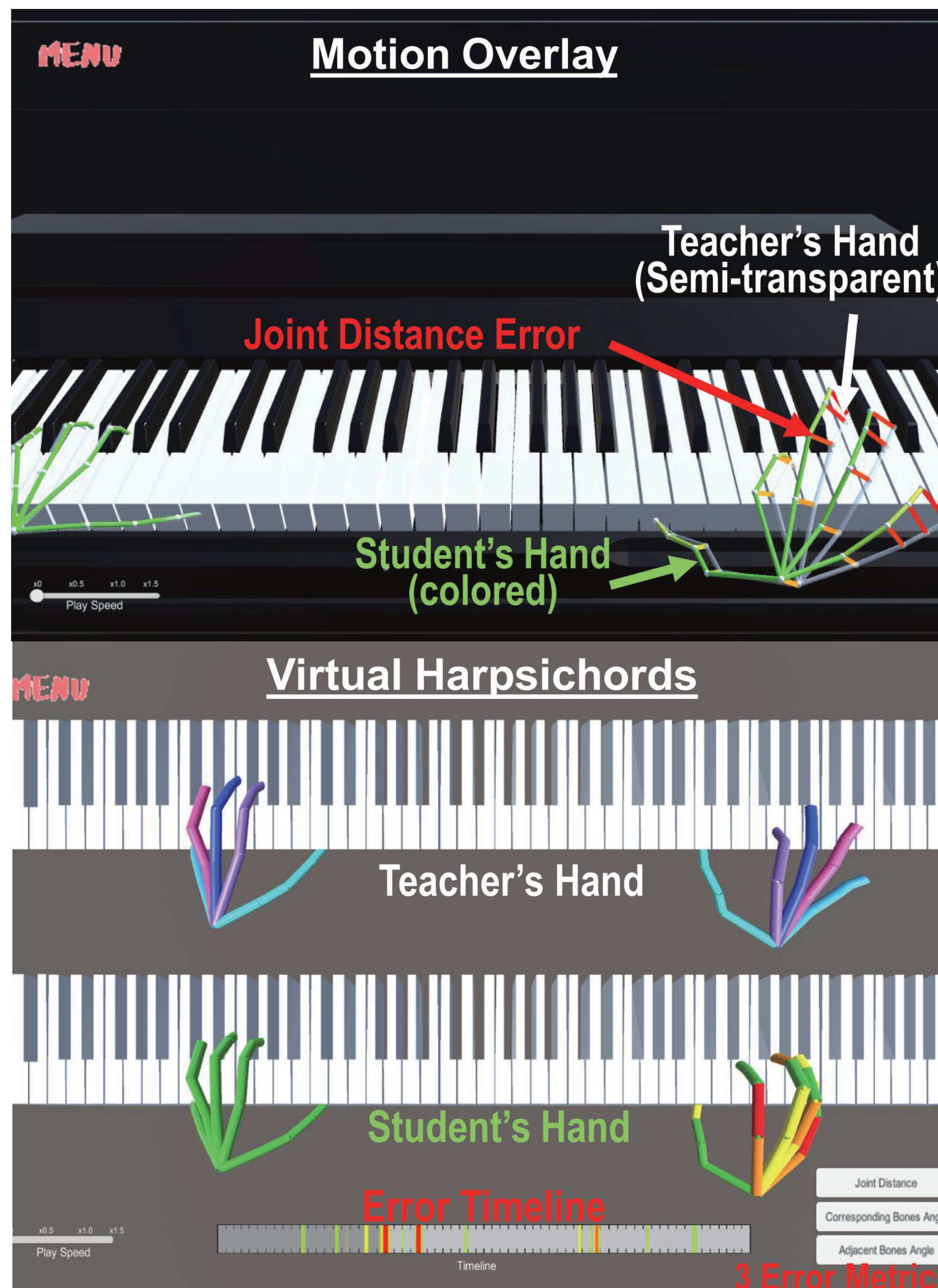
IDEA

- Collect the hand data through motion capture.
- Use the Temporal Cycle-Consistency (TCC) to temporarily synchronize the 3D data.
- Implement two visualization approaches to display aligned data.

REFERENCES

- [1] Werner Goebel and Caroline Palmer. Temporal control and hand movement efficiency in skilled music performance. PLOS ONE, 8(1):1–10, 01 2013.
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- [3] Takayuki Nozawa, Erwin Wu, Florian Perteneder, and Hideki Koike. Visualizing expert motion for guidance in a vr ski simulator. In ACM SIGGRAPH 2019 Posters, SIGGRAPH '19, New York, NY, USA, 2019. Association for Computing Machinery.
- [4] Seita Kayukawa, Keita Higuchi, Ryo Yonetani, Masanori Nakamura, Yoichi Sato, and Shigeo Morishima. Dynamic object scanning: Object-based elastic timeline for quickly browsing first-person videos. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems, CHI EA '18, page 1–4, New York, NY, USA, 2018. Association for Computing Machinery.

VISUALIZATION METHOD



Motion Overlay

- One Piano Keyboard
The student's hands overlay the teacher's
- Different Hands' Colors
Distinguish student's and teacher's hands
- Different Distance Lines' Colors
Show the magnitude of the error

Virtual Harpsichord

- Two Up and Down Keyboards
Better see where the differences occur
- Interactive Timeline
Visualize which segment of the entire clip the differences are happening
- Different Metrics
Joint distance, corresponding bone angle, adjacent bone angle

RESULTS & CONCLUSION

7 experienced pianists (6 female, 1 male, with experience ranging from 15 to 39 years)

- B1: the two original videos of the student and teacher
- B2: the synchronized videos where the student's play speed is aligned with the teacher's
- V1: Motion Overlay
- V2: Virtual Harpsichord

- Both V1 and V2 are significantly better than B1. (V1-B1: $p=0.004$, V2-B1: $p=0.001$)
- When compared to B2, V2 is significantly better. (V2-B2: $p=0.033$)

- The proposed 3D visualizations are effective.
- The majority of participants prefer the virtual harpsichord.
- This is because the side-by-side visualization and the error timeline provide better feedback on "when" and "where" the differences happen.

