课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	医学大数据 Medical Big Data
2.	**授课院系 Originating Department**	生物医学工程系 Department of Biomedical Engineering
3.	**课程编号 Course Code**	BMEB331
4.	**课程学分 Credit Value**	3
5.	**课程类别 Course Type**	专业核心课 Major Core Courses
6.	**授课学期 Semester**	春季 Spring
7.	**授课语言 Teaching Language**	英文 English
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师） Instructor(s), Affiliation& Contact （For team teaching, please list all instructors）**	王文锦，生物医学工程系 wangwj3@sustech.edu.cn
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填) Maximum Enrolment （Optional）**	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
学时数 Credit Hours	32		32		64

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	无 None
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	无 None
14. 其它要求修读本课程的学系 Cross-listing Dept.	无 None

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

医学大数据是智能医学工程专业的重要专业必修课。本课程分为理论课和实践课，理论课将重点介绍医学健康数据处理的理论、方法和前沿进展；实践课将通过嵌入式编程强化学生对理论的掌握和应用。课程要求学生独立研发一套的智能健康监测系统以训练其专业核心能力，包括信号和图像数据处理、机器学习算法、C/C++嵌入式编程。理论课将分为两个阶段，第一阶段介绍视频传感器和嵌入式芯片，信号和图像处理的原理和方法，机器视觉中和人体健康监测相关的经典问题（检测、追踪、分割、识别）；第二阶段介绍人体生理系统和光学监测生理信息的原理，多维生理参数监测及健康语义识别的经典算法，并同第一阶段内容整合形成知识闭环。通过本课程的学习和项目实践，学生将掌握医学健康数据处理的基本原理和具体方法，掌握构建嵌入式智能系统的核心技能，为智能医学工程的科研奠定基础。

Medical Big Data is an essential course of intelligent medical engineering. The course has two parts: theory and practice. The theory part will focus on the fundamentals, methods and recent advances of data processing related to healthcare. The practice part will strengthen students' capabilities in applying the learned theories to practice by embedded programming. The course demands the students to develop an intelligent health monitoring system on an embedded chip independently, building up their core competence such as signal and image processing, machine learning and C/C++ programming. The theory part includes two stages: the first stage introduces the basics of camera sensors and embedded systems, signal and image processing, classical methods in machine vision that are related to health monitoring (detection, tracking, segmentation and recognition); the second stage introduces the fundamentals of human physiology and optics, the classical algorithms in physiological measurement and semantics, which will construct a closed-loop with the first stage. Based on the learning and practicing in this course, students will master the principles and major approaches in health-related data processing, be familiar with the construction of embedded intelligent system, and establish a solid basis for research in the future.

16. 预达学习成果 Learning Outcomes

1. 深入学习并掌握数据处理的理论和方法，了解医学大数据领域的前沿发展及研究热点。培养学生的自主学习意识和科研思维。
2. 掌握机器视觉的基本理论和经典算法，包括目标检测、追踪、识别、分割。
3. 掌握人体生理系统和光学监测的理论，深入了解光学-生理监测的算法和关键技术。
4. 掌握嵌入式编程和智能系统的研发过程，独立实现一套嵌入式智能生理监测系统，展示研究及学习成果。
5. 培养项目管理和科研推进的思维。
6. 通过英语教学，培养学生的专业英语能力，掌握课程核心词汇，能够阅读英语专业文献。

1. learn the fundamentals and methods of data processing, be familiar with the recent advances in health informatics, shaping a mindset for self-learning and researching.
2. learn the basics and classical methods in machine vision, including object detection, tracking, recognition and segmentation.

3. learn the basics of human physiology and optics, be familiar with the algorithms and approaches for optical based physiological measurement.
4. learn the embedded programing and construction of intelligent systems, develop an embedded intelligent health monitoring system independently, and prototype the results.
5. train the mindset for project management and R&D.
6. train the capability of reading and learning in English.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

第 1 章 绪论

理论课（2 学时）：介绍医学健康数据处理的基本概念、发展状况和未来趋势，课程设置和所需软硬件准备工作）

实验课（2 学时）：准备软件和硬件，安装实验课所需的程序，配置实验环境

第 2 章 视频传感器和嵌入式系统

理论课（2 学时）：介绍视频传感器的基本原理和嵌入式系统的特点

实验课（2 学时）：练习视频传感器的嵌入式使用，搭建视频处理框架

第 3 章 信号处理和图像处理基础

理论课（2 学时）：介绍信号处理和图像处理的基本概念，智能健康监测系统的整体框架

实验课（2 学时）：练习基本的信号处理和图像处理算法（滤波，降维，分割，基本的矩阵运算等

第 4 章 目标检测

理论课（2 学时）：介绍在视频图像中自动检测目标的原理和经典方法，包括机器学习的基本概念

实验课（2 学时）：实现 2-3 种目标检测的方法，如物体检测，人脸检测等

第 5 章 目标追踪

理论课（2 学时）：介绍在视频图像中追踪目标的原理和经典方法，包括单目标追踪和多目标追踪

实验课（2 学时）：实现 2-3 种目标追踪的算法，如 correlation filter, discriminative classification, tracking by learning

第 6 章 目标识别

理论课（2 学时）：介绍在图像中识别目标身份的原理和经典方法，包括经典机器学习方法和深度学习方法

实验课（2 学时）：实现 1-2 种目标识别的算法，如人脸识别，字典学习

第 7 章 视频分割

理论课（2 学时）：介绍在对视频图像进行区域分割和语义分割的原理和经典方法

实验课（2 学时）：实现 2-3 种图像/视频分割的算法，如 Kmeans, 谱聚类

第 8 章 展示回和顾（智能视觉系统）

理论课（2 学时）：期中展示初步完成的项目成果，回顾梳理知识点

实验课（2 学时）：展示中期项目成果，解决问题

第 9 章 人体生理和光学监测基础

理论课（2 学时）：介绍人体生理系统和光学监测生理信息的基本原理

实验课（2 学时）：实现生理监测的基本算法框架

第 10 章 光电容积脉搏波

理论课（2 学时）：介绍光电容积脉搏波的基本原理，监测心率、心率变异性的经典算法

实验课（2 学时）：实现 2-3 种脉搏波和心率的监测算法，如生理模型法

第 11 章 血氧饱和度监测

理论课（2 学时）：介绍监测血氧饱和度的基本原理、经典算法、嵌入式实现方式，包括 ratio-of-ratio 法，生理标签法等

实验课（2 学时）：实现 1-2 种血氧饱和度监测算法，如 ratio-of-ratio 法，生理标签法

第 12 章 呼吸监测

理论课（2 学时）：介绍监测呼吸的基本原理、经典算法、嵌入式实现方式，包括光流法、卷积法、脉搏波载波法等

实验课（2 学时）：实现 2-3 种呼吸监测算法，如光流法，卷积法，脉搏波载波法

第 13 章 血压监测

理论课（2 学时）：介绍监测血压的基本原理、经典算法、嵌入式实现方式，包括多波段/多区域脉搏波传导时间法，波形法等

实验课（2 学时）：实现 1-2 种血压监测算法，如脉搏波传导时间法

第 14 章 面部表征和运动特征

理论课（2 学时）：介绍提取面部表征的基本原理、经典算法、嵌入式实现方式，以及同人体健康的关系，包括疼痛、情绪、睡眠等

实验课（2 学时）：实现 1-2 种面部表征的提取算法

第 15 章 运动特征

理论课（2 学时）：介绍提取运动特征的基本原理、经典算法、嵌入式实现方式，包括行为、步态等

实验课（2 学时）：实现 1-2 种运动特征的提取算法

第 16 章 展示和回顾（智能健康监测系统）

理论课（2 学时）：期末回顾梳理知识点

实验课（2 学时）：答辩及展示完整的项目成果

lecture 1: introduction

theory (2 hours): basics, advances and trend in health informatics, prepare the needed software and hardware

lab (2 hours): install hardware and software, prepare the programming SDK

lecture 2: cameras and embedded systems

theory (2 hours): basics of camera sensors and major features of embedded systems and programming

lab (2 hours): learn how to use camera sensors with embedded devices

lecture 3: basics of signal and image processing

theory (2 hours): concepts of signal and image processing, framework of intelligent health monitoring on an embedded chip

lab (2 hours): implement basic signal and image processing techniques (filtering, detrending, matrix operations, etc.

lecture 4: object detection

theory (2 hours): principles and methods for object detection in videos, including basic concepts of machine learning

lab (2 hours): implement 2-3 object detection algorithms

lecture 5: motion tracking

theory (2 hours): principles and methods for object tracking, including single object and multi-objects tracking

lab (2 hours): implement 2-3 motion tracking algorithms

lecture 6: recognition

theory (2 hours): principles and methods for object recognition, including classical machine learning based and deep learning based

lab (2 hours): implement 1-2 object recognition algorithms, e.g. face recognition

lecture 7: video segmentation

theory (2 hours): principles and methods for video segmentation, including different clustering methods and semantic segmentation

lab (2 hours): implement 2-3 image and video segmentation algorithms, e.g. clustering, kmeans

lecture 8: prototypes and reviews I (intelligent vision system)

theory (2 hours): review of lectures

lab (2 hours): prototype the basic system

lecture 9: basics of human physiology and optics

theory (2 hours); basics of human physiological system and optics that measures physiology

lab (2 hours): implement the basic framework for vital signs measurement

lecture 10: Photoplethysmography and pulse

theory (2 hours): contact-based/non-contact optical methods for PPG measurement, including the measurement of HR

and HRV)

lab (2 hours): implement 2-3 PPG extraction algorithms

lecture 11: Blood oxygen saturation

theory (2 hours): Methods for measuring SpO2, including ratio-of-ratio, signature-based, etc.

lab (2 hours): implement 1-2 SpO2 extraction algorithms

lecture 12: Respiration

theory (2 hours): Methods for measuring respiration, including optical flow, convolution-based, PPG-based, etc.

lab (2 hours): implement 2-3 breathing signal extraction algorithms

lecture 13: Blood pressure

theory (2 hours): Methods for measuring blood pressure, including multi-wavelength PTT, multi-region PTT, waveform-based, etc.

lab (2 hours): implement 1-2 blood pressure measurement algorithms, PTT based approaches

lecture 14: Facial attributes

theory (2 hours): Methods to extract facial attributes and body motion features for health analysis, including pain assessment, mode/depression detection, gait, sleep staging, behavior analysis, etc.

lab (2 hours): implement 2-3 methods for extracting facial features

lecture 15: Motion actigraphy

theory (2 hours): Methods for extracting health-related informatics from body motion, including behaviors, gait, etc.

lab (2 hours): implement 2-3 methods for extracting motions related health informatics

lecture 16: prototypes and reviews II (intelligent healthcare system)

theory (2 hours): review and summary

lab (2 hours): prototype and final report

18. 教材及其它参考资料 Textbook and Supplementary Readings

- 爱思唯尔书籍《Contactless Vital Signs Monitoring》 https://www.elsevier.com/books/contactless-vital-signs-monitoring/wang/978-0-12-822281-2
- IEEE-JBHI -2021年特刊收录文献: https://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=9428033&punumber=6221020
- CVPM workshop 2018-2021 (CVPR/ICCV) 收录文献:
- https://openaccess.thecvf.com/CVPR2018_workshops/CVPR2018_W27
- https://openaccess.thecvf.com/ICCV2019_workshops/ICCV2019_CVPM
- https://openaccess.thecvf.com/CVPR2020_workshops/CVPR2020_w19
- https://openaccess.thecvf.com/CVPR2021_workshops/CVPM
- IEEE-TBME, IEEE-JBHI, IEEE-Sensors 核心期刊文献（近三年）
- IEEE-CVPR/ICCV/ECCV, IEEE-EMBC, IEEE-BHI国际会议文献（近三年）

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		10%		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects		50%		
平时作业 Assignments		40%		
期中考试 Mid-Term Test				
期末考试 Final Exam				
期末报告 Final Presentation				
其它（可根据需要改写以上评估方式） Others (The above may be modified as necessary)				

20. 记分方式 GRADING SYSTEM

√ A. 十三级等级制 Letter Grading
☐ B. 二级记分制（通过/不通过） Pass/Fail Grading

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
This Course has been approved by the following person or committee of authority

生物医学工程系教学委员会