Lecture 5: Virtual,augmented reality

Human Robot Interaction

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1 Mixed Reality

spectrum

- Reality
- Augmented Reality
- Augmented Virtuality - Add real objects to virtual environemnts
- Virtual Reality

NUI - Natural User Interface

2 Robot Navigation

You can use AR to display the path/ waypoints

3 Robot Manipulation

Can also display the path /waypoints for the robot manipulator.

4 Robot Debugging

Can for example show collisions on the robot.

5 Social Interaction

Can display e.g. eyes on the robot to make it more human like to make it show more emotions on the robot that way.

6 Display Hardware

How do we view these augmented reality features.

- Screen - the user is tethered for the screen.
- 3D monitor - More expensive.
- Projector based - Project some lines onto objects using a standard projector. This can also be used to display xrays of what is inside a box for example. Volnurable to occlution by the user.
- Tables - They are cheaper, provide realtime video feed from the camera. Comes with a touch screen interface for the user.

- Head mounted Displays. (Optical seethrough which is expensive) some can also have hand tracking enabled. The augmented reality part is however quite restricted in the users field of view. Creates a "letterbox effect". May be difficult to know where the edges of the internal box ends. You have to keep your eyes locked straight ahead to keep your eyes within the augmented field of view.
- Video pass-through HMD - as expensive as the applevision pro. There is a video delay which may make it difficult to use in close collaboration, or if they break you are essentially blind.
- VR headset, which only displays a virtual world exclusively.
- Cave Automatic Virtual Environments - Back projection on 5 walls around you. (Biomuseum in panama)

Track the user in the living room and distort the image on a screen to fit their movement.

7 Tracking the real world

- Fiducial markers (those used for camera calibration)
- Motion capture cameras. Very expensive and very restrictive
- Odometry, great if combined with other tracking methods, like visual inputs.
- Virtual object manual alignment
- Iterative Closest point alignment - point cloud alignment algorithms. Iterate to minimize the distance between two pointclouds. Suitable for initial frame synchronization between multiple agents.
- Machine learning based. E.g. Estimate human pose or object pose estimation algorithms. Works great on already trained objects, but they have problems with estimating positions of unknown objects.

8 Design Taxonomy

Split up into the above categories (the ones first presented)

9 Virtual entity

Entities that are added to virtual or real environment (Augmented reality)

- Visualisation robots: current real robot status.
- Simulated robots: completely isolated from the real world.
- Digital twin: Tandem between real world and simulation. Preview actions.
- Simulated agent: Simulated for training for agents. Can be human agents, asl long as it is used for training robots.

10 Virtual Alterations

Used to change the proporties of the robots

- Could be cosmetic
- Could be functional
- Morphological
  - Body extensions
  - Body diminishments
  - Form transformations

11 Robot status visualisation

- Internal
  - Internal readings
  - Internal readiness - is the sensors ready to send data etc.
- external
  - Robot Poses
  - Robot alterations

12 Robot comprehension Visualisation

How do we display anything that is in the control system of the robot.

- Environment - can show spatial region. What region can the robot manipulate within.
- Entity - Entity labels, attributes, entity locations, appearances.
- Task - Headings, waypoints, callouts (a list of commands that have been sent to the robot), Spatial previews (what are things gonna look like), alteration previews.

13 Exercises

Brainstorm vam-hmi usecases. What hardware is best suited, make sketches.