Mixed reality and robotics-1

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Interaction

Current interaction paradigm:
1. Keyboard+mouse
2. No need to share same space with robots
3. User can't see robots intention

Goals for MR based Human robot interaction
1. Natur interaction +cooperation
2. Better transparency
3. Enable research and new applications

MR spectrum

AR VR

Ar- arcore Arjit
Vr- Oculus vr Htc vive Windows mr Headsets

Ar on mobile devices: see digitial content as an overlay on real world
Multi touch interface
Robotics- ar+ robot colocalization with tags

Hololens - mixed reality headset
Hololens2 - better field of view
Includes RGB camera depth.cam head tracking can (imu+cam)
Ir track camera microphone array

Hololens 2 - semantic mapping (slam application)

hand tracking (hand segmentation runs on hololens DNN accelerator) (deep learning application, efficient geometric fitting)

Eye tracking too...eye gaze as another mode of interaction

Apps can access high level spatial data

The research mode in hololens2 can be used to access more sensor data ...mainly for research mode

Magic leap 1: head and handeye tracking...controller input

VR headset: hand tracking...for Oculus...occlusded view-> visualise digital reality

Windows mR headsets - shared runtime components, interaction with Controller, hand tracking with asstional leap motion controller

Mixed reality capture

Volumteric capture to make holographic content

MR- robot communication (my fav part)
Mobile- ros# + rosbridge
रोशवा
RBS manager

For HL
Ros# + rosbridge (most recommended)
Ros2**** (not fully developed)
Custom communication protocol with e.g. websockets, grpc (not advised)
Development platforms: unity in c#, unreal in c++ openXR in c++ webXR in js

Development tools

Ptc vuforia
Merk for unity and unreal
Merk for ROS
ARViz - Rviz for Mr devices

Visualise robot spatial data- what data can visualise and what data should visualise

- Raw sensor data
- Maps
- Meshes
- Reference frames
- Planned frames
- Planned paths
- Camera frustrum
- Manipulaor workspace
- Current robot state

Good to visualize sparse or integrated sensor data (to reduce communication bandwidth and computation cost)

- Reference farmes while working with spatial data
  First co-localize MR device and robot..deal with handednessand orientation
  In ros- leverage TF to handle transforms
- Modes of interaction
  Mr device + UX for interaction
- Interaction: physical reality

- Mr - head pose eye gaze pointing touch hand tracking
- Vr- head pose and controllers
- Teleoperation in MR and VR
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- System architecture:
  Headset, robot ,cloud, base station

2. Co& localisation

   Real goal: share space collaborate and interact with robots
   Methods of co-localization:

A. Marker based...April tags..aruco artoolkit vumark
B. Vision based - azure sptaual anchors google cloud anchorss apple location anchors
C. Common maps - use 2 different localisation schemes on robot and MR

Marker based

Hololens uses cam to detect tag,
Relatively fast
Precise positioning
But***
instrumenting environment might not always be easy
Also agents must observe same tag or mapping for multi-tag setups
Accuracy is viewpoint dependent here

- Image- > adaptive thresholdinf -> segmentation -> detected quads -> tag detection

Vision based co-localization

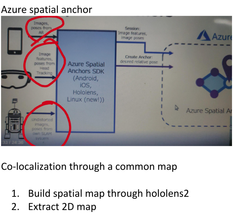
Query image with local features-> descriptot space... establish 2d-3d correspondences through descriptor matching ->estimate camera pose -> final camera pose

Example: drone visual intertidal teach and repeat for aerial inspection (interesting paper)

Cloud based services for MR devices

Google arcore apple location anchor
Spatial anchor: common reference frame for placing digital content , stable relative to real world , persistent over time, using the cloud

Azure spatial anchor



Co-localization through a common map

1. Build spatial map through hololens2
2. Extract 2D map

Demos** (in next post)