Chapter 1 – Abstract

# Background

Understanding the why, how, and what of sleep in humans is a very complicated, complex, and challenging. One of the abnormalities developed in sleep in humans is sleep apnea. Sleep apnoea is associated with the cessation of breath during sleep for at least 10 seconds.

# Objectives

The objectives of this chapter are to provide the reader with an overview of:

1. Sleep
2. Sleep architecture
3. Sleep apnoea
4. Sleep apnoea monitoring
5. Current challenges in sleep apnoea monitoring

# Method

The objectives of this chapter will be achieved by done a detailed systematic literature review.

# Results

At the end of the chapter, the reader should have an appreciation of

1. Sleep
2. Sleep architecture
3. Sleep apnoea
4. Sleep apnoea monitoring
5. Current challenges in sleep apnoea monitoring

# Conclusion

Sleep and sleep apnoea is a very broad, complex, and fascinating subject matter that needs more research and innovation

Chapter 2 – Clinical Requirements

# Problem

As highlighted in chapter 1, currently there is no home based intra oral system for capturing the airway dynamics during sleep apnoea for clinical diagnosis of sleep apnoea.

# Objectives

The objectives of this chapter is to specify the specification of a home based intra oral sleep apnoea system for clinical diagnosis of sleep apnoea

# Method

In order to achieve the chapter objective, the following aspect of a home based oral sleep apnea system was evaluated:

1. Camera size
2. Megapixel count
3. Image quality
4. Shutter lag
5. Weight
6. Design
7. Zoom lens
8. Image stabilisation
9. Raw mode
10. Manual focus
11. Storage
12. Battery life
13. Wireless features
14. Camera holder

# Results

10 key parameters have been specified for a home based intra oral sleep apnoea system for clinical diagnosis of sleep apnoea

# Conclusion

The design and development of a home based intra oral sleep apnoea system for clinical diagnosis of sleep apnoea must achieve 10 key design parameters.

Chapter 3 – Single Intra Oral Camera System

# Problem

As highlighted in chapter 1, one of the major challenges in home sleep apnoea monitoring is a lack of anatomical data on the dynamic changes in the airway of sleep apnoea patient. This means sleep physicians and surgeons cannot adequately properly plan surgical intervention for patients with severe sleep apnoea.

# Objectives

The objectives of this chapter are to:

1. Design a system architecture for a single camera system
2. Develop a prototype of a single intra oral camera system
3. Test the prototype of a single intra oral camera system in different mouth configuration
4. Report on the testing done in Objective 3
5. Discuss and conclude on the findings

# Method

1. A dental impression of the upper teeth of the patient’s mouth is obtained to capture the anatomical structure of the teeth.
2. A 7mm mini USB endoscopic video cameras is attached to the customized denture.
3. The camera is connected to a laptop to capture the airway dynamics during sleep.
4. A data system is used to merge, synchronize, display and store anatomical and physiological data

# Result

To be created ☺

# Conclusion

An intra oral single camera system can capture the airway dynamics during natural sleep for sleep apnoea patients for up to 8 hours which is not currently clinically possible. The next step is to clinically validate and improve our system.

Chapter 4 – Double Intra Oral Camera System

# Problem

As highlighted in chapter 1, one of the major challenges in home sleep apnoea monitoring is a lack of anatomical data on the dynamic changes in the airway of sleep apnoea patient. Although a single intra oral camera system has been proposed in chapter 3, the limitations of the proposed system are:

1. No volumetric changes
2. Limited view angle
3. No stereoscopic vision.

# Objectives

The objectives of this chapter are to:

1. Design a system architecture for a double camera system
2. Develop a prototype of a double intra oral camera system
3. Develop a volumetric change software
4. Develop a stereoscopic vision software
5. Test the prototype of a single intra oral camera system in different mouth configuration
6. Report on the testing done in Objective 3
7. Discuss and conclude on the findings

# Method

1. A dental impression of the upper teeth of the patient’s mouth is obtained to capture the anatomical structure of the teeth.
2. Two 7mm mini USB endoscopic video cameras is attached to the customized denture.
3. The camera is connected to a laptop to capture the airway dynamics during sleep.
4. A data system is used to merge, synchronize, display and store anatomical and physiological data

# Results

To be created ☺

# Conclusion

A double intra oral single camera system can capture the airway dynamics during natural sleep for sleep apnoea patients for up to 8 hours which is not currently clinically possible. The next step is to clinically validate and improve our system.

Chapter 5 – Merging Sleep Studies Data

# Problem

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

1. Two video displays for the sleep endoscopy
2. Two video display for anaesthetic monitoring
3. A sleep physiological monitor system

The problems with the 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

# Objectives

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.

# Method

Later ☺

# Result

Later ☺

# Conclusion

The problems with the clinical 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.

The proposed system design can:

1. Data can be displayed on one screen.
2. Data are stored on one system
3. Data can be retrieved easily for post processing analysis.
4. Data can be easily synchronised in time

Chapter 6 – Merging Laryngeal Studies Data

# Problem

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

1. One video display from the laryngoscope
2. One video display for exercise monitoring
3. One audio input from a microphone

The problems with the 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

# Objectives

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.

# Method

Later ☺

# Result

Later ☺

# Conclusion

The problems with the clinical 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.

The proposed system design can:

1. Data can be displayed on one screen.
2. Data are stored on one system
3. Data can be retrieved easily for post processing analysis.
4. Data can be easily synchronised in time

Chapter 7 – Conclusion

# Summary of results

# Errors and limitations

# Future work and recommendations