



Shiva as the King of Dance (Nataraja)

VIRTUAL PERCUSSION FOR BHARATANATYAM

Shwetha Ram

National Institute of Technology Karnataka, Surathkal.

Project Guide : Dr. K.R.Ramakrishnan



OUTLINE

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- Brief Introduction to Bharatanatyam and Mridangam
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Introduction – Virtual Musical Instruments

- A. Mulder describes about Virtual Musical Instruments as:
"... , analogous to a physical musical instrument, as a gestural interface, that will however provide for much greater freedom in the mapping of movement to sound. A musical performer may control therefore parameters of sound synthesis systems that in real time performance situations are currently not controlled to their full potential or simply not controlled at all."
- H. Katayose et al talk about their system, Virtual Performer :
"... the Virtual Performer which is a system composed of gesture sensors, a module analyzing and responding obtained information, and a facility for presentation."

Virtual Percussion Instruments

- An interface that simulates the playing of percussion instruments.



RELATED WORK

- **Creating Musical Expression using Kinect**
- **Daft Datum- An Interface for Producing Music through Foot based Interaction.**
- **Movement to emotions to music: using whole body emotional expression as an interaction for electronic music generation.**
- **LoopJam: turning the dance floor into a collaborative instrumental map**

BHARATANATYAM

- Bharatanatyam is a South -Indian classical danceform.
- A possible origin of the name is from Bharata Muni, who wrote the Natya Shastra to which Bharathanatyam owes many of its ideas.
- This etymology also holds up to scrutiny better since Bharathanatyam is pronounced with short forms of "bha", "ra" and "tha" whereas each of "bhavam", "ragam" and "talam" contain the longforms. Hence the initialization proposed above is more probably a backronym.
- Today, it is one of the most popular and widely performed dance styles in India and is practiced by both male and female dancers.

MRIDANGAM

- Mridangam is an ancient Indian percussion instrument. Nandi is said to have played the mridangam during Lord Shiva's Tandava dance and for this reason, it is called the "Deva Vaadyam" or "Divine Instrument".
- 'Mrith' means mud and 'angam' means body. The Mridangam got its name because it was originally made of mud.
- The instrument has seen a transformation and today's Mridangam is made out of a single wood piece of Jackwood or Teakwood.
- Today, Mridangam has evolved to be the king of the percussion instruments and become an indispensable accompanying instrument for Bharatanatyam performances.

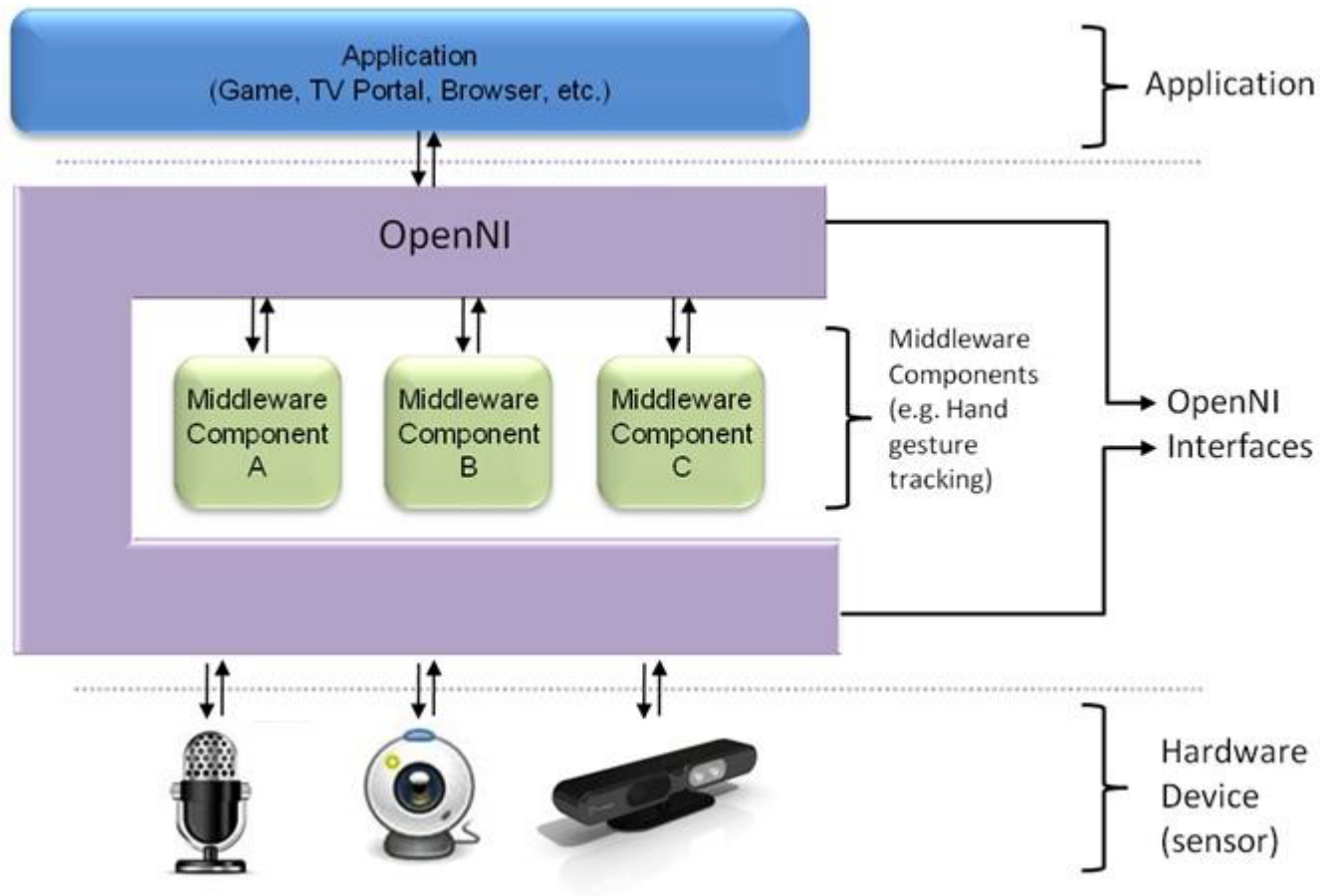
Approach

- The basic idea was to map the footwork of a Bharatanatyam dancer to the corresponding Mridangam sounds.
- This approach would be suitable for 'Nritta' performances where there is a direct relation between the dancer's footwork and the mridangist's strokes.
- On the otherhand, this approach is not suitable for an 'Abhinaya' performance.
- The problem was handled in two stages:
 - The first was to detect the different foot movements.
 - The second was to map them to different Mridanga sounds.

Tools and Technologies Used

- Microsoft Kinect
- OpenNI
- Sensor Kinect
- NITE
- OpenCV

Abstract Layered View



Design and Implementation

- Detect the floor plane.
- Define a plane2 slightly above the floor plane.
- Segment the dancer and display a binary image where only the part of the dancer below plane2 (dancer's feet) is coloured white.
- Track the dancer's feet positions.
- If a foot is raised above the plane2, wait for the foot to be brought below the plane2 in subsequent frames.
- When foot is brought below the plane2, process the binary image to find the foot orientation.
- Give appropriate mridangam sound.

Detecting the Floor Plane

- The Scene Analyzer Middleware was used to detect the floor plane.
- It analyzes the scene and returns the coordinates of a point on the floor.
- These coordinates were then mapped onto the 2-D image of the dancer.

Segmenting the Dancer

- The Scene Analyzer Middleware was used for the purpose of segmenting the dancer.
- This returns a labelled depth map, in which each pixel holds a label that states whether it represents a figure, or it is part of the background.
- This information was in turn mapped onto a binary image where only the part of the dancer below Plane2 is coloured white.

Foot Movements

- Tattu_right
- Tattu_left
- Mettu_right
- Mettu_left
- Naattu_right
- Naattu_left
- Kuditta
- Kudittatattu_right
- Kudittatattu_left
- Kudittamettu

Tracking the feet and detecting Naattu

- The User Generator Middleware, which can track the positions of joints in the body was used to track the feet.
- If the leg is stretched, it is the naattu position.
- If the leg is not stretched, it is either tatttu or mettu position.
- The orientation of the knee-to-ankle bone is used to distinguish between the naattu and aramandala positions.
- The User Generator Middleware was used to track the bone orientation.

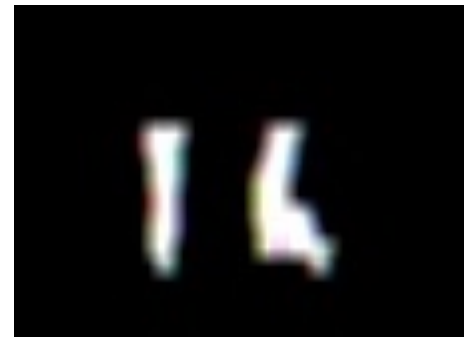
Detecting Tattu and Mettu

- Blur the image.
- Find edges using Canny's edge detection.
- Find contours in the image and find the largest two contours.
- Fit a hull around the largest two contours and fill them with white colour.
- Apply a mask to get the image of each foot separately.
- Find the ratio : $\text{length of contour of interest} / \text{length of the other contour}$.
- If ratio greater than 0.6, return tattu
- Else, return mettu.

Tattu



Mettu



- If both the feet are above the plane2 simultaneously, the dancer is jumping on the toes. This position is referred to as Kuditta.
- A tatttu with the right leg following a Kuditta is Kudittatattu_right
- A tatttu with the left leg following a Kuditta is Kudittatattu_left.
- If Kuditta is followed by the slapping of the dancer's heel onto the ground, it is a Kudittamettu.

Sollus

- Thaleft
- Ki
- Ta
- Ka
- Dhi
- Mi
- Tharight
- Gileft

- Giright
- Na
- Thom
- Di
- Tham
- Jham
- Dharight
- Dhaleft

Mridangam Sounds

- Dhim1
- Dhim2
- Dhim3
- Thom
- Ki
- Gu
- Nam
- Dhi
- Chapu
- Tha
- The sounds Chapu and Thom being played simultaneously has been referred to as Dhim1.
- Dhim2 is the sound referred to as Dhim by the mridangists.
- The sounds Dhim and Thom being played simultaneously has been referred to as Dhim3.

Mapping Footsteps to Mridangam Sounds

Footstep	Step Array				Sollu	Sound
Tattu_right	-	-	-	Tharight	Ka	Gu
	-	-	-	Na	Thom	Dhim3
	-	-	Tharight	Thaleft	Tharight	Dhim1
	-	-	-	Thaleft	Tharight	Dhi
	-	-	-	Gileft	Na	Nam
	-	-	-	Giright	Mi	Chapu
	-	-	-	Di	Tham	Chapu
	-	-	-	Dhi	Mi	Dhim2
	-	-	-	-	Tharight	Dhim1

Footstep	StepArray				Sollu	Sound
Tattu_left	-	-	-	Tharight	Thaleft	Dhi
	-	-	-	Giright	Na	Nam
	-	-	-	Gileft	Mi	Chapu
	-	-	-	Dhi	Mi	Dhim2
	-	-	-	Dharight	Thaleft	Chapu
	-	-	-	Na	Thom	Dhim3
	-	-	-	Thaleft	Ka	Gu
	Tharight	Thaleft	Tharight	Ki	Ta	Dhim2
	-	-	Tharight	Ki	Ta	Ki
	-	-	-	Di	Tham	Chapu
	-	-	-	-	Thaleft	Dhim1

Footstep	SoundArray				Sollu	Sound
Mettu_left	-	-	-	Ka	Dhi	Dhim2
	-	Tharight	Thaleft	Tharight	Ki	Dhim2
	-	-	-	Tharight	Ki	Thom
	-	-	-	-	Di	Tha
Mettu_right	-	-	-	Ka	Dhi	Dhim2
	-	-	-	-	Di	Thom
Naattu_left	-	-	-	-	Gileft	Dhim3
Naattu_right	-	-	-	-	Giright	Dhim3
Kuditta	-	-	-	-	Jham	Dhim1
Kudittatattu_right	-	-	-	-	Dha_right	Dhim2
Kudittatattu_left	-	-	-	-	Dha_left	Dhim3
Kudittamettu	-	-	-	-	Ta	Dhim2

Conclusions

- A Kinect based virtual percussion instrument was developed to accompany a Bharatanatyam performance.
- The virtual mridangam can be used to give junior dancers the feel of a stage performance with accompanying artists.
- Unlike a mridangist, the system will highlight, rather than cover-up any mistake made by the dancer. This would be of help to dancers in correcting any mistakes in their footwork.

Future Work

- For a given rhythmic pattern, our system plays the same sound sequence. It can be taught a number of such sequences and made to play a suitable one each time. This would more closely approach a traditional performance.

However, 'suitable' needs to be very well-defined such that the sequences of sounds played are not harsh on the ears.

- Similar systems can be developed for other Indian dances.

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- Abhinaya Sharade Vidushi Sandhya Keshav Rao



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Thank You