

Developing an experimental platform for Human Robot Interaction based on human motions

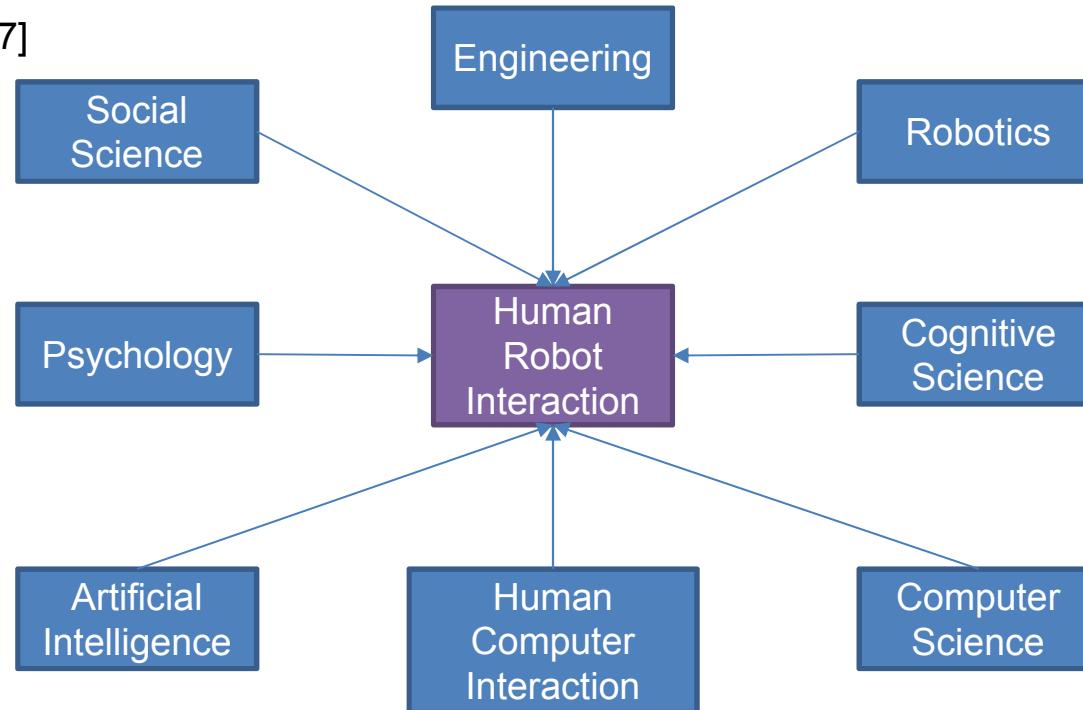
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Yannick AOUSTIN, Maître de Conférence à l'Université de Nantes
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Human Robot Interaction (HRI) and Social Robots

- [Dautenhahn, 2007]



- A Social robot should have the ability to interact with humans by adhering to certain social cues and rules. [Yan et al, 2014]

Where is HRI now?



ASKNaо (Autism Solution)



Nao in Education



Romeo - Physical Interaction



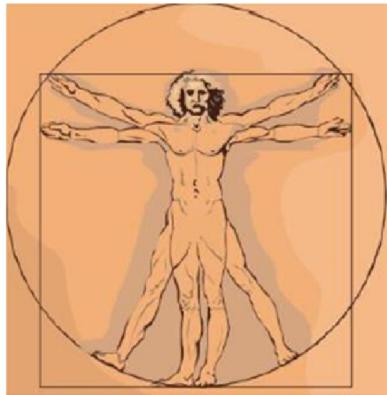
Juliette (Pepper) - Casual interaction

Images from Aldebaran (<https://www.aldebaran.com/en>)

Motivation(s)

- Humans interacting with intelligent Robots has been seen as a potential game changer in the future.
- Human motion (Non-verbal communication) is rich in information and understanding it is very important to improve the interaction.
 - Motion conveys intention, health, emotion etc.,
- Existing tools for designing HRI scenarios and robot behaviors are not scalable and requires skilled roboticists' assistance
- **Goal : To develop an experimental platform which**
 - **Facilitates interaction based on human motion**
 - **Is easy to use by a common user to design and execute interaction scenarios**

Problem Statement(s)



Interaction Scenario

Human Robot Interaction



From Robot-Viewpoint:

- Where am I?
- What is the human trying to convey?
- Where is the object I have to manipulate?

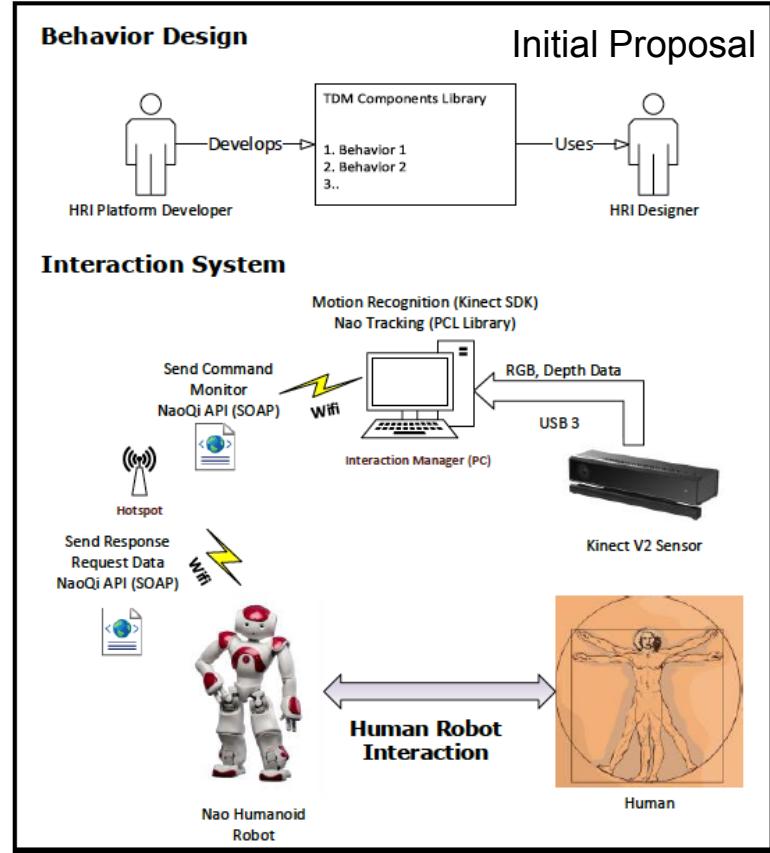
HRI Platform Designer

How to

- Capture & understand Human motion?
- Localize Nao?
- Communicate Information?
- Design behaviors?

Summary on Bibliographic study

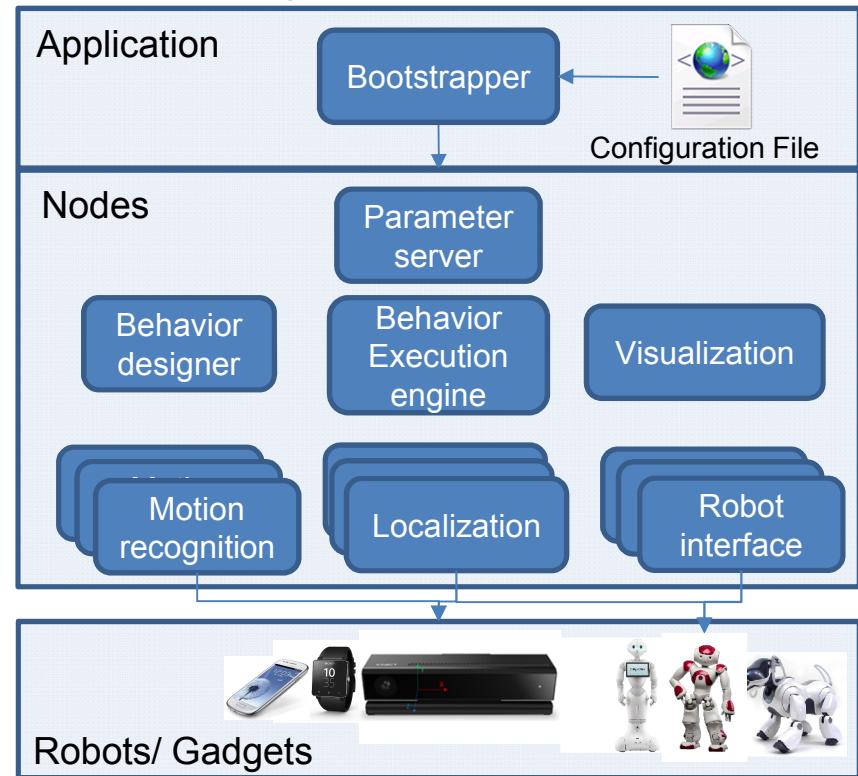
- **Motion capture:**
 - Stereophotogrammetric system, Monocular Cameras, IMU, **RGB-D Cameras** (Kinect V2)
- **Localization:**
 - **Marker based approaches**, Point cloud library algorithms (Monte carlo localization)
- **Designing behaviors:**
 - ROS, Choregraphe, Task Description Language, URBI, Microsoft Robotics Developer studio, **Target Drives Means?**
- **Evaluation techniques:**
 - **Self-assessment**, Interviews, **Behavioral measures**, Psychophysiology measures, Task performance metrics



Platform infrastructure design

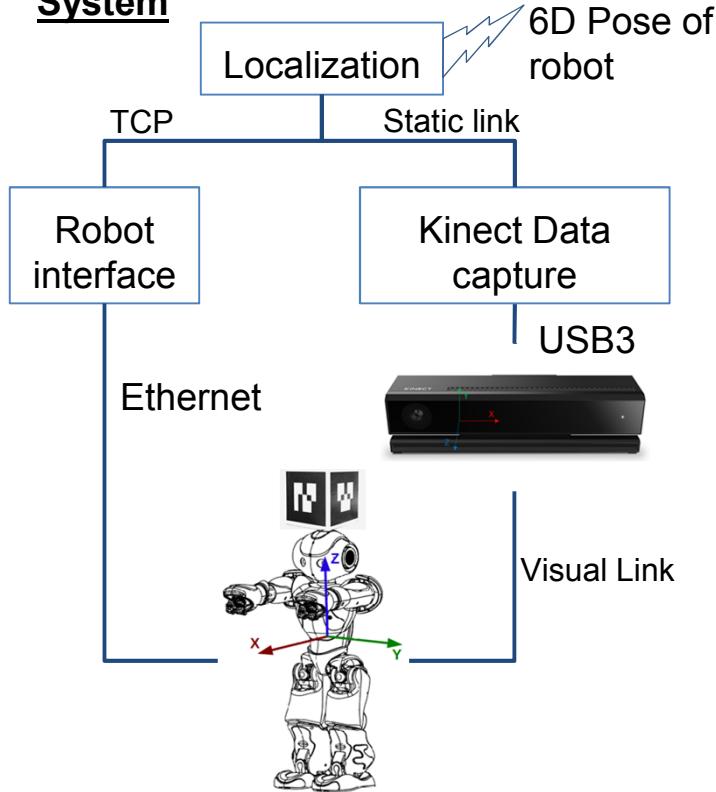
- Goals
 - Distributed nodes
 - Achieved using ZeroMQ (TCP, UDP, IPC)
 - PUB-SUB Protocol, REQ-REP protocol
 - Transparent messaging protocol that enables good interoperability
 - Google protocol buffers. Many primitive messages are imported from Gazebo
 - Visualization capability
 - OpenRAVE – Open source robotics planning / simulation framework
 - Visual Programming/ Natural language description of behaviors
 - Under investigation

• Software design concept



Robot Localization module

System



Algorithm

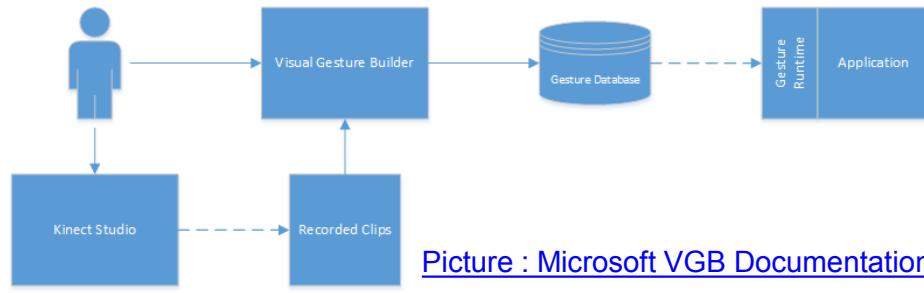
Data: Marker_size, Cube_size, MDH_Params

Result: TORSO_POSE

```
1 Init;;
2 k_model := INIT_MDH_PARAM(MDH_Params);
3 m_model := MARKER_MODEL(Marker_size, Cube_size);
4 while True do
5   data = READ_SENSOR();
6   marker_poses = DETECT_MARKERS(data);
7    ${}^W T_M$  = TRANSFORM_TO_TOP_FRAME(marker_poses, m_model);
8   [headyaw, headpitch] = READ_JOINT_VALUES();
9    ${}^T T_M$  = COMPUTE_TOP_FRAME(k_model, headyaw, headpitch);
10   ${}^W T_T$  =  ${}^W T_M \times {}^T T_M^{-1}$ ;
11  TORSO_POSE = MEDIAN_FILTER( ${}^W T_T$ );
12  PUBLISH(TORSO_POSE);
```

Motion Recognition Module

- Kinect Visual Gesture builder work flow



[Picture : Microsoft VGB Documentation](#)

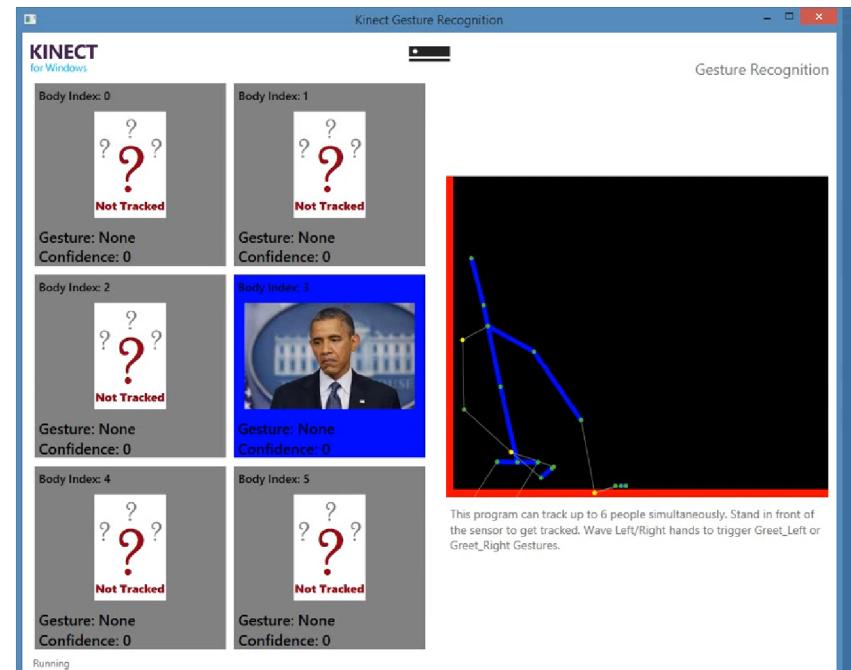
- Algorithm

Data: Gesture database

Result: Gesture Triggers

```
1 Init:;  
2   gestures = READ_DATABASE();  
3   REGISTER_GESTURES(gestures);  
4 while True do  
5   skeletons = GET_SKELETONS();  
6   gesture = DETECT_GESTURE();  
7   if detected then  
8     PUBLISH(gesture);  
9     PUBLISH(skeletons);
```

- Hand wave discrete gesture

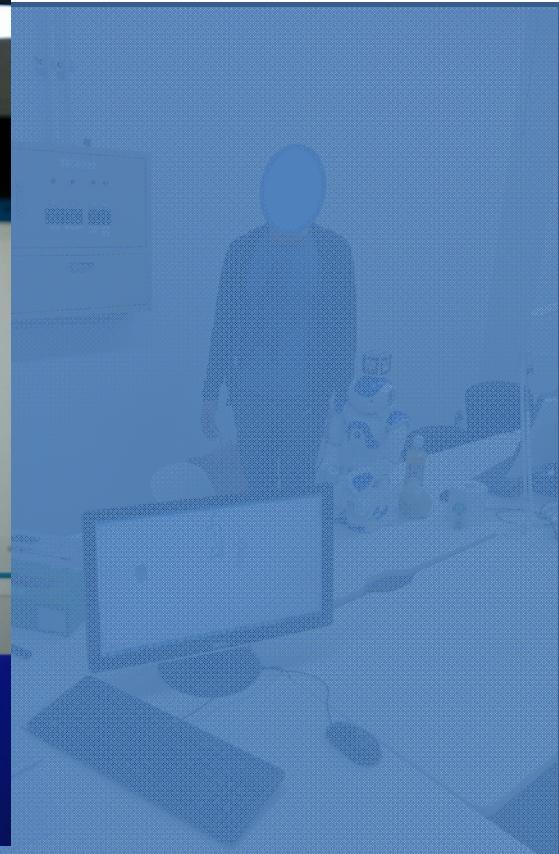
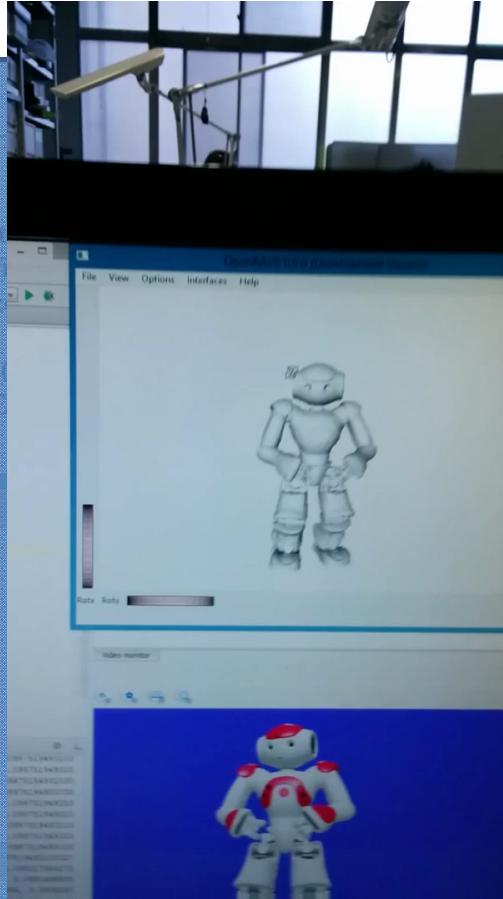


Visualization Module

Algorithm:

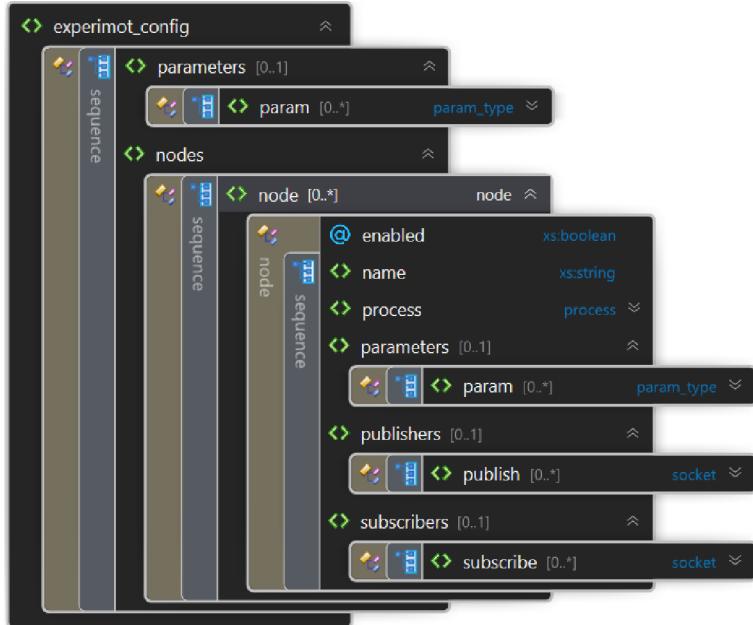
Data: simulation.config

```
1 Init:  
2   INIT_SIMULATION_ENGNE(simulation.config)  
3   INIT_SUBSCRIBERS(simulation.config)  
4   LOAD_ENVIRONMENT(simulation.config)  
5   while True do  
6     sensors = READ_SENSOR_VALUES()  
7     skeletons = READ_SKELETON_DATA()  
8     RENDER(motion, sensors)
```



Platform implementation

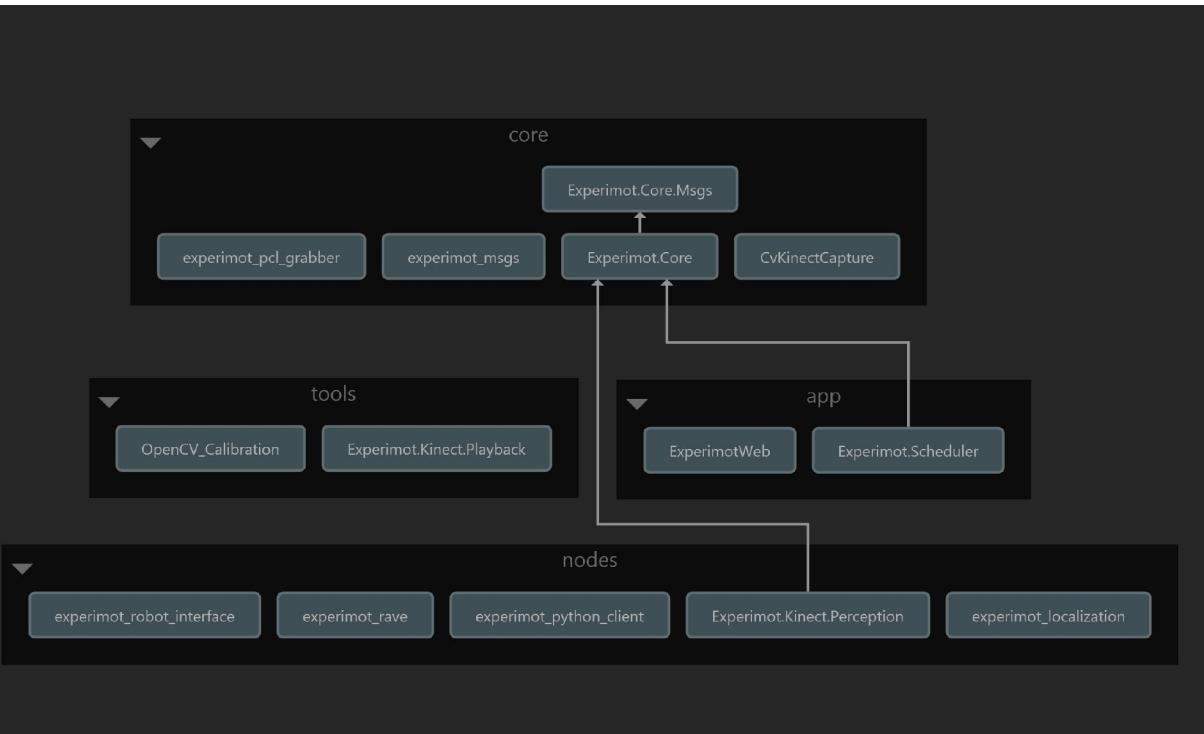
- Configuration Management



- Example node configuration

```
<node enabled="true">
  <name>gesture_recognition</name>
  <process>
    <type>executable</type>
    <path>%DEV_SDK_ROOT%\experimot\bin\nodes\Experimot.Kinect.Perception\</path>
    <args></args>
  </process>
  <parameters>
    <param key="database" type="string" value="Database\experimot.gbd"/>
  </parameters>
  <publishers>
    <publish>
      <host>tcp://*</host>
      <port>5570</port>
      <topic>KSP</topic>
      <msg_type>KinectBodies</msg_type>
      <name>KinectBodyPublisher</name>
    </publish>
  </publishers>
</node>
```

Platform implementation contd.,



Source Code

[praveenv4k / ExPeriMot](https://github.com/praveenv4k/ExPeriMot) PRIVATE

Experimental platform for effective human robot interaction based on human motions — Edit

190 commits	1 branch	0 releases	1 contributor
branch: master	ExPeriMot +		
making presentation			
praveenv4k authored 7 hours ago	latest commit	78bc197722	
assets	assets to be used as block icons in eyesweb	2 months ago	
data	moved calib files and added robot models	25 days ago	
docs	making presentation	7 hours ago	
external	projects output folder configuration	13 days ago	
include	python generated files commented "syntax" as it is not supported in p...	2 days ago	
lib	fixed the errors in the experimot studio project. now the startup is ...	18 days ago	
props	adding ekt filter for filtering the pose of the torso	9 days ago	
src	making presentation	7 hours ago	
.gitattributes	Added .gitattributes & .gitignore files	2 months ago	
.gitignore	added the schema config for nodes description.	17 days ago	
ExPeriMot.sln	removed unnecessary project	a day ago	
ExPeriMot.sln.DotSettings	modifying the context specific classes and data change notifications	11 days ago	
README.md	modified post build to copy all the files to the output folder	13 days ago	
cloc-1.62.exe	added pcl grabber	6 days ago	
cloc.txt	added cloc configuration	6 days ago	

<https://github.com/praveenv4k/ExPeriMot>

TO-DO List

- Improvement of Pose estimation of marker
 - Some times the Z-Axis of the detected markers is inward instead of outward
 - Possible solution: Check the detected frame is right handed/left handed?
- Collaborate with Mr. Vincent Berenz to use TDM framework for behavior execution
- Improve the data structure that contains the description of the world
- Natural Language representation and translation of high level representation into gesture triggers and robot behaviors
 - Example: **“When some one waves their hand, respond by waving hands”**
 - Gestures Trigger : Hand waving
 - Robot behavior : Say hello behavior
- Develop an easy to use interface for designing behaviors using high level language
- Designing concrete scenarios and evaluate (Receptionist, Exercise cheer leader)