Towards an Augmented Reality System for Violin Learning Support

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Motivation

- Violin is one of the most difficult instrument
  - No fret on the fingerboard
  - Manipulation of the bow

Previous works (1)

- MusicJacket
  - Advices using vibro-tactile feedbacks
  - Works only for the bowing arm

van der Linden, J., Schoonderwaldt, E. and Bird, J. “Good Vibrations: Guiding Body Movements with Vibrotactile Feedback”. *Proceedings of the Third International Workshop on Physicality*, 13-18, 2009

Previous works (2)

- Guitar playing support
  - AR toolkit markers for tracking the fingerboard
  - Display a virtual hand for advising the finger position

Y. Motokawa, H. Saito. “Support system for guitar playing using augmented reality display”. *In Proceedings of the 5th IEEE and ACM ISMAR*, 243-244, 2006

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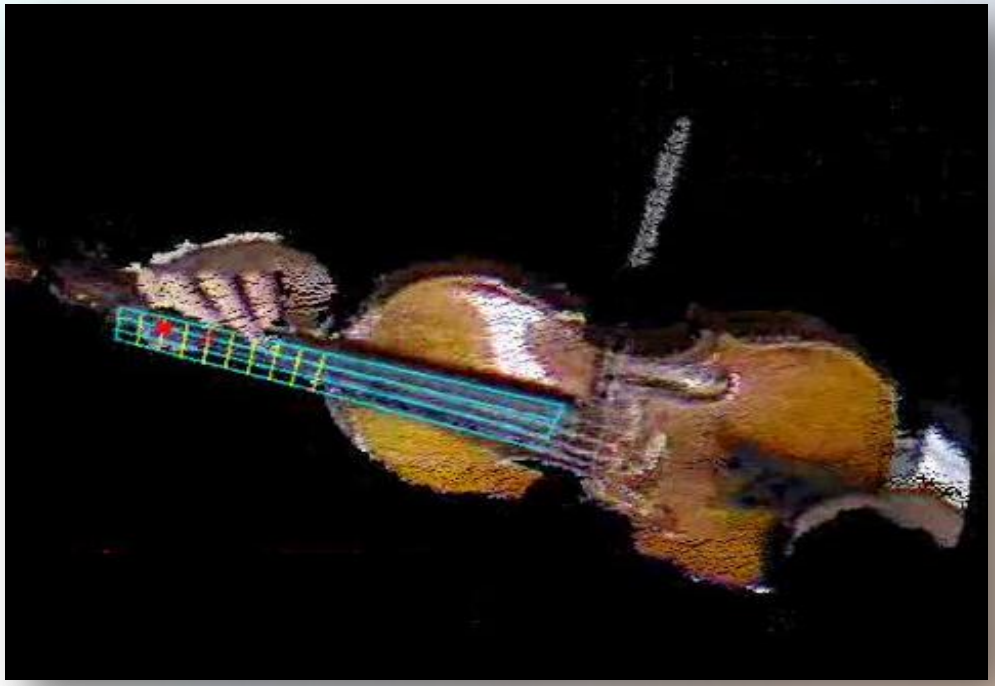
Our goal (1)

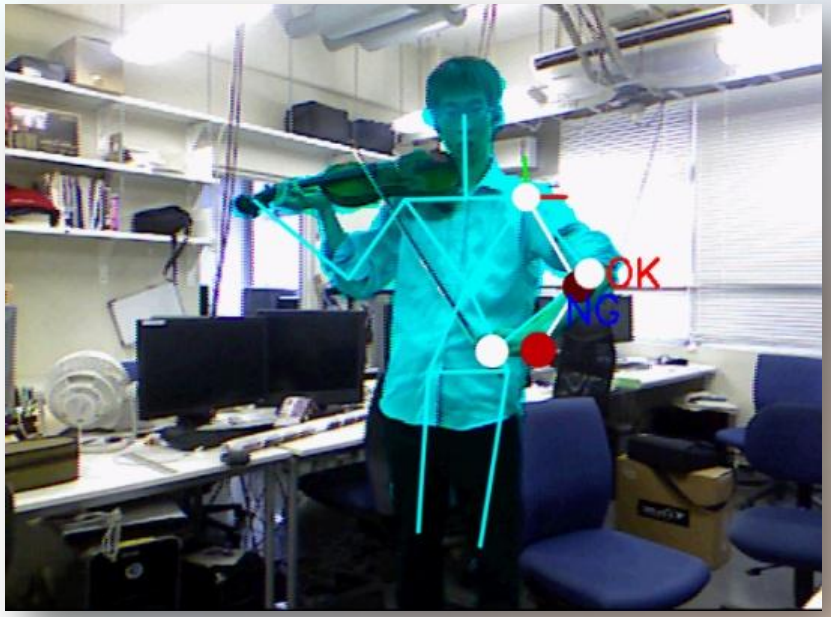
- Display virtual frets and visual guides on the screen



➢ Require to estimate the pose of the violin

Our goal (2)

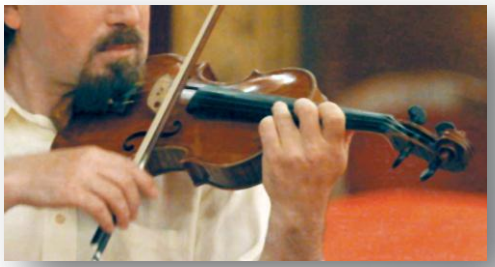
- Teach the correct position of the bowing arm

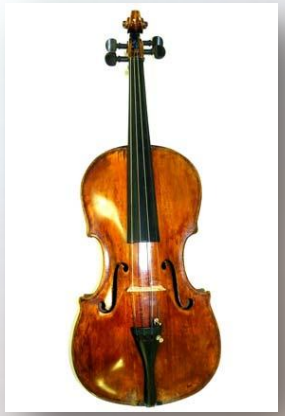


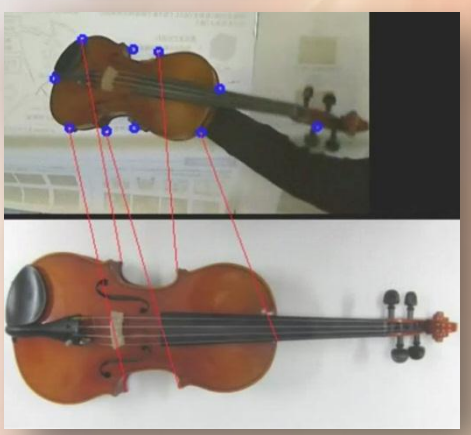
➢ Require to track the player's bowing arm

Pose estimation without marker

- Using a feature detector
  - Many occlusions caused by the player
  - The surface of the violin has a poor texture
  - The material of the violin is highly specular



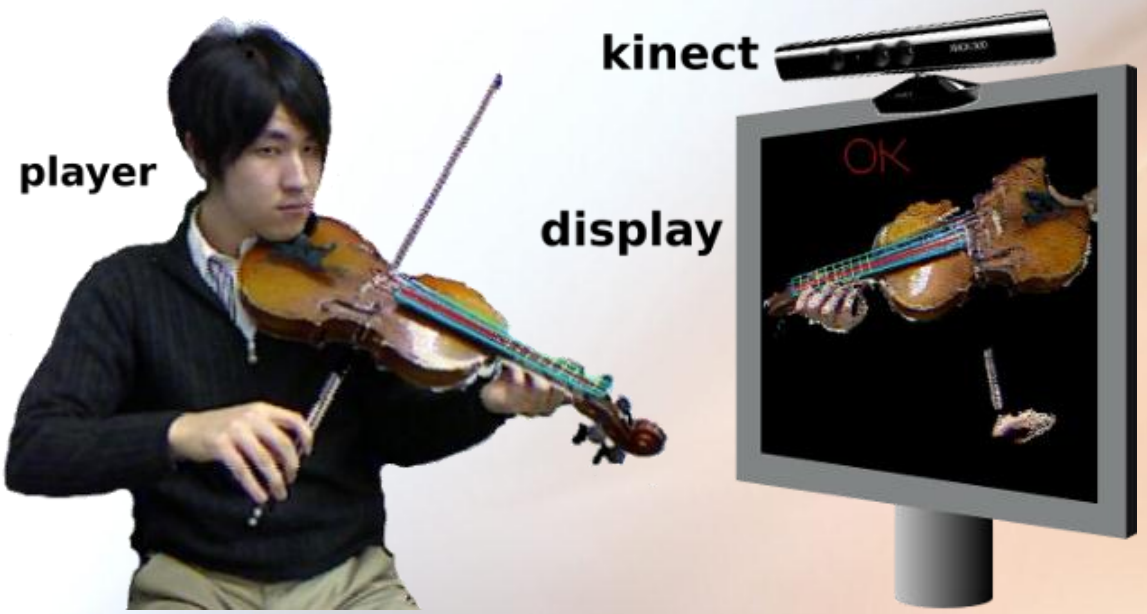




➢ Using feature detection is not robust

Our approach

- Kinect for estimating the pose of the violin
- Also used for tracking the player



- Feedback displayed onto a screen

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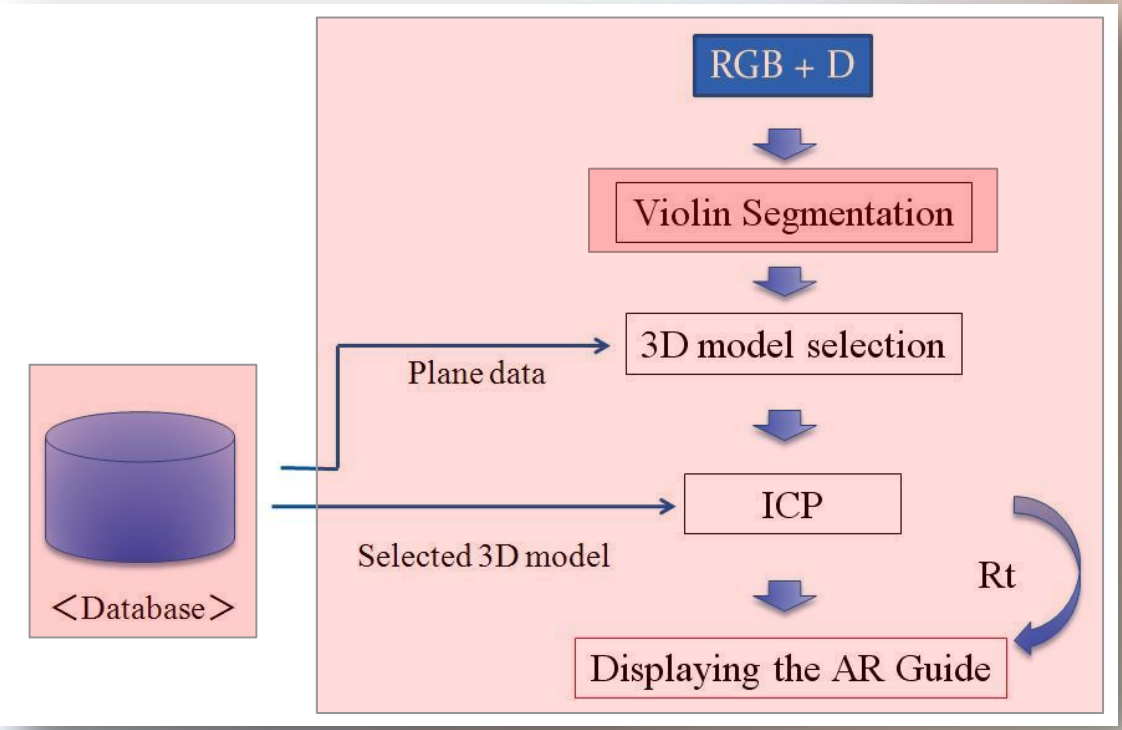
Our system workflow

1. Offline phase: build a 3D model of the violin with AR references
2. Online phase: pose estimation and feedback



Pose estimation with ICP

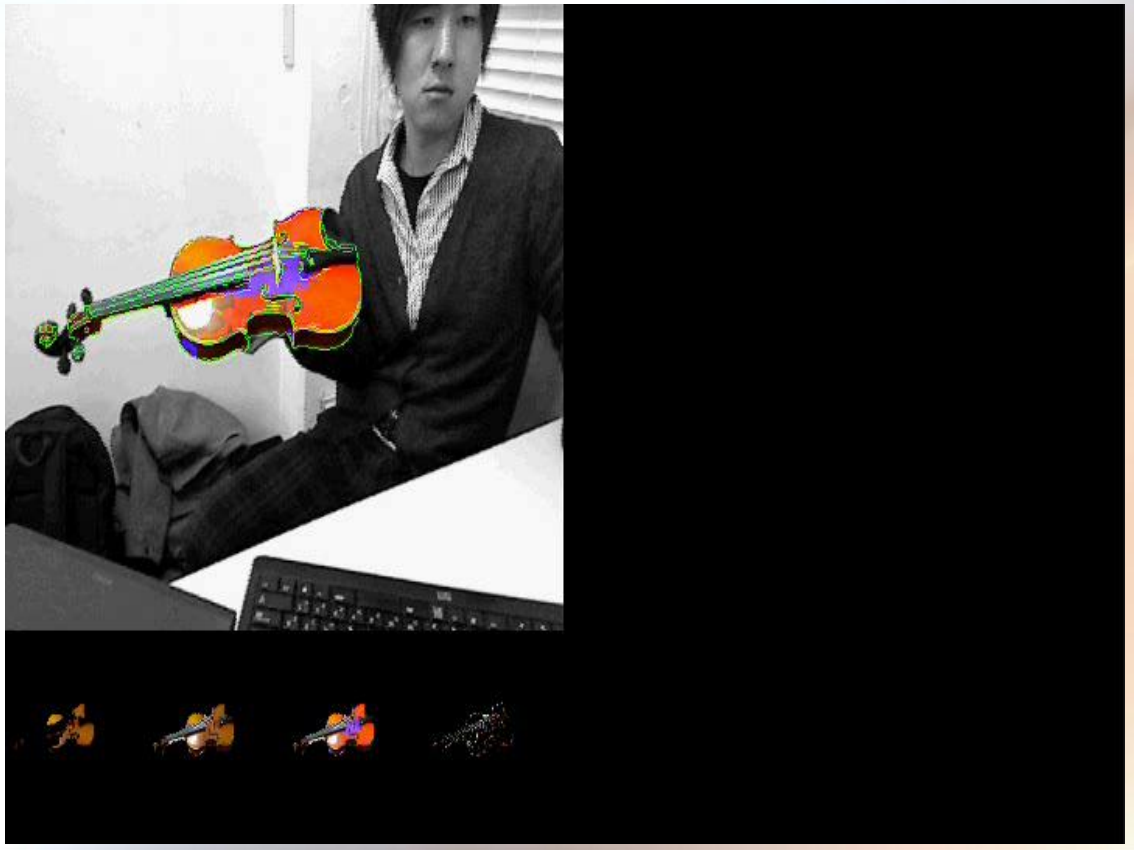
- Iterative Closest Point algorithm
  - Slow if too many points
  - Inaccurate if not enough
- Proposed solution
  - Use several template for describing the reference model
  - Associate a plane equation for describing a violin template
  - Construct a 3D model from templates for AR datas
  - Detect the violin in the color image
  - Estimate the pose between the current point cloud and one given template

Segmentation of the violin

- Segment the violin based on its color
- From corresponding 3D points
  - Compute a plane equation
  - Create a 3D box along and centered on it
  - Refine the segmentation

Storage of the templates

- Add a new template when candidate is enough different from stored ones
- Compute the final 3D model



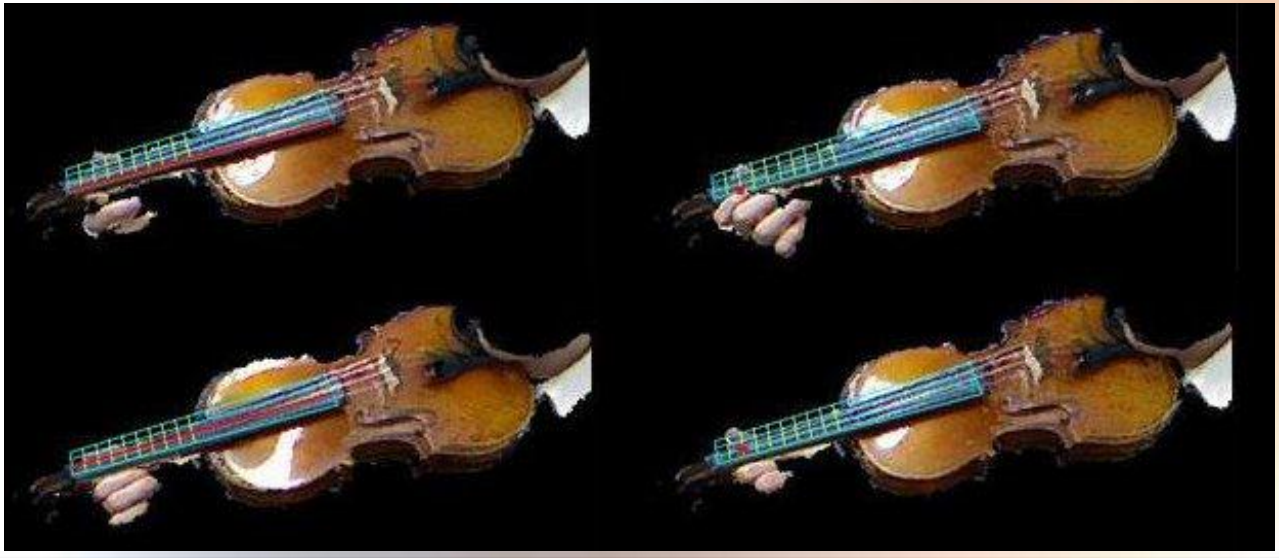
Online tracking of the violin

- Same segmentation than in the offline stage
- Deduce the corresponding template by comparing plane equations
- Compute the rigid transformation *Rt* by applying the ICP algorithm
- Display virtual advices on the captured model defined based on the pre-computed model

Violin tracking result

Virtual Frets on the violin

- Virtual information associated with the pre-computed 3D model
- Transform the captured violin to the pose of the 3D model
  - Computed with the result of the tracking
  - Result displayed in a stable manner

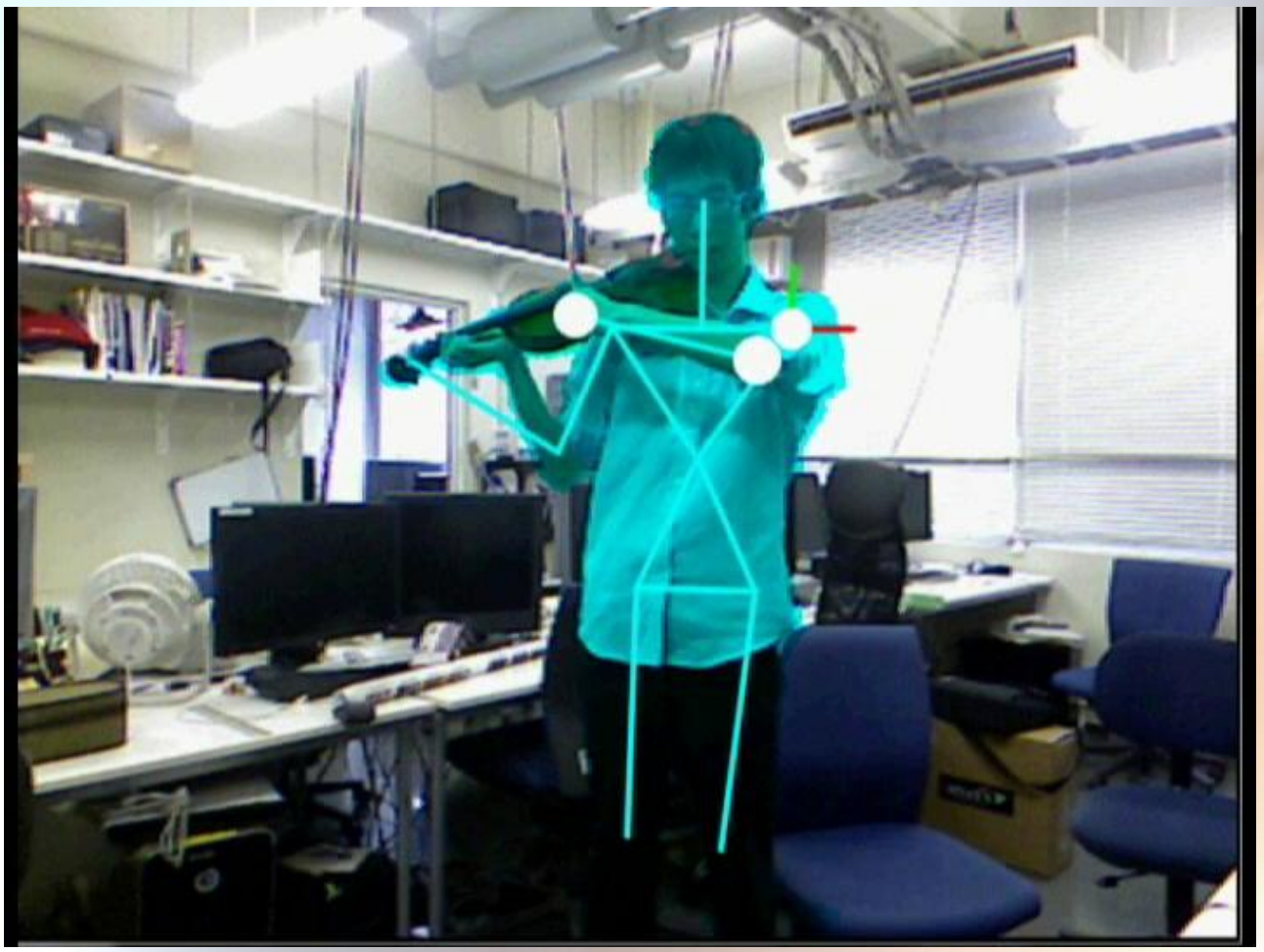


Fingering and bow advices

- Analysis of the note played
  - A fret and a string highlighted
  - Advise on the position of the bow

About the bowing technique

- Follow movements of a scaled and aligned captured movement



Results

- Processing time: 21ms
- About the tracking

	Rx(deg)	Ry(deg)	Rz(deg)	T(mm)
Minimum error	0.12	0.25	0.20	0.22
Maximum error	13.29	8.27	7.89	32.1
Average error	3.07	2.69	2.78	7.20

- Difference of Pitch

Fret number	1	2	3	4	5	6	7	8	9	average
Difference of pitch	11.1	14.1	12.0	12.4	13.4	15.8	12.8	13.9	19.2	13.8

Conclusions

- Violin pedagogy with augmented reality using Kinect
  - Real time tracking of the violin and the player
  - Display virtual frets and strings
  - Detect the note played
  - Advise on position of the bow and the position of the bowing arm

Future works

- Perform an evaluation with different kind of players
- Study about another visualization option
  - See-through HMD
- Extension to other string instruments
  - sanshin

Questions?

Thank you for your attention

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