Towards Robot Instruction through Bayesian Approaches to Laban-based Manipulative Action Characterization

Goals:

- To research Bayesian networks to deal with perception of manipulative actions
- To develop a novel manipulative movement descriptor based on the so-called Laban Movement Analysis (LMA)
- To reproduce and replicate the human manipulative actions onto either a humanoid or simulated robot hand

Expected Activities:

Laban-based Hand Movement Analysis (LHMA), Multi-modal (eventually, visuo-haptic) Perception using Hierarchical Bayesian Models, Human Grasp Behaviour Learning and Imitation using Computer Vision.

Motivations

- As LMA lacks the extension to grasping and handling movements, we plan to re-formulate the basic concepts of LMA so as to drive a new descriptive language for hand motions, named Laban-based Hand Movement Analysis (LHMA).
- Important key points to understand the grasping behaviour are the relationship between object size and grasping parameters and other properties (fragility, size of the contact surface, texture and weight).

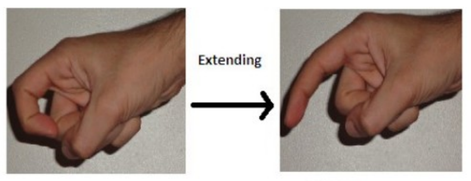
Challenges

- **Recognizing Motion Primitives**
  - Recognizing the demonstrator's hand manipulative gestures motions, specifically when and how objects are grasped, is a first step towards Learning by Imitation and has been commonly addressed in the respective literature.
  - Developing a novel approach called Laban-based Manipulative Action Perception (LMAP) founded on probabilistic frameworks (Hierarchical Bayesian Models, Hidden markov Models)
- **Learning by Imitation**

(Programming by Demonstration (PbD))

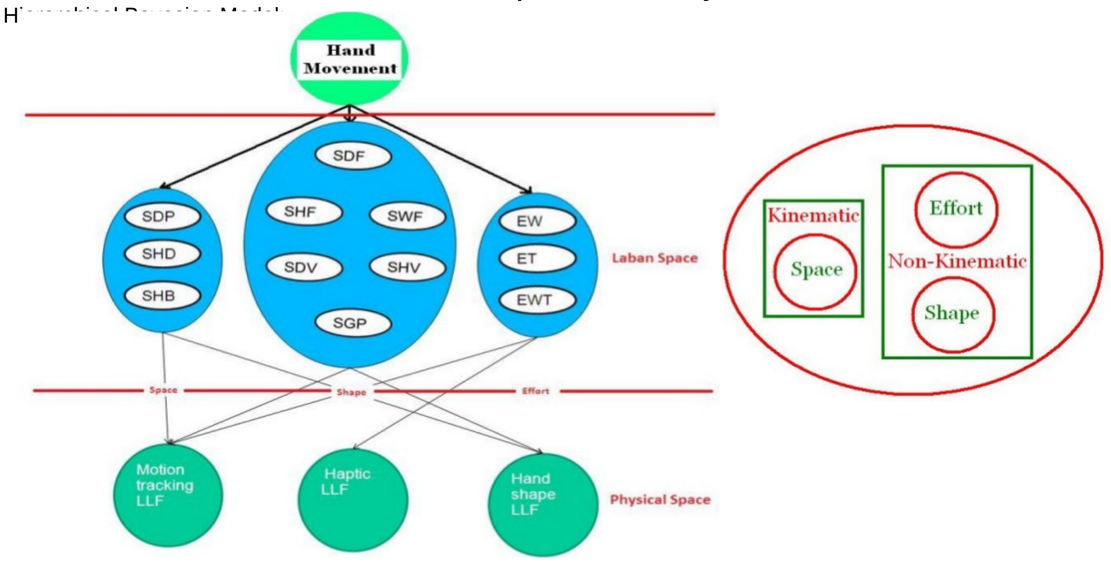
  - Humans often learn to manipulate objects by observing other people. In mush the same way, robots can use imitation learning to pick up useful skills.
  - Developing control algorithms to implement PbD frameworks through vision alone.
  - Visual segmentation / recognition / localization of different objects

We propose a generative language named Structural Description Language (SDL) which is a framework consisting of a set of rules and signs that enable us to graphically describe and represent various postures and motions of the hand, which a human being can perform naturally.

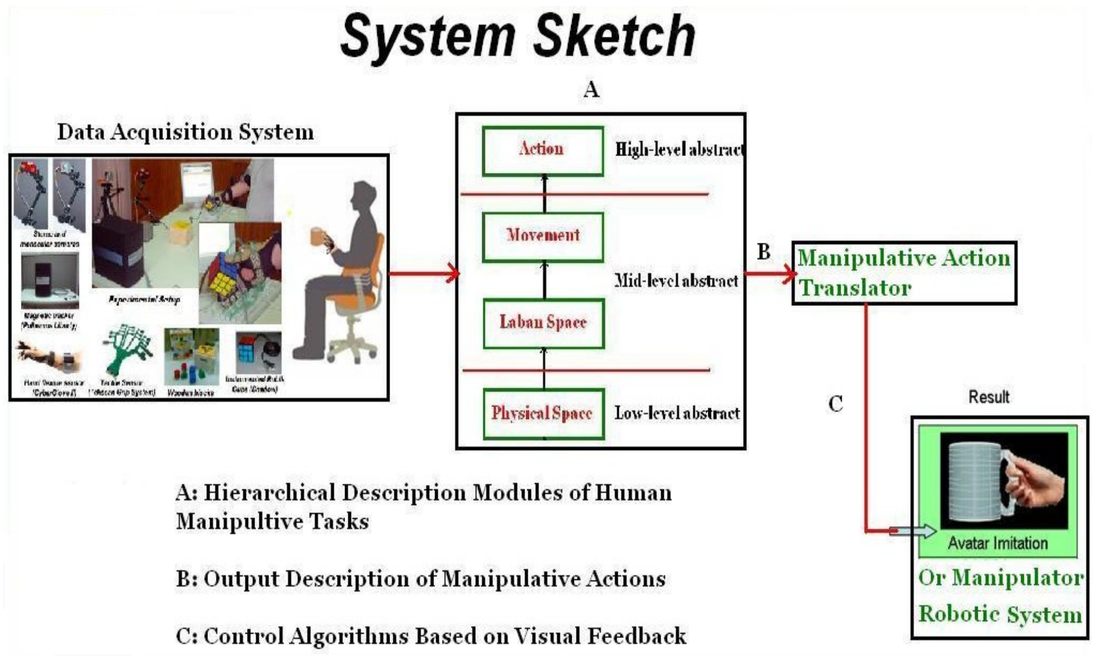


The respective sign is:

As an underlying concept, Laban Movement Analysis (LMA) is re-defined in a way that helps create a novel framework called Laban-based Hand Motion Analysis (LHMA) which is adapted to describe and characterize the movements performed by the hand.



We seek to develop a hierarchical Bayesian framework to model human-like grasp behaviors and corresponding action sequences given labeled data resulting from LHMA components. This framework will allow a robotic system to learn by demonstration how to classify the different grasps employed to manipulate different objects and consequently reproduce them using computer vision and an artificial hand.



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