Motor Learning by Multimodal Feedback

Research Direction Discussion

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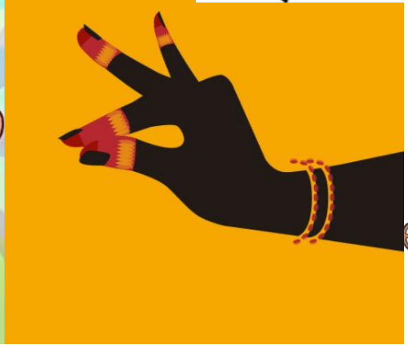
So, what is Motor Learning?

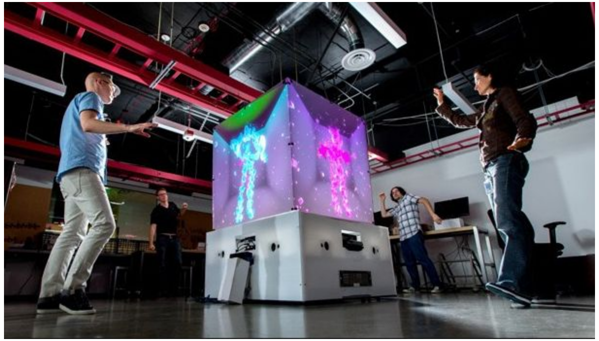
Motor Learning can be defined as
- A set of internal processes
- Associated with practise or experience
- Leading to relatively permanent changes in the skilled behavior of a person.

It moves through the stage of **Cognition, Association** and finally **Automation**.

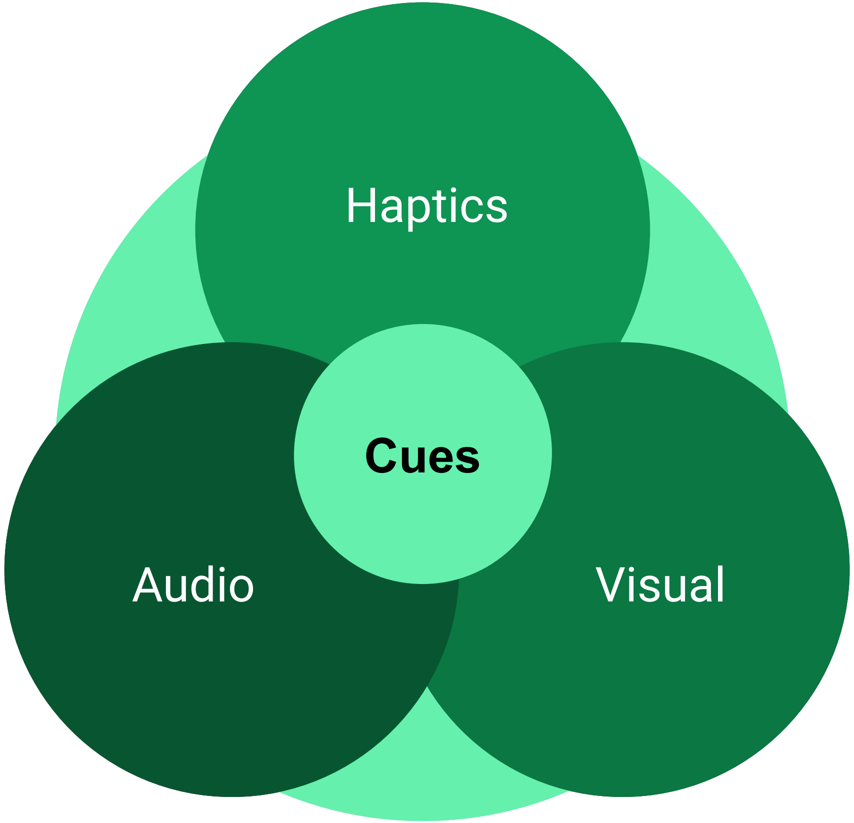
Motor Learning



Traditional Learning vs Learning with Multimodal Systems



Learning through Multimodal Feedback



What’s the case when you only use Audio-Visual Cues?

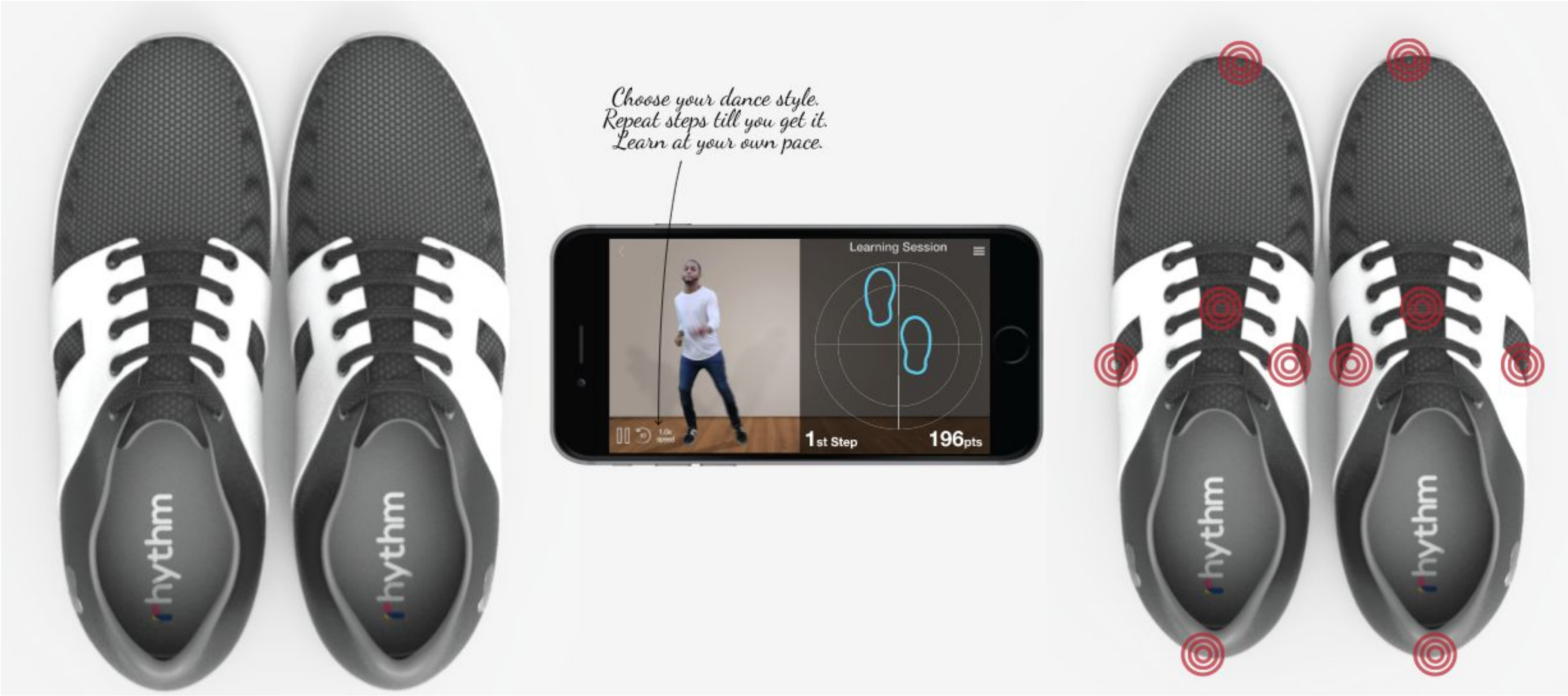
- Lack of effective direct real-time feedback.
- In a noisy environment audio/visual clues are limited or unavailable.
- You cannot follow the audio-visual communication effectively while performing.
- Makes it really difficult for visually and hearing impaired community to follow those cues.

Why Haptics?

- Direct Mapping to the body where action is actually taken.
- Vibrations can be directly mapped to user’s performance.
- Give real time feedback which can be perceived properly even in noisy surroundings and while performing certain actions.
- Haptics cues are often perceived better than audio or visual cues when you are actually performing a motion.
- It can be a solution to the problem of learning various physical tasks/activities for visually and hearing impaired community.

Background Research

Rhythm Shoes, 2016

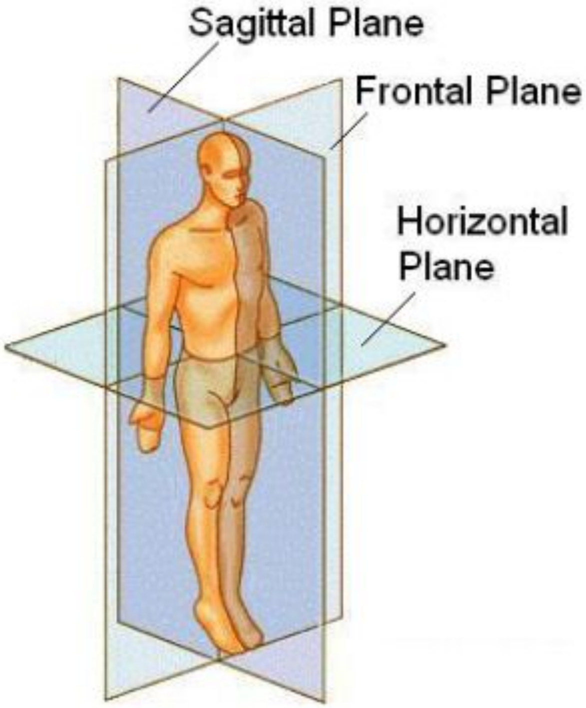


MOVeMENT - A Framework for Systematically Mapping Vibrotactile Stimulations to Fundamental Body Movements

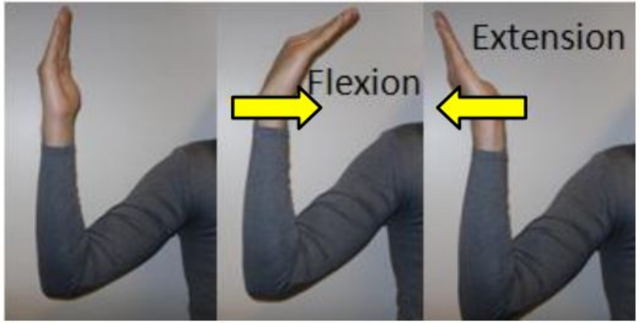
Troy, Daniel 2010

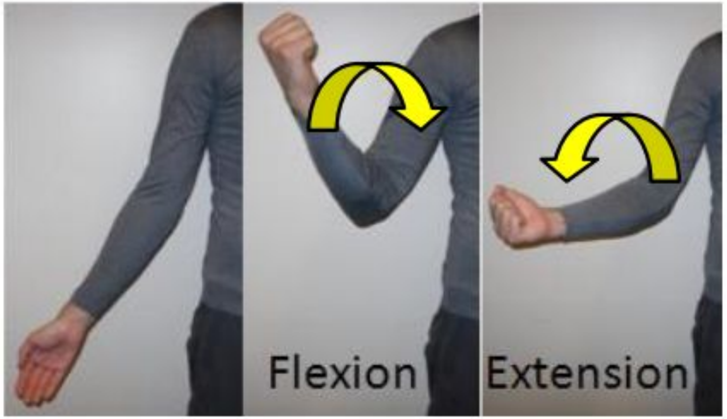
- MOVeMENT (Mapping Of Vibrations to moveMENT), for using vibrotactile stimulation to teach motor skills
- Used limited sets of fundamental body motions and linked it to vibrotactile cues.
- Used the concept of Saltation while placing the motc in the arm for experimentation.

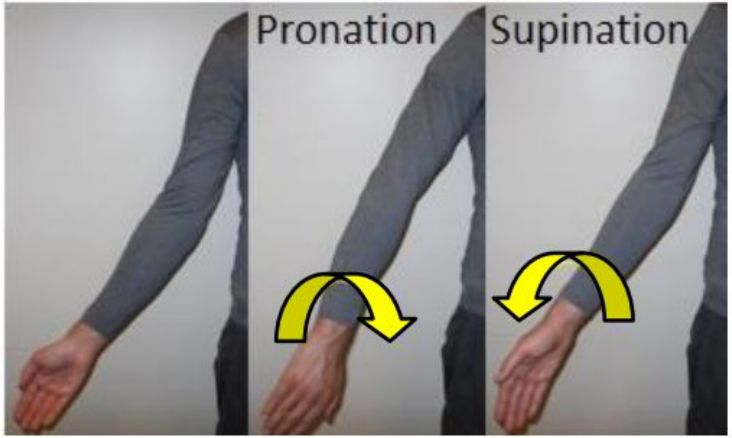
Overall recognition accuracies across subjects and cues was 95.5%



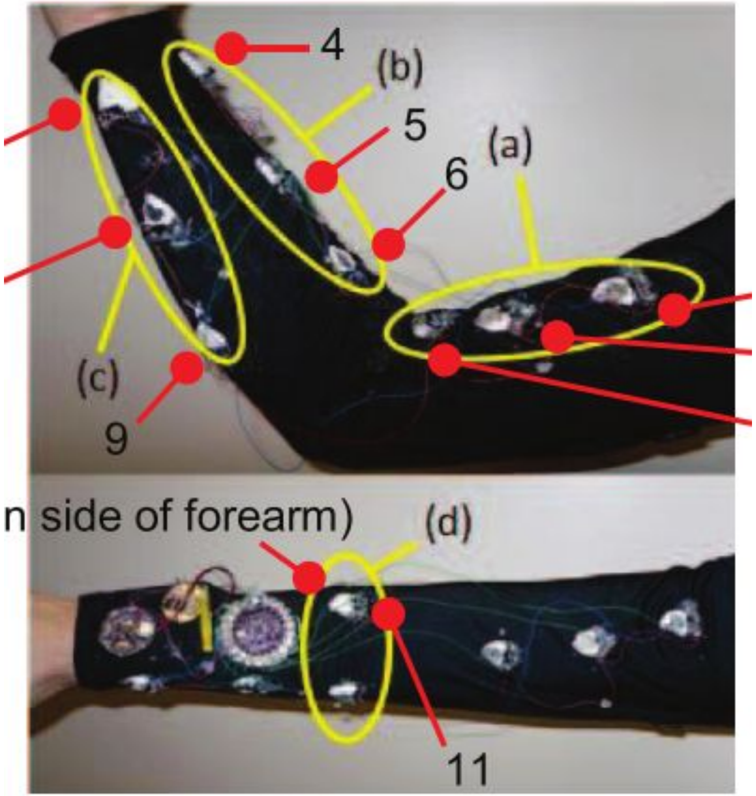
Fundamental Movements of ForeArm and Wrist





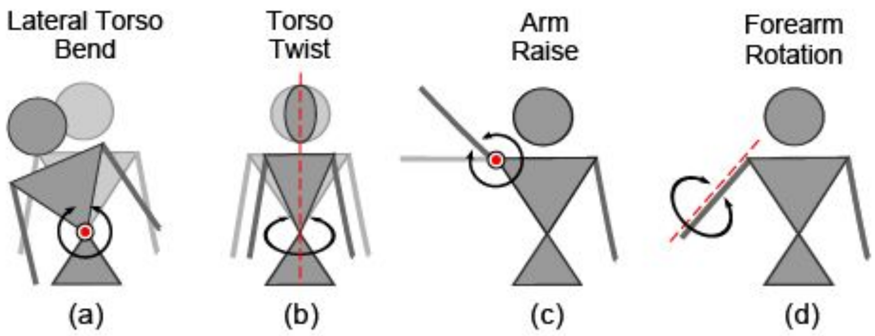


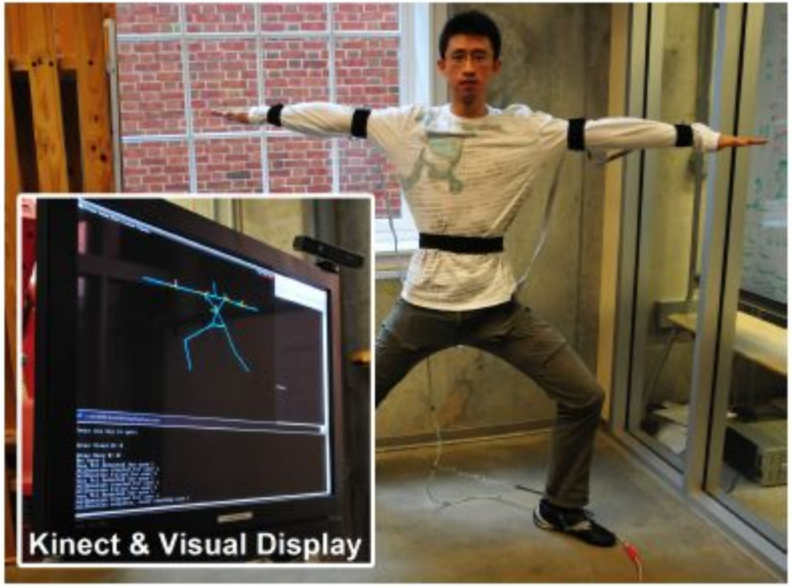
Motor Placement in the Forearm



Hapi Bands M. Rotella, Haptics Symposium 2012

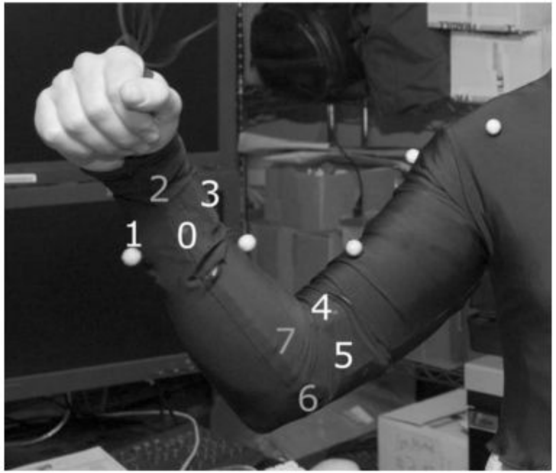
- Bands in the body using EMMs. Give feedback for 15 degrees of freedom
- Kinect, Body mounted accelerometers for sensing, haptics for feedback.
- Developed some algorithm for pose estimation and error corrections.

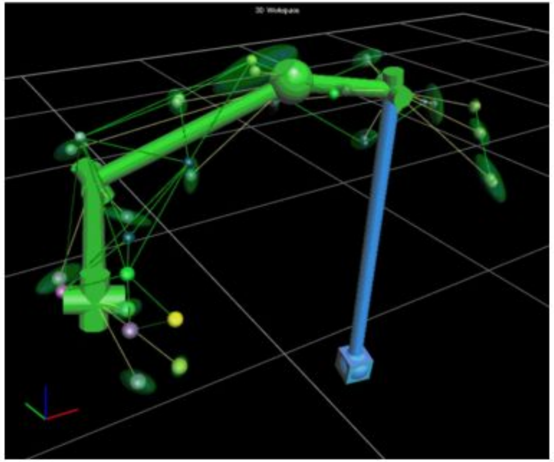




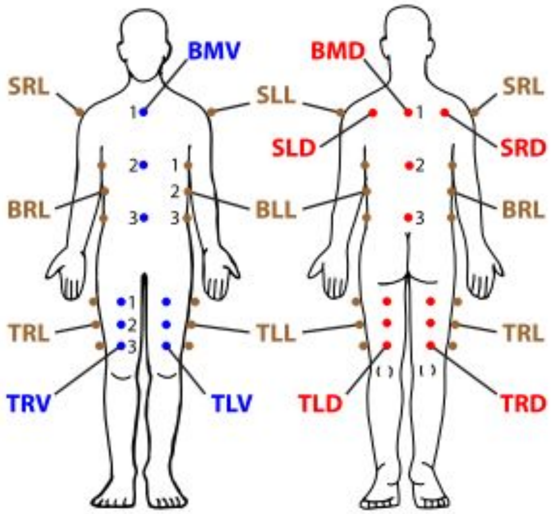
TIKL: Development of a Wearable Vibrotactile Feedback Suit for Improved Human Motor Learning, Jeff Lieberman et.al. 2007

- Modeling the 5 degrees of freedom of arm using the motion capture markers.
- Improved joint angle errors in motor learning using haptics by 27% when compared to only visual learning.
- However, testing is done for limited actions of arm.





Tactile Motion Instructions For Physical Activities, CHI 2009



SLL	shoulder left lateral	SRL	shoulder right lateral
SLD	shoulder left dorsal	SRD	shoulder right dorsal
BLL	body left lateral	BRL	body right lateral
BMV	body medial ventral	BMD	body medial dorsal
TLL	thigh left lateral	TRL	thigh right lateral
TLV	thigh left ventral	TRV	thigh right ventral
TLD	thigh left dorsal	TRD	thigh right dorsal

Table 2. Three-letter acronyms denote the placement of actuators (Part of body, Left/Right/Medial, Ventral/Dorsal/Lateral).

Location of vibration motors on the body. Actuators were inserted into small pouches, which were sewn onto tightly fitting cycling shorts and T-shirts.

Study 1 : Informed the design of our **tactile patterns**, and determined appropriate locations for feedback on the body.

Study 2 : Showed that **users perceived** and correctly classified our **tactile instruction** patterns in a relaxed setting and during a cognitively and physically demanding task.

Study 3 : Snowboarders on the slope **compared their perception of tactile instructions with audio instructions** under real-world conditions

Figure 3. The cognitive and physical load condition of the experiment required participants to respond to tactile motion instructions on the balance board. A backpack served as storage for the actuator boxes.

An Approach to Ballet Dance Training through MS Kinect and Visualization in a CAVE Virtual Reality Environment,

Mathieu et.al., 2015

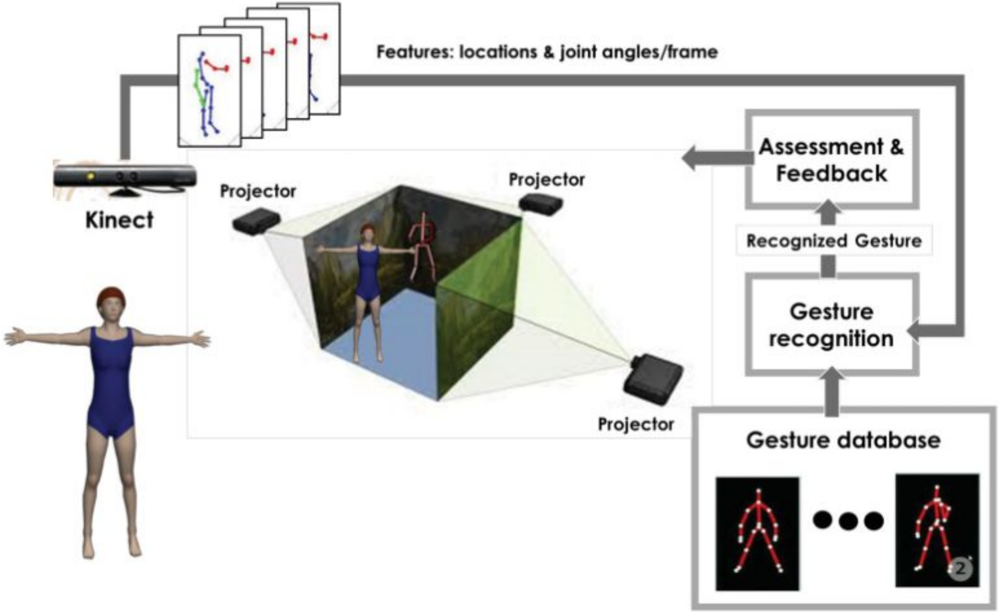


Fig. 1. System architecture.

An Advanced Computational Intelligence System for Training of Ballet Dance in a Cave Virtual Reality Environment, G.Sun et.al. 2014

(a) (b) (c)

Figure 5. Illustration of (a) side-by-side feedback, (b) overlay feedback, and (c) the feedback of score curve.

Major Challenges

- Reduce the cost of motion tracking. Expensive computation.
- Make it mobile. Can be performed in any indoor/outdoor setting.
- Setup is not bulky. Who wants to learn dance with all those circuitry attached to your body?
- Should be intuitive and give a good learning curve.

Proposed Idea

- Focussed on learning motor learning through dance.
- Study 1 : With visual cues for dance movement in lateral space. Haptic feedback for error signals.
- Study 2 : Haptics feedback all over the body according to sets of fundamental actions. Reducing number of haptuators on the body by increasing the abstraction level of haptic vibration using different tactons studies. Utilizing saltation for various movements related to flow.

Open to Discussion