

# MRI Compatible Olfactometer

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## Abstract

An olfactometer device is needed to deliver timed increments of odors to a subject during an fMRI scan for psychology research. This device will primarily be used for research purposes in the laboratory of Dr. Vivek Prabhakaran; however, it is potentially marketable to scientists and doctors doing the same type of research.

## Motivation

Olfactometer are available in many olfactory research laboratories, but they are not commercially sold. This device allows the researcher to more accurately perform experiments that require an odor to be delivered to the subject. Currently, the client, Dr. Prabhakaran is using small sticks to deliver odor in timed increments to the subject. This method of performing olfactory experiments is extremely inaccurate, and a better method of delivering odor is needed.

## Background

### fMRI Imaging

Blood oxygen level dependent (BOLD) functional magnetic resonance imaging (fMRI) is used to monitor brain activity. The fMRI measures the oxygen delivered to neurons by hemoglobin. This difference in detection of oxygenated and deoxygenated hemoglobin allows the fMRI image to display the brain's neural activity. The activity is recorded on a map of the brain that shows where the brain activity is increased during a stimulus, such as an odor. Simple experiment alternating between a visual stimulus and dark every 30 s creates an activation map (Fig. 1).

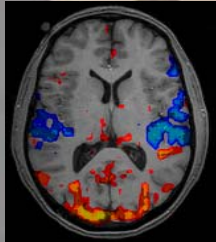


Figure 1: Activation Map of a simple fMRI experiment [1]

### Olfaction Research

Olfaction is a relatively new field, although there are some very important discoveries being made in this line of work. Alzheimer's disease could be diagnosed earlier by a loss of the sense of smell. Also, obesity studies have shown that the sense of smell is closely linked to the sense of taste, and olfaction researchers are discovering new treatment methods for this. Moreover, in patients who are going through cancer treatments, the delivery of pleasant odors during treatment procedures has proven to relax the patient. The perfume industry also uses olfactory methods to determine if a scent is pleasant to people before marketing the perfume.

### fMRI Olfactometer Experiment

The odor delivery will imitate a pulse waveform pattern (Fig. 2).

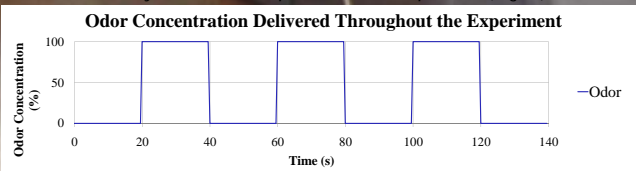


Figure 2. Waveform of Olfactory Experiment

## Product Design Specifications

- Constant humidity and temperature
- 4+ odor canisters
- Must have computer interface compatible with EPRIME
- Easily portable, must weigh less than 15 kg
- Must fit within limited table space (1 m x 1 m)
- Must present odor for controllable amount of time
- Must have ability to control the flow rate and air pressure
- Easy to set up
- USB Connection
- Must be able to go to the no-odor condition in under one second
- Must be compatible with the "active sniffing" technique
- Must be able to determine when odor reaches subject

## Final Design

### Electronics

Power Supply:

- AC/DC Converter

Switches:

- Switch & Sense 8 (Power Relay Board)
- Manual pushbutton switches (With LED indicator)

Solenoid Valves:

- 12 VDC, 2.6 W power consumption

Figure 3. Block diagram of current flow

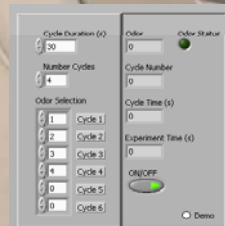
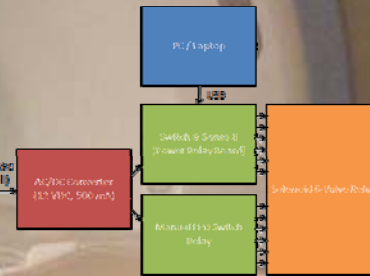


Figure 4. Program interface

### Program

LabVIEW required, interfaces with Switch & Sense 8 via USB

User Controls:

- Odor Selection
- Cycle Duration
- Number of Cycles



Figure 5. Olfactometer Prototype

## Testing

- Tested the LabVIEW program to ensure the valves opened at the correct intervals
- Tested the manual switches to ensure the valves open when the correct switch is on
- Tested to ensure air flow followed correct path

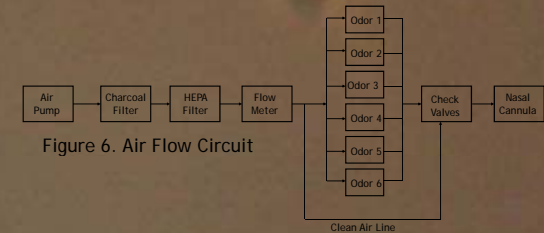


Figure 6. Air Flow Circuit

## Future Work

- Use a check valve system to be able to send the odors through a cannula
- Synchronize the LabVIEW program with EPRIME software
- Test the efficiency of odor delivery based on the response of the brain using fMRI
- Cut the 1/8" Teflon tubing to appropriate sizes for the MRI scanner
- Develop precise temperature and humidity control
- Create a system to send the odors to a closed mask
- Construct a lid for the tray to prevent damage to the components
- Improve aesthetics of the design

## Cost Analysis

Item	Price
6-way solenoid valves	\$498.00
Switch and Sense 8	\$299.00
HEPA-VENT capsule	\$55.00
Flow meter (direct read)	\$40.00
OmniFilter R200	\$9.42
Elite 801 air pump	\$6.49
Other parts	\$289.76
<b>TOTAL:</b>	<b>\$1197.67</b>

## References

[1] <http://www.fmrib.ox.ac.uk/education/fmri/introduction-to-fmri/what-does-fmri-measure>

## Acknowledgements

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