

## Teleperception - Technology for TBS - extensions

The technology for a TBS-Teleperception-System consists of the following sections:

- the **Visual Section**: transmitting a stereoscopic picture from WashBot to Operating Station and Brainwashing Station
- the **Audio Section** : transmitting the audial information from the Washbots microphone to the Operating Station and Brainwashing Station
- the **Head Position Tracking** : transmitting the Brainwashing Operator's viewing direction to the Washbot
- the **Cam Positioning**: for adjusting the Cameras to the Operators viewing direction
- the **Washbot Landscape Tracking**: transmitting the 3D-characteristics of the landscape surface to the Operating Station
- the **Operating Station Movement Control**: moves the hydraulic systems of the VR-chair according to the Landscape characteristics the Washbot drives through.

### Visual Section

There are different ways, how stereoscopy in the human eyes can be pretended. In all cases images of a scene with two, in the viewing distance and angle positioned cameras, are created and these are joined over a certain technique to one signal or one image.

The i-glasses manufactured by the company virtual-io operate in the "interlaced mode" i.e. they divide the Composit PAL (or NTSC) signal into even and odd field, whereby in every case one field is shown the left and the other field the right eye over an own LCD.

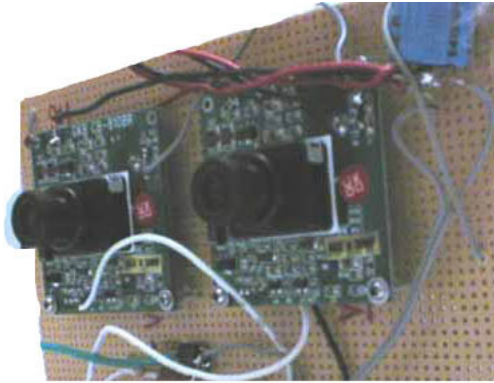


in the visual area, the following action have to be taken:

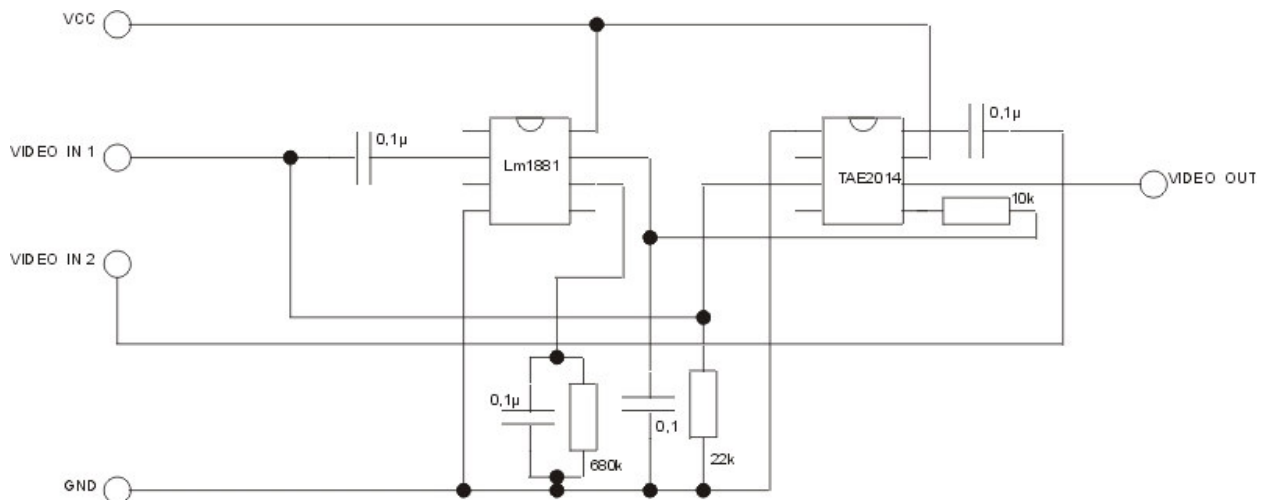
- to position two ccd cameras in the viewing distance and in an select angle
- to mix the signals output of the cameras into interlaced video
- this signal has to be transmitted
- if you want to mix two composit signals by field into one, the signals must be absolutely synchronous. if one camera is ready with one field, the second camera must be ready with this field, too.
- a flicker-free switching between the individual signals is provided by short switching times
- it would be an advantage to know when which field is sent. It could be e.g. that the field of the right camera is transmitted on the left eye.

### Implementation of the visual section:

the synchronisation of light ccd cameras can be done when deactivating the oscillator of one camera and feeding it with the oscillator frequency of the other camera. If the cameras are identically constructed, one can assume the two cameras record absolutely synchronously the same field. Over a Synchronisationsseparator (we decided for the LM1881N of National Semiconductors) one receives the vertical synchronisation signal from a composit signal (spek field synchronisation signal) and the odd/even signal. then you have to switch between the two signals via a video switch (TEA2014 of Thomson) to mix the two composit signals to one.



Stereoscopic camera transmission unit, mountable on washbot (teleperception robot)



electronic sceme for mixing up two cam-signals into one stereo signal

## Audio section

The audio signal is received from the washbot via giga-link-radio receiver. The signal is directly fed into the i-glassed audio-input (stereo).

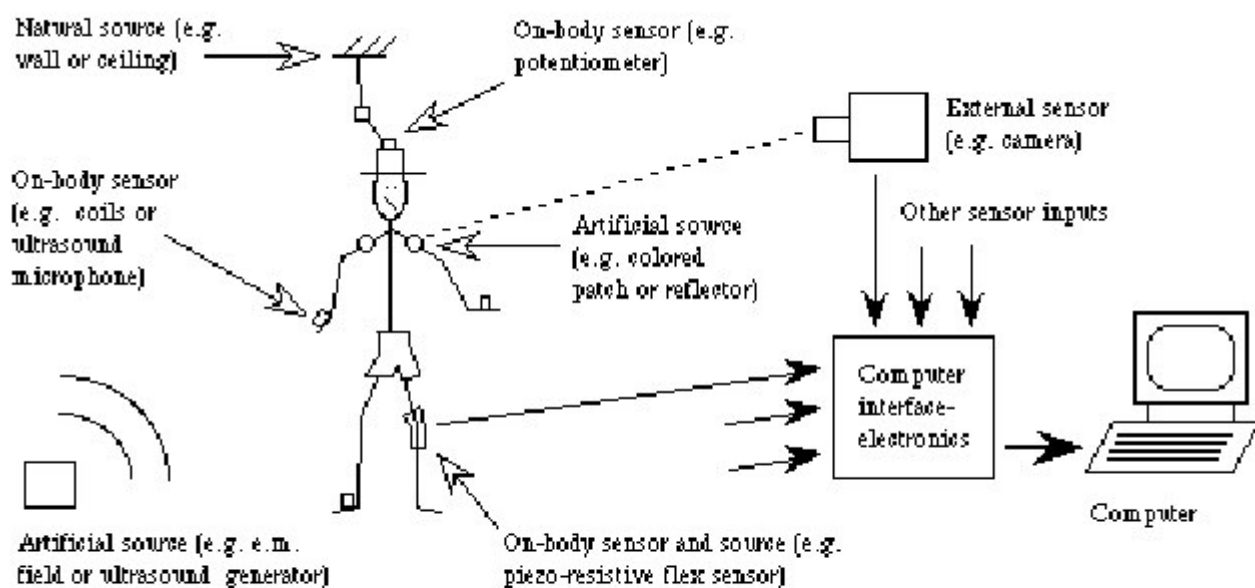
## Movement Tracking

Human movement tracking systems can be classified as inside-in, inside-out and outside-in systems.

**Inside-in** systems are defined as those which employ sensor(s) and source(s) that are both on the body (e.g. a glove with piezo-resistive flex sensors). The sensors generally have small form-factors and are therefore especially suitable for tracking small body parts. Whilst these systems allow for capture of any body movement and allow for an unlimited workspace, they are also considered obtrusive and generally do not provide 3D world-based information.

**Inside-out** systems employ sensor(s) on the body that sense artificial external source(s) (e.g. a coil moving in an externally generated electromagnetic field), or natural external source(s) (e.g. a mechanical head tracker using a wall or ceiling as a reference or an accelerometer moving in the earth's gravitational field). Although these systems provide 3D world-based information, their workspace and accuracy is generally limited due to use of the external source and their formfactor restricts use to medium and larger sized bodyparts.

**Outside-in** systems employ an external sensor that senses artificial source(s) or marker(s) on the body, e.g. an electro-optical system that tracks reflective markers, or natural source(s) on the body (e.g. a videocamera based system that tracks the pupil and cornea). These systems generally suffer from occlusion, and a limited workspace, but they are considered the least obtrusive. Due to the occlusion it is hard or impossible to track small bodyparts unless the workspace is severely restricted (e.g. eye movement tracking systems). The optical or image based systems require sophisticated hardware and software and are therefore expensive.



Examples of components of human movement tracking systems

## Head-Tracking and data-transmission for TBS

For the TBS, it is important to get the Head Position of the Brainwashing Operator and to adjust the viewing direction of the WashBot-Cameras to the right viewing angles of the Operator. The tracker that i-glasses support operates relative to the earth's magnetic field and supplies the three absolute angles of the tracker coordinate system to that of the earth's magnetic field. The transfer is serial, whereby alternatively the angles either in ASCII or as binary will be transferred. The motion control PC receives the measured angles via a RS 232 protocol and sends the received head tracking via radio-modem to the Washbot-avatar. On the Washbot, the viewing angles of the 3D-Cam-System are adjusted according to the head-tracking via the

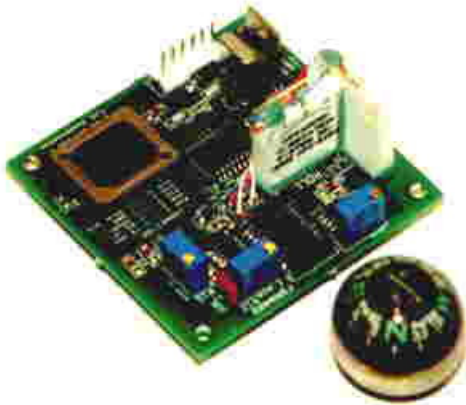
servo-controller.

## The Cam Positioning

The Positioning of the Cam-System on the Washbot is done via a microcontroller, that receives the Operator's Head Position via radio-modem. The microcontroller uses the RS232-serial data transmission protocol to get the angles from the modem. The two cameras on the Washbot are fixed to servos that determine the viewing direction. The microcontroller calculates appropriate servo-positions from the tracked head-position and sends the data-bytes to the servo-controller, also via RS232.

## The Washbot Landscape Tracking

The Landscape Tracking is used to get information about the 3D-characteristics of the Washbot's driving. The Mountains and road conditions the Washbot experiences are measured by a 3d-compass and sent to the Operating Station via radio-modem.

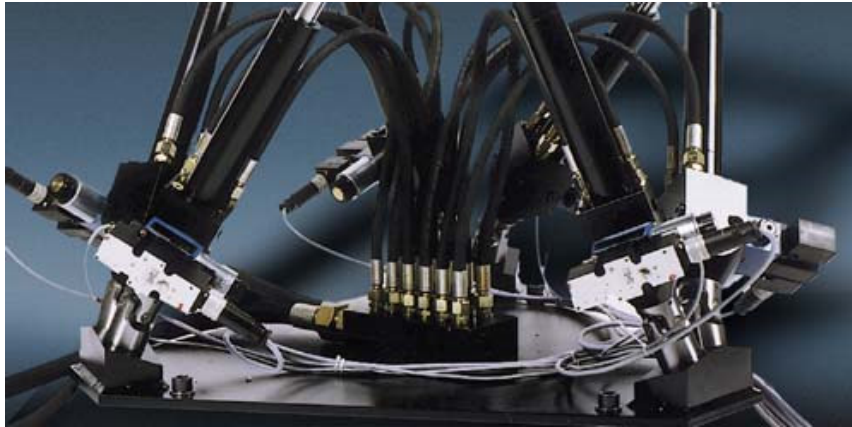


3d-compass measuring surface conditions of Perceptual Landscape

## The Tele-Operation-Station Movement

To get a haptic movement-feedback at the Operating Station, the 3D-Landscape information tracked by the 3D-compass of the Washbot is used to move the Operator's VR-chair via a hydraulic movement simulator. The Movement Control PC calculates the yaw/pitch/roll - angles from the transmitted compass information and effects the hydraulic system via RS232-connection.





hydraulic VR-Chair-Movement

## Parts-List / Prices

### 1. BrainWashing Station

EEG-measurement and feedback

\* **Wave Rider EEG-amplifier**

2 EEG Channels, 1 EKG, 1 GSR, RS232 communication interface,

WaveWare Software-Package, Cap, electrodes, electrode-gel

\* **Pentium PC** for EEG-measurement + visualisation *needed: 1*

### 2. Motion & Perception Operating Station

VR TeleExistence Environment

\* **Hydraulic motion system** Hydraudyne System Inc.



Payload 325kg / 700lbs  
 Degrees of freedom: 6  
 Design Payload Properties:  
 Weight : 325 kg (717 lbs)  
 Ixx :125 kgm<sup>2</sup> (92 slug-ft<sup>2</sup>)  
 Iyy : 238 kgm<sup>2</sup> (176 slug-ft<sup>2</sup>)  
 Izz : 207 kgm<sup>2</sup> (153 slug-ft<sup>2</sup>)



Actuators: Low friction hydraulically driven

Platform shape : Triangular

Platform size : 0,71 x 0,62 m (28" x 24")

Drive electronics : PC based

220 VAC / 50Hz (120 VAC/ 60Hz), 0,25 kW.

Ethernet or RS232 connection.

Update rate from 30 / 50 or 60Hz.



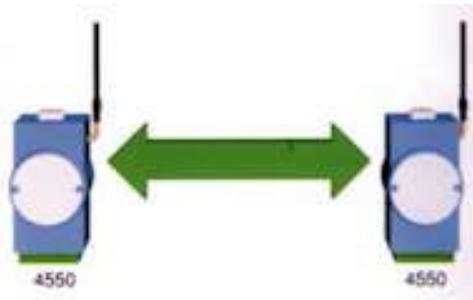
\* **I-glasses Virtual I/O-System** *needed:2*

3D-Video-glasses, PC-VGA-interface (640x480x256),

head-motion-tracker, RS232-interface

\* **Pentium PC for motion control**

\* **ADAM-4550 Funkmodem** *needed:2*



2,4 GHz Band, 100 mW, max. 200 m, RS-232 / RS-485 interface, up to 248 clients, Direct Sequence Spread Spectrum Modulation (DSSS)

bandwidth: 22 MHz (1 channel), data rate max. 115,2 kbps

handshake: Xon/Xoff, RTS/CTS, supply: +10 VDC bis +30 VDC, max. 4 W

\* **Multimedia-Projector** 3M MP 7630 *needed:1*



2,3 kg, 800 ANSI lumen, SVGA-mode (800 x 600 pixels)

weight 2,3 kg, DLP (B x H x T) 198 x 65 x 245 mm.

### 3. WashingRobot mobile Perception Unit

\* **Farb- PRINT-CCD- VIDEOCAMERA** 3,6 mm *needed: 4*



1/3" Chip 500x582 (291.000) Pixel; 0,5  
Lux/F2.0; Gamma=0,45; 12 VDC; 110 mA;  
Autoshutter 1/50-1/100.000, 49x49x40 mm BxHxT



\* **GigaLink radio-videotransmissionset** *needed:5*

\* **EZ-COMPASS-3 / MAGNETOMETER rev-2** *needed:1*





Pitch / Roll / Temperature compensated COMPASS / MAGNETOMETER system  
 standard RS-232 and RS-422 interfaces. 0-360 deg, continuous, 12 bit,  
 1 deg accuracy, pitch & roll range: -70 - +70, 300-38400 baud, 8,N,1,  
 supply: 5 VDC, size 2"W x 2.5"L x 1.0"H PCB Board

\* **PIC or Basic Stamp Microcontroller** *needed: 1*

16 Digital I/O-Pins, 2048 EEPROM bytes, 136 RAM bytes,  
 RS232- serial programming interface, 50 MIPS, supply: 5 Vdc

\* **Servo-Controller-Board** *needed:1*

8 Servo-outputs, RS232- communication input, supply: 6 Vdc

\* **Lego-Mindstorms Mobile Robotics Platform** *needed:1*

\* **Lego-Mindstorms Accessory-Kit** *needed:3*

### 3. Perception Park / Landscape

**LCD-Monitor LCM-445** *needed:10*



20-cm-TFT-LCD, 112 000 Pixel, PAL-TV system, cinch-video-input,  
 Supply: 400 mA/12 V, 410 g, (B x H x T) 149 x 134 x 40 mm

**Video Player** *needed:5*

#### **Materials for Basic Landscape**

Bühnenelemente, Stahl- und Holzkonstruktionen,  
 Beleuchtungskörper, Modelliermasse,  
 Bebauungsmaterialien

