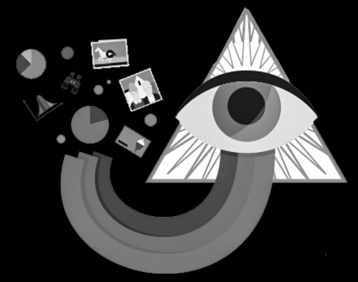
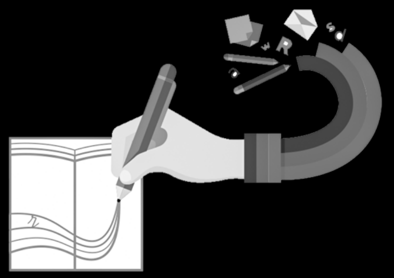
Kinesthetic learning through tactile interaction

Vision

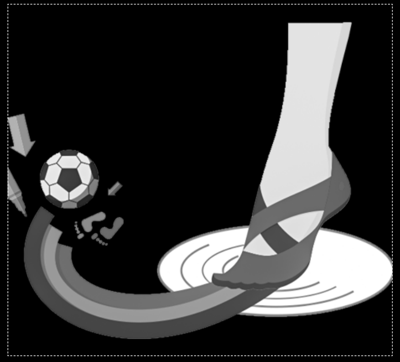


Visual learning

Aural learning



Verbal learning



Kinesthetic* learning

Human beings are lifelong learners, living in a world of ever increasing complexities and problems. Our physical interactions with the surroundings plays a major part in giving rise to new thoughts which in turn gives rise to new ideas and learnings by making our mind aware of the surroundings. Juhani Pallasama says, "The most intellectual endeavors depend on the union of mind and manual skills which play a crucial role in memory and learning" in his book "The Thinking hand".

As we are moving closer and closer to an era of ubiquitous computing, we realize that everyone has a different lifestyle and learns differently. Using technologies that captures their experiences, we can provide them, hyper personalized learning options. In this residency program we want to envision a new paradigm using artificial intelligence and kinesthetic learning to augment human skills and intelligence to improve their lives.

*the awareness of the position and movement of the body in space

Research proposal

Audio feedback

Instructor tactile feedback

Wearable tactile feedback

Movement based interaction is central to human skills, including emotional and perceptual motor skills. Self-awareness of this movement in space is kinesthetic learning that helps in building muscle memory. Kinesthetic learning is a task that confounds many - those with improper posture, people in physical rehabilitation and those wanting dance lessons to name a few. Real-time feedback provided by a coach or trainer is helpful to all such people through several channels like auditory (providing instructions verbally), visual (acting out the instructions) and tactile (guiding the subject manually). Although proved to be the most effective and direct form of feedback, it is seldom possible to provide tactile feedback especially if the instructor is performing it themselves. It may be even difficult for the instructor to provide tactile feedback on all bodily movements simultaneously. One of the quintessential factor in learning new motor skills is the presence of real-time feedback. The advantage that tactile provides is that it engages our motor learning systems directly. In visual as well as auditory the subject needs to map the actions or his instructions onto himself which is an unsustainable form of learning.

The act of acquiring, developing and improving bodily skills comes under the purview of Kinesthetic growth. This can be achieved in three possible ways - knowledge of time and place of application of action, knowing how to reconfigure the action to changing environment, or by practicing repeatedly. Our goal is to design interactive technologies that probe and discover ways to develop our kinesthetic intelligence in profound new ways.It is possible to spark subjects to take part in the interaction with technology by designing for the body in motion.

How is it done today ?

IMU based sensing

The state of the art products uses Inertial Measurement unit (Gyros and accelerometers) which have to be fitted on a human subject to provide real time tactile feedback which may be uncomfortable to a few. Further, attaching these units at several body points make it bulky and uncomfortable to be utilised in day to day setting. Previous attempts to solve this problem involved the use of optical devices like several high-resolution cameras making it infeasible for general use. However, recent advances in machine learning and the release of libraries like dense pose estimation using Neural Networks enable the user to extract the pose using just one camera. This, in turn, opens up a world of opportunity. Since auditory and visual may sometimes be not enough for people to follow the instructor the optical device would compare the pose of the instructor and subject and using the tactile language guide him to the correct posture.

Project

Our solution consists of a wearable interface comprising of a bodysuit embedded with haptic actuators at 13 important key points of the body and a smartphone to extract pose of teacher and student. At each keypoint, multiple actuators are placed in such a way as to provide directional information to users.

Teacher :

The camera extracts pose of teacher. The teacher would also decide the TFSL that would provide the tactile feedback to the student.

Student :

The camera extracts pose of the student and compares it with pose of teacher and computes the difference between them. Edge computing technology allows on device comparison of the actions being performed and real time feedback responses are transmitted back to the wearable interface. The comparison is done using Neural Networks.

Tactile feedback specification language (TFSL):

In order for easy customisation of the system for different activities, an intuitive specification language has been conceptualised in order to enable domain experts to define the right amount of feedback required for different actions at each key point.

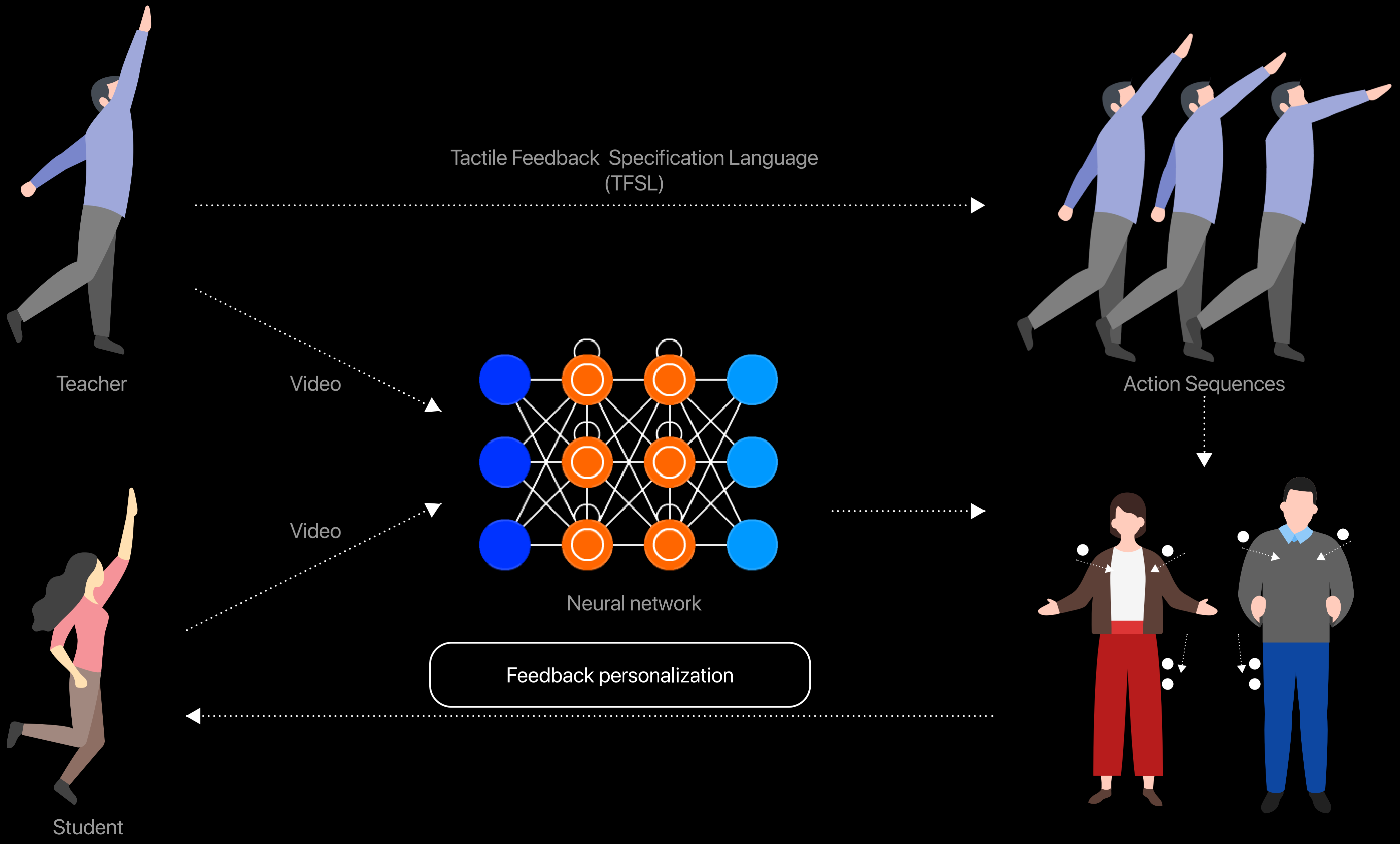
Action Sequences :

Using the TFSL, the teacher, who is the domain expert can piece together the exact set of actions to be performed and feedbacks to be given at various points in time though. These set of instructions created using the specification language is called an Action Sequence, which is then used by the feedback personalisation system to generate feedbacks for the learner.

Feedback personalisation :

The system allows the learners to get gradually increasing and decreasing levels of feedback from the tactile system as per their progress towards correctly performing the action. These interactions can be highly tailored to individual needs based on previous instances of feedbacks and the mistakes to be worked upon. In this way, the user can go through a personalised learning path to develop various skills needed for the activity.

Architecture

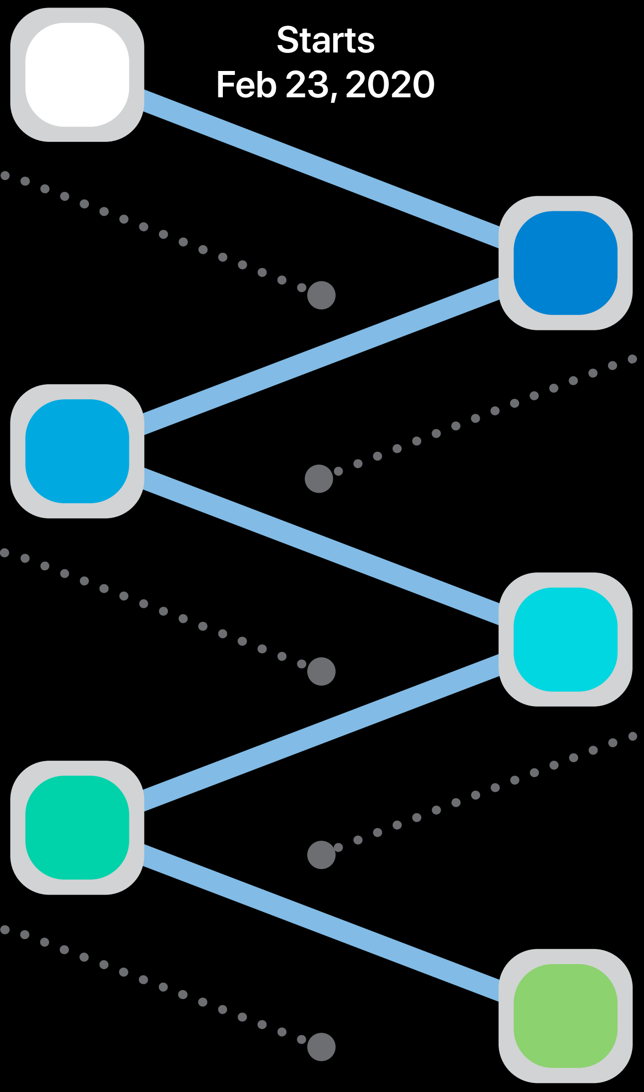


What impact will it have ?

Overtime we would like to build a culture wherein every human feels empowered to have control over his body and starts to feel confident. The goal is to create something actionable through playful research. Human beings start to develop their kinesthetic intelligence over time. Activities like dancing, sports and martial arts require an adroit control over your body. A learner develops muscle memory of the activity gradually as he repeatedly performs the action. The enthusiasm of the student goes low if he is not able to replicate the instructor and in absence of real time feedback on his weaknesses(as in which part of the body is going ashtray) he usually forfeits the thought of learning it. The presence of haptic feedback on their body would enable them to learn quickly.

Once learners gain control over their body, it also build their confidence tremendously and helps them pick up other new physical activities with ease. This would also enable adults who have lost touch with their bodies to gain back control and hence feel more confident individuals.

Milestones



Starts
Feb 23, 2020

Week 1
Build a prototype wearable consisting of a bodytight shirt and pants embedded with coin vibration actuators at important key points of the body like shoulders, arms, hands, hips, knees, ankles etc.

Week 2
Design a representation language for Tactile learning which will enable easy development of actuation sequences corresponding to different activities like different dance moves, sports actions etc. Implement a simple dance sequence rhythmic feedback using the language designed

Week 3 & 4
Collect initial data from a dance instructor and a 2-3 learners using the prototype wearable.
Extract keypoints using Dense Pose Neural Network algorithms and create training dataset

Week 5 & 6
Design and train a Deep Learning system to match the learners to the trainer such that the progress towards perfect dance steps can be quantified. The network needs to learn to ignore the body structure and style differences and match the trainer and learner only according to the action being performed

Week 7 & 8
User testing : Test the system on 3-4 users and collect feedback
Usage Analysis and Iteration

Ends
April 12, 2020