LiveTrack-AV for fMRI

1.0

Installation Manual

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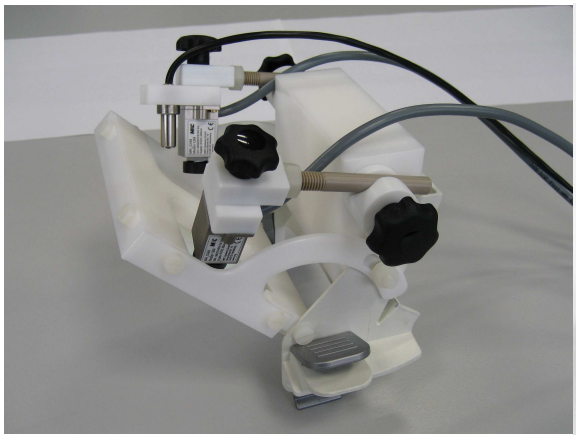

Version	Date	Changed by:	Description of Changes
1.0	1/6/2012	E.Wallington	First issue

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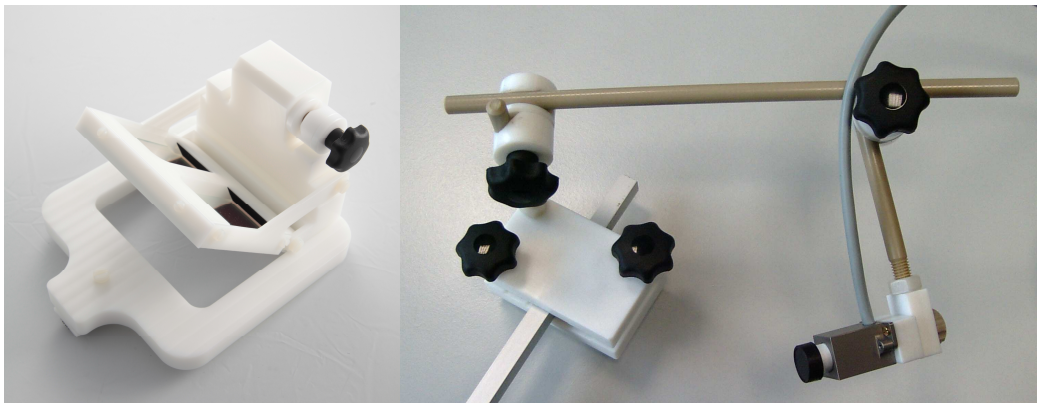
Parts List (items for use in magnet room)

Headcoil mount



The head-coil mount fits the camera to the head-coil (specific to particular head-coil and scanner, example on the left). Alternatively a "universal" camera mount is available (picture on right).

MRI compatible camera and 12mm lens

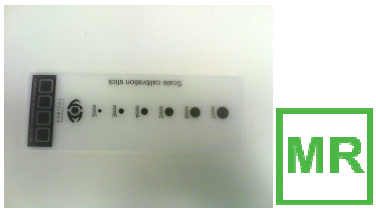
This is a type B device for use in the patient environment. It is internally fitted with a infra-red filter.

The camera lens is usually supplied fitted to the camera.

Camera cable

This extends the camera cable to connect to the filter box.

Pupil calibration stick –



used to calibrate the pupil area

Parts List (items for use OUTSIDE magnet room)

Camera filter box

The filter box MUST be fitted into the penetration panel of the magnet room, from the control room side.

LiveTrack DSP box–

the actual eye-tracker! This small box connects between the camera filter box and the host computer.

Camera power supply–

this connects to filter box and is located in a suitable wall socket in the control room. This is a special low leakage current power supply to EN60601.

BNC video lead

connects from the filter box to the LiveTrack DSP box.

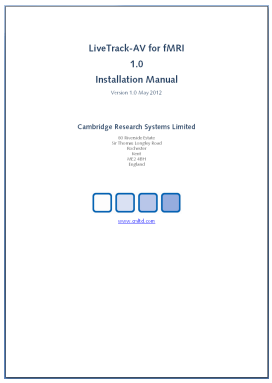
Trigger input lead (BNC to SMA)

connects from the stimulus generator to the LiveTrack DSP box.

USB cable

connects from the LiveTrack DSP box to the host computer.

Instructions



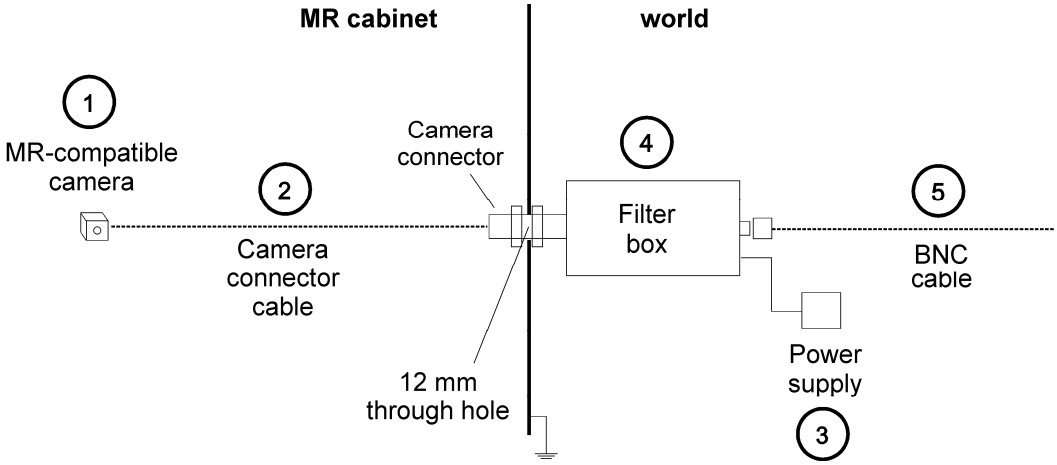
The printed version of these instructions

Introduction

Overview

LiveTrack-AV for fMRI provides a 60Hz eye-tracking solution for experiments utilising an MRI scanner. A miniature shielded video camera, with integrated 940nm NIR illumination source, plus a bespoke mirror mount, enable eye-tracking without distracting from the visual stimuli.

The camera connects via a filter box that must be permanently installed in the penetration panel of the magnet room. The filter box provides several vital functions: It prevents interference coupling into the scanner. It prevents RF leakage from the scanner. It provides safety isolation of the camera (EN60601 type B) from the computer equipment in the magnet room (which will have higher leakage currents not permitted in the "patient environment"). Consult your maintenance organisation for installation of the filter box in the penetration panel.



In the AV for fMRI version, there is one video camera and one or two DSP boxes per eye (depending on the host operating system). So a full system would comprise two video cameras and four DSP boxes.

The DSP box is located in the control room and connects to the host computer via a USB 2.0 connection. No power supply is needed for the DSP box, it receives its power from the host computer via the USB connection.

The host computer is only used for stimulation, control and to receive results, the actual eye-tracking is done by the DSP box.

How it works

Image Capture

The 940nm LED light is embedded in the camera housing. The distance to the lens is chosen in order to avoid undesired shadowing effects.

The image of the eye formed by the lens is captured by a built-in CMOS image sensor.

Image Processing

The LiveTrack device takes the frame and subjects it to on-board image processing to locate the Pupil and glint (the glint is a first Purkinje Image).

USB interfaces

The USB connection is configurable, and provides four different interfaces to the host computer over the single USB lead. It is compatible with all major operating systems.

1) Mass storage interface. This is used for initial configuration of the eye-tracker and for system upgrades.
2) Virtual serial port ('CDC interface'). This is the easiest way to control and get results from LiveTrack.
3) HID class interface. The LiveTrack emulates a Joystick device. Compatibility varies between different host software packages and operating systems.
4) Video feed (camera view). Used to align the camera to the subject.

Synchronisation

LiveTrack has a trigger input, which should be connected to a suitable output of the stimulus generator. This enables the eye-tracking results to be synchronised perfectly with the experiment.

Installation

Filter box

The filter box includes a low pass filter that suppresses frequencies higher than 1 MHz with over 100 dB. This filter prevents damage and interferences caused by the high frequency signals of the MR scanner. In addition, the filter box includes an optical isolation of the video signals. In that way a full separation of the MRI equipment from the external power network is guaranteed.

The filter box should be screwed onto the penetration panel board by means of the feed through camera connector.

- A 12 mm through hole in the penetration panel is required.
- The camera connector is guided through this hole from the control room side.
- The camera connector provides the ground connection to the shielding of the MR cabinet. The penetration panel around the camera connector must therefore provide good electrical contact. The area should therefore be free from paint or oxidisation and the clamping nuts on the connector must be done up tight.

Power supply

The camera power supply should be connected to a suitable wall socket IN THE CONTROL ROOM near to the penetration panel. DO NOT locate the power supply in magnet room. Plug the low voltage DC lead from the power supply into the filter box (see below). The power for the camera is then transmitted via the video cable. Next to the video connector is a green LED which shines when the device is powered.

Livetrack

Connect the LiveTrack DSP box to the VIDEO OUT of the filter box with the video BNC lead.

The USB lead goes from LiveTrack to a spare USB socket on the host computer, but see the section on setting up the host computer before attaching this lead.

Connect the trigger lead from LiveTrack to a TTL level trigger output from the stimulus generator (use the trig out BNC if using a Cambridge Reseach Systems Visage or Bits# system.

Note: We recommend connecting the isolated scanner trigger to the stimulus generator, rather than to LiveTrack, as this provides the lowest latency for control of the stimulus.

Camera and illuminator

Fix the camera(s) into the head-coil mount whilst in the control room. Do not take screwdrivers into the magnet room for obvious reasons!!

Start by fitting the lens to the camera (if not already fitted). The lens is connected to the standard **M12 mount** in the housing.

The camera then mounts with two small brass screws typically on to a arm on the head-coil mount. Once the camera is fixed to the arm, then fix the arm on to the head-coil mount.

You can then slowly take the assembly into the magnet room. The head-coil mount typically clips or clamps on to the head-coil (depending on the version).

Then attach the camera cable to the short pre-attached cable on the camera. The device is connected to the filter box via this extension cable which must be plugged into the **"MR CAM Signal IN"**connector. This connector should be the only part of the filter box on the magnet room side of the penetration panel.

The powering of the camera and the LED is arranged via the filter box. The camera/LED is connected to the filter box with the shielded camera connection cable which includes the power and the signal lines.

Setting up the control Computer

To access the "mass storage" interface, **hold the button pressed for at least 5 seconds whilst connecting the USB lead** (with a small screwdriver)**.** Connect this way the first time that LiveTrack is used.

The Image above demonstrates the location of the button on a LiveTrack AV system.

With a laptop computer, you may receive a message that there is insufficient power available for the LiveTrack device. LiveTrack requires 500mA to be available from the USB connection. In this case try (in this order):

1. A different USB socket on the laptop.
2. Connecting the laptop to its mains charger.
3. Or finally connect LiveTrack by a powered USB hub.

Apple OSX

Due to a deficiency of the operating system, Apple computers running OSX are not compatible with the CDC interface being active simultaneously with any of the other interfaces (to be technical, OSX does not support interface association descriptors for a CDC interface, which is necessary for a composite USB device). It is therefore possible to choose between CDC only or video and HID interfaces. The all interfaces option will not function under OSX.

Microsoft Windows (all versions)

To connect a *new* device to Windows, an **".inf" file is needed** (some device classes are already "known" to the operating system, for LiveTrack only the Mass storage interface falls into this category). The required ".inf" files for the other interfaces are located on the LiveTrack drive.

So when LiveTrack is connected to the Windows computer for the first time, **copy the ".inf" files from the drive to the computer.**

Configuring LiveTrack and interfaces

To set which USB interfaces are active, edit the **config.xml** file located on the LiveTrack device. You can edit this file with any suitable text editor (for instance Notepad on Windows, or TextEdit on OSX).

The following combinations of USB interfaces are supported:

CDC only: For use with OSX as detailed previously.

UVC + HID: Alternative configuration for use with OSX.

UVC + HID + CDC: Typical setting for Microsoft "Windows" and "Linux" operating systems.

Set **TrackLeftEye** to '1' and **TrackRightEye** to '0'. Due to physical constraints in the scanner bore, it is only possible to track one eye with each camera and Livetrack DSP box. The **GrabRate** should always be set to "FIELD" which will give you 60Hz results.

VideoOverlay and **FrameCounter** can be enabled or disabled as desired. However note that if the overlaid frame counter is disabled, there is no other means of reconciling the eyetracking results with the video frame.

numberOfGlints should be set to 1, as there is only one glint source.

The default calibration matrices can be left as they are. You may after some experience with the unit wish to update these with values from your particular setup, though it is recommended that a calibration is performed at the start of each experiment.

Once you have finished editing the Config.xml file, exit the text editor (saving the file when prompted). The status LED will light up to indicate activity (the drive is rather slow, compared to other USB drives you might use).

Once the status light has gone out, eject the drive, then re-boot the LiveTrack box by disconnecting the USB lead, waiting for 2 seconds, then reconnecting it. Do not press the push button this time.

When editing, saving or deleting files on the LiveTrack system, an orange light next to the USB input will be illuminated. The device should only ever be unplugged or reset if this light is off. Any cycling of power while the light is illuminated could result in corrupted data.

Note that the operating mode of LiveTrack requires an active video input. Livetrack will not start if the camera is not connected and switched on.

Aligning the video camera

Viewing the video image

For Windows XP the camera image can be view directly from explorer. A "video device" icon will appear if Livetrack is connected. For later versions of Windows there are many 3rd party apps for video devices. We have used an application called "Amcap", but there are plenty of others.

For OSX the standard Apple applications like Facetime or Photo Booth can be used to view the video stream.

Our recommended software platform for use with LiveTrack is MATLAB (or Octave) with PsychToolbox. This provides a consistent interface between different host computer platforms.

Assuming the computer has Psychtoolbox installed and LiveTrack is connected (with the camera connected and powered), type:

>>**PsychSetupCamera**

After a few seconds the video image should appear overlaid on the top left corner of the computer screen.

The intensity of the LED light can be adjusted by means of a potentiometer at the filter box.

Focusing the video image

If the eye is blurry then the image can be adjusted by twisting the lens to adjust the focus.

When focusing, the important feature is the pupil. Do not make the mistake of trying to focus on the eye-lashes or the illumination glint, as these are both in quite different focal planes to the pupil.

The other focusing clue that can be used is the structure visible in the iris.

The images in the near infra red do look quite "soft" compared to visible light images. This is quite normal.

Once focus has been achieved (and assuming video overlay is on), a white ellipse should be shown over the pupil iris boundary. There will also be a black circle around the glint. These indicate that tracking has successfully locked on.

Safety

The MRI scanner should only be used by suitable qualified personnel aware of the risks involved. National regulations and guidelines should be followed. Follow all safety instructions from the MRI scanner manufacturer.

Life support applications

LiveTrack should NOT be used in situations where failure of the device, or failure of eye-tracking, would constitute a hazard. It is designed for research applications only, and like any other regular electronic device could fail at any time, without warning.

Photo Sensitive Epilepsy

Any system capable of creating flashing images can potentially induce photo sensitive epilepsy in susceptible individuals. Experiment design should take this risk into account.

http://www.hardingfpa.co.uk/resources/photosensitive-epilepsy-pse/

Cleaning

Clean external components of LiveTrack with a damp cloth only. Do NOT allow fluids to enter any of the LiveTrack components. Do not sterilise in an autoclave.

Take special care when cleaning the camera's lens. Use only a clean lens tissue or lens brush.

The camera is not specially protected against splash water. It should only be used in dry environments. If moisture is entrapped into the housing a short circuit can occur leading to a damage of the electronics.

Servicing

DO NOT ATTEMPT TO DISMANTLE LiveTrack or the camera. It contains no user serviceable components, refer all servicing to Cambridge Research Systems.

Optical Hazard

Do not shine the LED directly into the eye from a small distance. We recommend to use the lowest power required for tracking and to keep a distance of 10 cm to the eye. Disconnect from mains whenever it is not in use.

Radio-frequency leakage and electrical safety bonding

The camera housing must be electrically connected to the shielding of the magnet room. The filter box must be permanently installed in the penetration panel to achieve this grounding. Failure to do this would compromise the safety of the patient environment and exposes those outside of the scanner to risk from radio-frequency fields.

Electrical safety

The LiveTrack-AV for fMRI system is supplied with a EN60601 approved power supply for use with the filter box and MRC camera. Do not substitute a different power supply as this will invalidate the safety approval of the system. Do not connect the power supply to a voltage or frequency outside of its stated range.

Magnet hazards

Due to the metallic housing the camera can be attracted and accelerated by the MRI scanner during a quench of the super-conducting magnets. Therefore the camera should be mounted to a fixed object, whenever it is brought into the magnet room.

The camera should not be moved fast in the environment of the MRI scanner. The movement can generate eddy currents leading to unforeseeable forces.

A stable attachment is required, whenever the camera is mounted above a person to make sure, that the camera cannot fall down onto this person.

Only the camera / head-coil mount assembly and camera cable are safe for use in the magnet room.

DO NOT take the DSP box, filter box, or power supply into the magnet room. These items are MR-unsafe.

Radio-frequency heating

The metallic housing and the cables of the camera can absorb energy from the electromagnetic fields of the MRI scanner. This absorption can lead to heating of the housing. The heating level depends on the orientation of the camera and its cables relative to the MRI scanner and on the imaging sequences used. Therefore the temperature of the camera should be checked before it is touched and no inflammable objects should be attached to the camera.

The camera is tested with different orientations of housing and cables. However, it is not possible to check all possible situations which might occur in different applications. The cables can act as antennas and disturb the sensitively adjusted fields of the MRI scanner. If interferences of MR images or video images occur, one should try to change the directions of the cables.

Radio-frequency burns

Whenever metallic parts are used in an MRI scanner there is a residual risk of an electric discharge from this part to the human body. Do not to place the device closer than 10 cm to the subject or the user.

The risk of an electric discharge can be further reduced if the connection cable is guided on a direct way (without loops and without crossing the middle axis) out of the bore.

Do not drop the camera

The device is equipped with sensitive optical components. It should not be dropped from larger heights.

The filter box is only suitable for the Camera “12M-i” with integrated LED. Connecting the standard 12M or CS camera to the filter box will destroy the integrated electronics.

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