NSF Engineering Research Center
for Computer Integrated Surgical
Systems and Technology

601.455/655 (formerly 600.445/645) Computer-Integrated Surgery

Fall Semester 2021

http://www.cs.jhu.edu/cista/455

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WHITING SCHOOL OF ENGINEERING
THE JOHNS HOPKINS UNIVERSITY

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Organizational Information

- **Instructor**
  - Russell H. Taylor (rht@jhu.edu)
  - Emad Boctor (eboctor@jhu.edu)
  - Guest Lectures
- **Class Place & Times**
  - Tuesdays and Thursdays 1:30-2:45
  - 601.455 will meet in Maryland 310
  - 601.655 will meet in Hackerman B17
  - The material will be the same in both sections and instructors may trade off lectures
  - Section times: TBD
- **TA**
  - Maia Stiber (mstiber@jhu.edu)
  - Ben Killeen (killeen@jhu.edu)
  - Office hours and section times: See the course web site (link below)
- **Textbook**
  - Handout Material (on web site)
  - Recommended: *Computer-Integrated Surgery:* (Editors: Taylor, Lavallee, Burdea, Mosges), MIT Press, 1996
- **Office hours**
  - By appointment, but we will usually be available before or after class
- **Web site**: https://ciis.lcsr.jhu.edu/doku.php?id=courses:455-655:455-655
  - Links to lecture notes and homework found here
- **Piazza Page:** piazza.com/jhu/fall2021/601455655
  - Mostly used for class communications and Q&A
- **Blackboard Page:** Follow link for EN.601.455.01.FA21
  - Non-public links; pointers to video recordings; etc.
- **Gradescope:** Students will submit assignments on Gradescope (gradescope.com)
  - The course entry code is 6P53RJ

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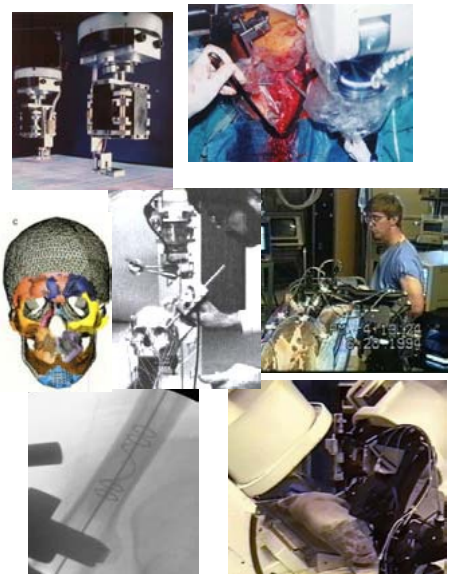
A short personal background: Russ Taylor

- **1970: BES from Johns Hopkins**
- **1976: PhD in CS at Stanford**
- **1976-1988: Research/mgt in robotics and automation technology at IBM**
- **1988 - 1995: Medical robotics & computer-assisted surgery at IBM**
  - Robodoc
  - Surgical navigation
  - Robotically assisted MIS and percutaneous interventions (with JHU)
- **1995: Moved to JHU**
  - CS with joint appointments in ME, Radiology, Surgery
  - X-ray guided MIS & orthopaedics
  - "Steady Hand" microsurgery
  - Radiation therapy
  - Modeling & imaging
  - Etc.
- **1995 - 1996: NSF ERC Proposal**
- **1997 - now: NSF ERC Director**
- **2013 – now: LCSR Director**



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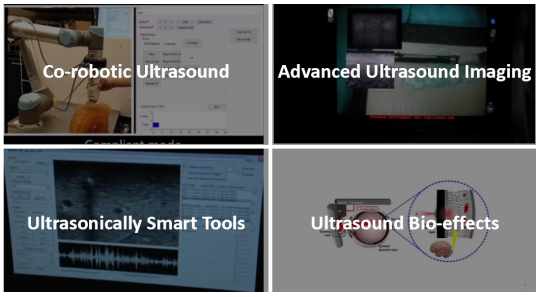
A short personal background: Emad Boctor



- Emad Boctor received Master's and Doctoral degrees in 2004 and 2007 from the Computer Science Department of Johns Hopkins University.

- In 2007, he joined both The Russell H. Morgan Department of Radiology and Radiological Science and the Whiting School of Engineering, where he initiated a research program in the field of advanced ultrasound imaging.

- Since 2009, founder and director of the Medical Ultrasound Imaging and Intervention Collaboration (MUSiiC) research laboratory.

- Dr. Boctor's research focuses on brain imaging, early detection of aggressive cancer, and image-guided therapy and surgery, a subject in which he has authored and co-authored over 78 peer-reviewed manuscripts and 150 conference articles, has filed more than 40 pending and issued patents, and has been recognized with numerous awards and fellowships including the National Science Foundation CAREER award.

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Overview of the CIS Course Sequence

- **601.455/655 (Fall)**
  - Goal is to provide overview of basic techniques & applications and to provide background for subsequent research
  - Lectures + homework + programming
  - Optional “project” is usually a report and plan for subsequent implementation project
- **601.456/496/656; 601.452 (Spring)**
  - Combination advanced seminar + lectures + student team projects
  - Emphasis on student projects + project management + presentation skills
  - 601.452 is same course without the project

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601.455/655 Course content

- Basic concepts of computer-integrated surgery
  - Image segmentation, registration, modeling
  - Robotics
  - Safety
  - Human-machine interfaces
- Application case studies
  - Lectures by clinicians & systems implementors
- Outcomes and economic analysis
- Other topics of interest
  - E.g., regulatory affairs

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601.455 vs 601.655

- 601.455 is intended for upper-level undergraduates
- 601.655 is intended for graduate students

- The course content will be the same.
- Students are urged to work in teams of 2, but they may work independently.

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Other courses

- **530/601.856 – Medical Image Analysis Seminar**
  - Spring semester
  - Papers on selected topics in medical image analysis
  - Jointly led by Prof. Prince & Prof. Taylor
  - Students read a paper every week & review it in detail during weekly recitation
- **500.745 – CISST/LCSR Seminar**
  - Wednesday 12-1pm (Online in 2020)
  - Various topics related to CIS and robotics research
  - Distinguished outside speakers + JHU faculty members + grad students talking about their work

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Other CIS education activities

- **Computer-Integrated Surgery Minor**
  - WSE undergrad degree
  - CIS "Minor" advisor selected from approved faculty
  - CIS Course Sequence is base
  - Additional courses from selected menu / consent of advisor
  - Tracks for robotics & imaging
  - See me for information

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Guest lectures

- Generally, will have between 6-7 lectures from outside speakers, either to cover times when Prof. Taylor has unavoidable travel or to broaden course
- Speakers/topics will include
  - Surgeons
  - Radiologists
  - Radiation oncologists
  - Regulatory issues
  - Health economics
  - Entrepreneurs
  - Specific technical topics
- We we are aware of the two rooms situation and will arrange electronic means for students to see these if they are not meeting in the room where the speaker is lecturing.

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601.455/655 Prerequisites

- No hard and fast rules, but …
- Mathematical background
  - You will need to work with coordinate transformations and linear approximations
  - Calculus will be assumed
  - Linear algebra is highly recommended
  - Probability/statistics will be helpful
- Programming
  - No specific languages required. Homework can be handed in in any "usual" language (C, C++, MATLAB, Python) but needs to be well discussed and documented.
  - We will need to be able to run your programs.
  - Example handouts will be in pseudo-code, C++ and/or C
  - But the language is less an issue than basic concepts
  - Familiarity with basic data structures is important
  - Your lab partner choice is important. Pick complementary skills

Piazza Page

- Piazza page is: piazza.com/jhu/fall2021/601455/home
  - Signup page is piazza.com/jhu/fall2021/601455
- Primarily, this will be used for announcements and to provide a means for students to ask questions of the instructor and the TA. We will be monitoring it fairly closely, but don't guarantee instantaneous response.
- Students enrolled in the class need to activate their Piazza accounts and check to see that they have access to the page. If you have problems, contact the TA.
- Here are a few of the uses that are legitimate for the Q/A section of the page:
  - Advertising for a lab partner
  - Asking general questions about concepts in the class (though you may be referred to the TA)
  - Asking for clarification on homework (to be answered **only** by TA or instructor)
  - Pointing out typographical errors or other problems in handouts
- Here are some things that are not proper:
  - Giving or seeking specific help or providing answers to homework assignments
  - Electronic collaboration of any kind
  - Uses unrelated to the course

Grades and homework

- **Course grade is based on take home assignments plus in-class quizzes**
  - 6 **take home exams** (called "homework") done in teams of two
    - Single person teams only on an exception basis, with my permission
    - See me if you need an exception
  - 5 **Programming assignments** done in teams of two (PA#5 optional)
  - Frequent in-class quizzes done individually
  - Grading formula discussed on next page
- **Assignments will be handed in on GradeScope**
  - Link: https://gradescope.com
  - Code: **6P53RJ**
- **All assignments must be turned in BEFORE class on the day that they are due**.
  - This is because we may discuss answers in class and TAs will discuss in section
  - Contact the TA immediately if you have a problem or special need
  - Penalty policy for turning in assignments late (subject to change)
    - 1 day late – 5 points
    - 2 days late – 10 points
    - 3 days late – 20 points
    - 4 days late – 40 points
    - 5 days late – not accepted

NOTE: We may change number of assignments. We expect to make a decision on this in first 4-6 weeks of class. Basic grading philosophy will remain, but we may change the number of droppable assignments

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Graded Homework

- Thought exercises with essay-type answers & analytical problems
- Answers should be neat and legible. I prefer typed answers to the essay questions.
  - If your answer for a question is illegible or too sloppy to allow reasonable grading, then your score for that question will be 0
- Homework is open-book (and open library) but you must work alone or with your designated partner (depending on assignment). You may not consult with other students about the answers, and you may not consult the answers to previous years' homework and exams. You need to cite any and all external references that you consult. Also, you may not provide assistance to anyone other than your lab partner.
- Typically, due about 2 weeks after handed out, but I may modify dates
- **Late assignment policy:**
  - Penalties for late assignments
    - 1 day late – 5 points
    - 2 days late – 10 points
    - 3 days late – 20 points
    - 4 days late – 40 points
    - 5 days late – not accepted
  - We will accept later homework only in extraordinary circumstances. We may make arrangements for makeup assignments.

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Grading formulas

- **NOTE Revision from earlier formula**
- Throw out grades for 2 homework assignments (one from HW#1-3 and one from HW#4-6) or one of PA#1-3.
- **Must** hand in PA#4. Do not to cursory job on this one. If grade is less than 60, I may throw out the lowest of the other assignments instead.
- I will use optional PA#5 to replace the lowest remaining grade in the formula, except that I will not throw out both HW#3 and HW#4
- Numerical grade formula:
  - Max(0.4P+0.6H,0.6P+0.4H)
  - H is homework average , P is the programming average
- Letter grade thresholds vary but usually fairly close to 90-80-70
- Optional project with negotiated modification to formula
  See me by add/drop date if you want to do this

Programming Problems

- Programming projects build on each other
- Typically involve using CIS algorithms discussed in class to determine an “unknown” quantity
- I will provide several debugging data sets with answers and an “unknown” data set
- You should hand in a report containing:
  - Description of the problem and method used to solve it
  - Description of the program structure & who did what
  - The “answer” & short discussion of the answer (why you think it is correct). I recommend that you include also a discussion of the debugging data. Also, the answers should not be embedded somewhere in a program printout. Put them clearly in the report.
  - The documented program listing
  - Include full bibliography and acknowledge any consulting help you get on algorithms (see next page)
- You can use C, C++, Matlab, Python, or something else with concurrence of TA

Programming Problems (continued)

- For programming, work in teams of two
  - Single person team only on an exception basis
- Teams should not share code with other teams or assist other teams in debugging but may discuss algorithmic questions
  - But you must cite **ALL** sources, including consulting in your handed-in reports
  - Again, you may not use any material from previous years' assignments, nor should you provide such material to others or post it on public sites.
- If work in a team, grade is identical for the assignment, but I want you both to participate about equally and also tell me who did what.
  - **NOTE:** If one partner essentially abandons the other, I am likely to take this into account in computing the culprit's grade
- Assignments must be handed in on day due. I will accept late homework only in extraordinary circumstances. I may make arrangements for makeup assignments.

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2019 Grades (600.455/655)

	455	655
A+	2	4
A	12	12
A-	2	4
B+	3	5
B	2	1
B-		2
C+		2
C		
C-		
I		
AU		

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Use of Course Materials

- You are free to make and retain private copies of any course materials for your own use.
- However, you are **not** permitted to share or redistribute any materials (lecture slides, videos, homework assignments, etc.) to any third party.
  - You may share materials with a lab/homework partner who has registered for this course.
  - But that person is also bound by this policy
- Private recording of lectures is prohibited
  - Videos of lectures will be available on Blackboard, and their use is subject to the abovementioned policy

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A final word about grades

- This course is a lot of work and includes some difficult material. Our experience has been that students who do the work tend to do well, even if they get stuck on one assignment. The grading formula is very forgiving.
- We do not view grades as prizes in a competition so much as a means to help you assess progress and as a motivation to do the work. We give take-home assignments and allow you to work in teams because our experience is that this can help learning, but you both must do the work.
- Do not abuse our trust, either by one member of a team dogging an assignment meant to be done together or (even worse) by breaking the ethics rules. If we find evidence of cheating, we will refer the case to the Ethics Board. The usual consequence of conviction is failure of the course and an annotation on your transcript.

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