# Data Fusion for Laryngeal Studies

## Aim

The aim of this chapter is to discuss the design and development of a system for merging, displaying, storing and post processing of anatomical, physiological, and audio data from multiple acquisition channels.

The key objectives of this chapter are:

1. Design and develop a system to merge anatomical data, physiological data and audio data during sleep apnea and UARS
2. Design and develop a system to display anatomical data, physiological data and audio data during sleep apnea and UARS into one monitor screen
3. Design and develop a system to store anatomical data, physiological data and audio data during sleep apnea and UARS display on one monitor screen
4. Design and develop a system and software tool to post process anatomical data, physiological data and audio data stored during sleep apnea and UARS for diagnosis.

## Clinical Problem

### Sleep Apnoea Studies

Sleep studies is an important clinical studies required to determine diagnose the severity of a patient’s sleep apnoea and recommend the most appropriate treatment which includes surgery. Sleep apnoea studies in Chelsea and Westminster Hospital are done by Mr Collier Jonathan and Dr Suveer Singh.

During the studies, there are

* Two video displays for the sleep endoscopy
* Two video display for anaesthetic monitoring
* A sleep physiological monitor system

### Upper Airway Resistance Syndrome Studies

A continuous laryngoscopy during exercise studies is required for studying unexplained hypoxemia and diagnosing upper airway problems during exercise.

These studies are carried out by Dr James Hull at Royal Brompton Hospital.

During the studies, there are

* One video display from the laryngoscope
* One video display for exercise monitoring
* One audio input from a microphone

### General Problem

The problems with the both studies set up are:

* 1. Data are independently displayed
  2. Data are independently stored in different systems
  3. Data are independently retrieved for post processing analysis
  4. Data are don’t synchronised in time

### Proposed solution

* A proposed solution will be to have one system that will
  + 1. Merge all the data
  + 2. Display all the data on screen
  + 3. Store all the data simultaneously
  + 4. Automatically synchronise the data in time.
* However, we will start by combining different systems to achieve the solution proposed above

## System Architecture

*S-Video*

*VGA*

*VGA*

**VGA Splitter**

*VGA*

*VGA*

**Picture in Picture System**

*VGA*

*VGA*

*DVI*

**Monitoring System 1 (laryngoscope)**

*VGA*

**Monitoring System 2**

**(physiology sensors)**

*S-Video*

**S-Video to VGA Converter**

*S-Video*

*VGA*

*VGA*

**Display Monitor**

**S-Video Splitter**

*S-Video*

*S-Video*

*S-Video*

**Clinic Display Monitor**

**VGA Splitter**

*VGA*

*VGA*

**Clinic Display Monitor**

**DVI to HDMI Converter**

*DVI*

*HDMI*

**Game Recorder**

*HDMI*

*HDMI*

**HDMI to VGA Converter**

*HDMI*

*VGA*

**Microphone**

*Audio In*

*Audio Out*

**Data Time Synchroniser**

*VGA*

*VGA*

Figure 13: System design for merging and displaying anatomical and physiological data on one display screen (UARS set up)

M

*DVI*

*DVI*

*DVI*

**VGA Splitter**

*VGA*

*VGA*

**Picture in Picture System**

*DVI*

*VGA*

*DVI*

**Monitoring System 1**

*DVI*

**Monitoring System 2**

*DVI*

**DVI to VGA Converter**

*DVI*

*VGA*

*VGA*

**Display Monitor**

**DVI Splitter**

*DVI*

*DVI*

*DVI*

**Clinic Display Monitor**

**DVI Splitter**

*DVI*

*DVI*

**Clinic Display Monitor**

**DVI to HDMI Converter**

*DVI*

*HDMI*

**Game Recorder**

*HDMI*

*HDMI*

**HDMI to VGA Converter**

*HDMI*

*VGA*

**Microphone**

*Audio In*

*Audio Out*

**Data Time Synchroniser**

*VGA*

*VGA*

Figure 14: System design for merging and displaying anatomical and physiological data on one display screen (Sleep Apnoea set up)

### System Architecture Overview

This section of the report gives an overview of the system architecture for merging, displaying, recording, and synchronising anatomical, physiological and audio data during clinical studies (in real time). The system architecture will focus on sleep apnoea studies carried at Chelsea and Westminster Hospital and Upper Airways Resistance Studies at Royal Brompton Hospital

**Upper Airway Resistance system**

**Current System**

*Monitoring System 1 – Upper Airway*

A laryngoscope is used to monitor the movement in the upper airways during continuous laryngoscopy during exercise (CLE) test. The laryngoscope is connected to a medicapture system for data transmission to a clinical monitoring via s-video connection.

Laryngoscope

MediCapture

Clinical Monitor

Figure 15: Continuous Laryngoscope during exercise system – Upper Airway data

*Monitoring System 2 – Physiological and Flow Sensor Monitor*

A physiological monitor to capture the heart rate and oxygen level and a flow sensor is used to capture flow rate during CLE test. The sensors are connected a desktop computer via a data transmission module. The desktop computer is connected to clinical monitor via VGA connection.

Physiological Sensors

Data Capture System

Clinical Desktop

Flow Sensors

Clinical Monitor

Figure 16: Continuous Laryngoscope during exercise system – Physiological and Flow data

**Sleep Apnoea Studies**

### Graphic Display Interface Format

**DVI**

**VGA**

**S-VIDEO**

**HDMI**

### Audio interface Format

Composite Video

Mono

### Video Capture System -

### Picture to Picture System