
# Work Progress Report

Project Period: 2015/02/16 ∼ 2015/08/18

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Title

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

# 1 2015/02/15-2015/02/21

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/02/15 | • Arrival in Japan | - |
| 2015/02/16 | • Project discussion with professor.<br>• Showed demo of ALVAR toolkit, CMT (Consensus based matching and Tracking) toolkit. Demo based on PC webcam.<br>• Received Kinect V2 sensor. | - |
| 2015/02/17 | • Play with Kinect sensor SDK samples.<br>• Setup Point cloud library environment.<br>• Undergraduate presentation.<br>• Welcome party. | • Problem with acquiring Kinect data and displaying in PCL viewer. |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/02/18 | • Fixed the PCL Kinect Grabber problem (Signal for PCL point type PointXYZRGBA has not been registered in OpenNISegmentTracker)<br>• Tried to make 3D model of smartphone to be able to track using PCL tracker. | • PCL tracker could not be used using reference point cloud. Under investigation (postponed) |
| 2015/02/19 | • Started integrating ALVAR,CMT to be used with the Kinect Stream<br>• It needs custom build of OpenCV. OpenCV v2.4.10 does not support OpenNI2. So had to build the latest version of OpenCV. | - |
| 2015/02/20 | • Setting up new PC (VS2010, VS2013, PCL, Kinect SDK) | - |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/02/21 | • Continue PC setup (Aldebaran Softwares, Intel XE composer 2015)<br>• Start custom build of OpenCV (v3.0.0). Fixed many issues related to building the software.<br>• Build of OpenCV (version 20150221) successful | - |

## 2 2015/02/23-2015/02/27

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/02/23 | • ALVAR tookit build<br>• Glut32, FreeGlut build<br>• OpenNI2 + Kinect Driver V2 build and Test (http://youtu.be/nhNPri5Aees)<br>• Contacted Paolo Coletta of Eyesweb team and asked about how Kinect V2 is integrated in Eyesweb | - |
| 2015/02/24 | • ALVAR tookit Kinectv2 capture plugin build | • Problem encountered while capturing the Kinect Color frame |
| 2015/02/25 | • Started writing C#.NET Wrapper for libCMT (Consensus based Matching and Tracking library). After completion and testing will open source the library. | - |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/02/26 | • Kinect calibration and Marker tracking using ALVAR library complete (http://youtu.be/ypb3T9BUipQ). A 7.5 × 7.5 cm marker tracking range is ∼ 3 m.<br>• Wrote Kinect Video capture plugin and integrated with CMT. | • CMT → Very slow. And the tracking was not very robust. |
| 2015/02/27 | • Started again with PCL Tracker.<br>• Modified OpenNI2 Kinect2 driver ( Driver Initialization and Kinect Device setProperty )<br>• Started exploring BLORT toolkit (http://www.acin.tuwien.ac.at/index.php?id=290&L=1)<br>• Preparation to import 3D model of Nao Head | • Kinect2 device takes approximately 3 seconds to initialize properly !<br>• Particle filter tracking was very slow. Still not successful ( need to be studied systematically)<br>• Building BLORT in windows was very painful. |

## 3 2015/03/02-2015/03/08

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/02 | • Continue with BLORT toolkit build<br>• Marker based wrist tracking ( tested with ALVAR library )<br>• Made a simple cube to place over Nao robot's head with markers on it's sides.<br>• ROS setup in Virtual machine | Found that BLORT has dependencies with NVIDIA stuff. Figuring out a way to fix this. |
| 2015/03/03 | • Started with TrackerQt (successor of BLORT) (Advances in Real time object tracking - http://users.acin.tuwien.ac.at/tmoerwald/?site=4, http://users.acin.tuwien.ac.at/tmoerwald/?site=3#tracking).<br>• Tried to set up Chilitags as well<br>• Made the marker cube to put on top of Nao robot's head<br>• Ported dummysim example in Nao Simulator sdk v 1.14 to sdk v2.1. | • Trying to evaluate BLORT, TrackerQt and Chilitags in Ubuntu in virtual machine ( will use some monocular camera supported by OpenCV to test). If the results are promising will try to setup in windows. |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/04 | • Fixed the OpenGLSL errors in BLORT (GLSL Frag and Vert file errors). Both BLORT and TrackerQt requires GPU. Confirmed with Thomas Morwald (developer)<br>• Checked chilitags with webcam in ubuntu (14.04) environment. It is not as reliable as ALVAR toolkit. Also there are memory leaks.<br>• Ported robot_description sample from Nao Simulator sdk 1.14 to sdk 2.1.2 ( for exporting urdf file of the robot model)<br>• Setup PWP3D tracking library (Need CUDA GPU)<br>• Naoqi setup in Ubuntu<br>• Setting up openrave environment (thinking of use it as a simulation environment. put both robot and human in openrave simulator - don't know if it is good idea. But will give it a try) | - |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/05 | • Experiment with Jean (Reflective marker tracking on subjects head. Captured video using kinect studio). Also checked the marker tracking by putting the marker on Nao robot's head and made a video (http://youtu.be/VB0LHJM0dwI). Marker tracking affected by lighting.<br>• Setup ROS nao and openrave build.<br>• Investigated if VREP could be used as simulation environment ( It has a nao model but it is old. it has to be updated)<br>• Serial kinematic chain model for the case when Marker is put on Nao's head. (has to be checked after implementation and experimentation) | |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/06 | • Computing the pose of top of the marker cube when one or more of the markers are detected (if more than one quaternion slerp is used to find the best estimate)<br>• Setting up openrave<br>• Prepare Nao meshes and conversion of Urdf to dae ( wrote a simple ros node to do this) | • Openrave build unsuccessful.<br>• Dae conversion unsuccessful |
| 2015/03/07 | • Kinematic model design and implement implement in Python-sympy ( for quick checking)<br>• Visited Mujin bot office (www.mujin.co.jp). They do some impressive work in the field of industrial robotics | - |
| 2015/03/08 | • Continued with openrave setup | - |

# 4 2015/03/09-2015/03/15

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/09 | • Openrave setup complete<br>• Collada export using collada_urdf exporter | collada_urdf exporter not working with Ubuntu 14.04 and ROS indigo. Have to try with ROS Hydro |
| 2015/03/10 | • Studied usage of VisualGestureBuilder tool. Tried generating simple hand wave gesture<br>• Made a sample application to test the generated gesture database | • With both Left and right hand gestures available, only one of them is detected properly. Debugging to understand the problem |
| 2015/03/11 | • Fixed the bug in the gesture recognition sample. The sample video is uploaded at http://youtu.be/7E8TgLbQ4a8<br>• Kinect V2 setup guide documentation<br>• Nao Robot collada model export successful - Finally !!! ( Possible with ROS Hydro in Ubuntu 12.04 virtual machine) | - |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/12 | • Optimizing the 3d collada model of Nao | |
| 2015/03/13 | • Investigated the possibility to use Protobuf as interprocess communication exchange format<br>• Minor changes to the Experimot<br>• Try openrave-2013 build<br>• Joint data acquisition of Nao robot when Tai-chi motion is performed. | - |
| 2015/03/14 | • openrave-2013 build successful<br>• Protobuf build<br>• Decided to use Protobuf messages used in Gazebo to be used for the platform I am developing | - |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/15 | • Created a custom marker cube for Nao pose detection ( Cube bought from - http://www.amazon.co.jp/dp/B0049EVGC4/ref=pe_492632_159100282_TE_item )<br>• Imported Gazebo messages from repository and wrote an automatic script to export the headers and source files from *.proto files.<br>• Tested the export script and static library creation | - |

# 5 2015/03/16-2015/03/22

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/16 | • Seminar: Symptoms of being alive and shared life at Keio University<br>– Talks on life, emerging new organisms, non-verbal communication in human robot interaction, life and turing machine, di-chronic study using coral atolls, human chimpanzee interaction, animals perception of life.<br>• Observations relevant to my project<br>– Using ethics to interact may give the impression that the thing is living.<br>– The manner in which an agent/robot spends its idle time will have a greater impact on its liveliness.<br>- | |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/17 | • The joint values of the tai chi pose of Nao collected last week is used to simulate the Nao robot in openrave environment - Successful!<br>• The video is uploaded at http://youtu.be/aFECThEAivk | - |
| 2015/03/18 | • Boost ASIO and ZMQ setup.<br>• Seminar | - |
| 2015/03/19 | • Created kinect Video playback tool (http://youtu.be/vUdm8QeylP4)<br>• Boost ASIO and ZMQ client/server development<br>• Meeting | |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/20 | • Successfully got protobuf and zeromq working together<br>• Tested the joint value simulation using client server architecture<br>• Also tried with the python publisher. Inter-process communication works as expected. | - |

## 6 2015/03/23-2015/03/29

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/23 | • Improved Kinect XEF File Playback tool (File Open, Display Body Index Frame etc.,)<br>• Auto generation of C# classes from .proto files. Created the C# library containing the generated messages<br>• Tested the IPC between the C# application and OpenRave client application - Works perfectly!<br>• Kinect body information publication/subscription test | Kinect Playback Tool - The way to read the skeleton information from the event stream is still unknown. Have to figure it out. |
| 2015/03/24 | • Kinect body information display in openrave environment alongside Nao robot. - Works well<br>• Real time Nao robot simulation in OpenRave environment (http://youtu.be/wUgRbslD6jk)<br>• Absolute localization based on markers - test started | • - |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/25 | • Integration of localization module in the framework (experimot_localization)<br>• Kinect Playback tool IR stream support added | - |
| 2015/03/26 | • Integration of localization module. Developed nao Marker frame forward kinematics module and tested against openrave forward kinematics. | |
| 2015/03/27 | • Major refacoring of localization module<br>• Unit testing<br>• Localization IPC setup | - |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/28 | • Bug fixes<br>• Complete communication flow test (Localization, Robot-interface, Skeleton-tracking, Simulator) | • Need to fine tune localization. Position looks good. Orientation is a concern ( TODO Item : Modify the way in which the torso frame is computed. )<br>• Coordinate frames has to be synchronized. |
| 2015/03/29 | • Quartz scheduler - Feasibility study (Looks promising) | - |

# 7 2015/03/30-2015/04/05

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/03/30 | • Nao localization test. Fixed the torso frame calculation bug. | The pose computation is still sometimes strange. The frames of reference are not perfectly synchronized. Need more test. |
| 2015/03/31 | • Fixed bugs in the Nao pose estimation.<br>• Added the color stream support in the kinect playback tool.<br>• Investigation on how to extract skeleton data from raw buffer in XEF file | • The raw format used by Microsoft for color stream was Yuy2 ( 4 bytes for 2 pixels). The conversion from Yuy2 to RGB was implemented in Kinect Playback tool<br>• The skeleton buffer was 6288 bytes. I tried decoding the skeleton values from the byte stream. Still cannot figure out how the data structure is aligned while serializing. |
| 2015/04/01 | • Fixed Experimot studio startup problem.<br>• Scheduler design. Written core classes that will compose the Context of the scheduler. | - |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/04/02 | • Schedule core classes design<br>• Localization reference frame problem debugging | |
| 2015/04/03 | • Localization reference frame problem fix<br>• Testing | - |
| 2015/04/04 | • Bug fixes in the localization | • The camera frame considered by ALVAR was (x-right, y-down and z-forward). However for KINECT it was (x-right, y-up and z-forward). So basically I had to invert the y-axis position values after computing the Torso pose.<br>• *TODO*: Weighted pose estimation depending on the marker detection confidence. |

# 8 2015/04/06-2015/04/12

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/04/06 | • Lab meeting<br>• Application bootstrapper - Modified XML schema to support node parameters. In the process of supplying the node parameters as a command line arguments to the individual nodes during startup. | - |
| 2015/04/07 | • Application bootstrapper support - Extended the xml config file to support global and local parameters. global Parameter overriding, support the new configuration information in the individual nodes.<br>• Testing the supported nodes. | |

| Date | Content | Problems/Remarks |
|---|---|---|
| 2015/04/08 | • Node startup enable/disable support<br>• Integration of Gesture recognition and Skeleton tracking and supported start up of this node from configuration information.<br>• Application context information management support. Auto subscription of all the published messages. Under test | - |
| 2015/04/09 | • Migration from clrzmq to NetMQ .NET library for ZeroMQ<br>• Parameter server and Context synchronization from all publishing nodes - Multi-threading support<br>• UI update of current pose from the context | |
| 2015/04/10 | • Localization reference frame problem fix<br>• Testing | - |

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| 2015/04/11 | • Bug fixes in the localization | • The camera frame considered by ALVAR was (x-right, y-down and z-forward). However for KINECT it was (x-right, y-up and z-forward). So basically I had to invert the y-axis position values after computing the Torso pose.<br>• *TODO*: Weighted pose estimation depending on the marker detection confidence. |