CURRICULUM VITAE

Yong-Jun Shin, M.D., Ph.D.
Assistant Professor
Biomedical Engineering
University of Connecticut

260 Glenbrook Road
Storrs, CT 06269-3247
e-mail: yong-jun.shin@uconn.edu
mobile: (860)617-8003

EDUCATION/TRAINING

1990 - 2003 **Pre-Med & Doctor of Medicine (M.D.)**
Seoul National University College of Medicine, Seoul, Korea

*Military service (1998 – 2000): Served as a combat medic for 26 months in the Republic of Korea Army

2003 - 2004 **Research Associate**
Center for Genome Research, Samsung Biomedical Research Institute, Seoul, Korea

Participated in a project to develop a diagnostic chip for cancer in collaboration with Samsung Electronics

2004 - 2008 **Master of Science in Electrical Engineering (M.S.E.E.)**
University of Texas at Dallas

Advisor: Prof. Jeong-Bong Lee
Thesis Title: "EWOD (ElectroWetting-On-Dielectrics)-based Digital Microfluidics as a Platform for the Study of Systems Biology"
Supervisory Committee: Prof. Jeong-Bong Lee, Chair (Electrical Engineering), Prof. Rockford K. Draper (Molecular and Cell Biology), Prof. Wenchuang Hu (Electrical Engineering)

2004 - 2010 **Doctor of Philosophy in Electrical Engineering (Ph.D.)**
University of Texas at Dallas

Advisor: Prof. Jeong-Bong Lee
Dissertation Title: "Novel Computational Modeling and Experimental Approaches for the Study of Biological Dynamics"
Supervisory Committee: Prof. Jeong-Bong Lee, Chair (Electrical Engineering), Prof. Leonidas Bleris (Bioengineering), Prof. Mehrdad Nourani (Electrical Engineering), Prof. Rockford K. Draper (Molecular and Cell Biology), Prof. Wenchuang Hu (Electrical Engineering)

2010 - 2013 **Postdoctoral Associate**
Biolab, School of Electrical and Computer Engineering, Cornell University

Advisor: Prof. Xiling Shen
Studied the adaptive and robust behavior of biological systems (p53-Mdm2 negative feedback gene network and effector T helper cells) using the principles and theories from engineering (e.g., feedback control theory and adaptive system identification)

ACADEMIC APPOINTMENTS

2013 - Present **Assistant Professor**
Computational and Systems Medicine Lab (CSMLab), Biomedical Engineering, University of Connecticut

LICENSES/CERTIFICATES

2003 **Korean Medical License**
Registration No. 78807

2005 **US Educational Commission for Foreign Medical Graduates (ECFMG) Certificate**
Certificate No. 0-626-655-5
Passed United States Medical Licensing Examination (USMLE) Step 1, Step 2 Clinical Knowledge (CK), and Step 2 Clinical Skills (CS)

RESEARCH INTERESTS

"Nanoservices: A New Computing Paradigm for Distributed and Adaptive Personalized Medicine"

Modern distributed systems and networks (e.g., smart and connected health, smart grid, sensor networks, etc.) should perform real-time learning, decision-making, and control. Often the properties (other names: variables, fields) and actions (other names: methods, functions) of each system or network component cannot be clearly defined in advance. In addition, the network topology among these components may dynamically change over time. Therefore, hard-coding the properties, actions, and neighbors of every network component becomes cumbersome in the presence of such uncertainty as they need to be added, updated, or removed under dynamically-changing circumstances. For example, a patient model with "body temperature" property may need to add "blood glucose level" property when the continuous glucose monitoring (CGM) data become available from a wearable CGM device. Since a human body can have virtually an unlimited number of properties, it is not possible or even necessary to hard-code them in advance. For the same reason, actions can be decoupled and outsourced without being hard-coded. In this case, each network component consumes external action services which provide **1) knowledge via relational/logical operations** (e.g., hyperglycemia is diagnosed when the blood glucose level is greater than 200 mg/dL) for high-level decision making and **2) engineering algorithms** such as adaptive system identification and model predictive control for physical model-based tasks (e.g., controlling blood glucose levels so that they become below 200 mg/dL). Two example action services (PID control as a Service and LMS adaptive parameter estimation as a Service) can be found at https://github.com/yshin1209/EaaS. Since actions are not tightly coupled to individual components, they can readily be adapted to changes and/or updates in knowledge and engineering algorithms.

Although a microservice framework enables independent scalability and flexibility compared to traditional monolithic approaches, the properties and actions of each microservice are still tightly coupled within each microservice. In this context, I propose "nanoservices" as a new computing paradigm for distributed and adaptive complex systems. My lab is currently developing cloud-enabled REST

(Representational State Transfer) APIs (Application Programming Interfaces) that researchers can use to readily develop customized distributed and adaptive networks by creating objects (actors) and adding or removing the properties, actions, and neighbors in real-time and without downtime (a powerful feature enabled by a microservice orchestration platform such as Azure Service Fabric). While collective decision making can be done through this cloud-enabled network, the knowledge, model, and algorithm learned in the collective process can be deployed to each network component using the Internet of Things/Web of Things/Edge Computing in an event-driven fashion to achieve better speed, reliability, and security. We use Azure Service Fabric, Service Fabric Actor Model, Azure IoT Hub, Azure IoT Edge, and Azure Event Grid which provide an integrated development environment to increase productivity, interoperability, and security. Since nanoservices are very fine-grained, their overhead (communications, maintenance, etc.) can be expensive and we are also exploring the trade-offs between the utility and cost of the proposed approach. The applications of nanoservices to achieve distributed and adaptive personalized medicine include:

1. **Distributed and adaptive personalized artificial pancreas**
   This is a new collaborative project I recently initiated. For more information, please find the attached PDF. The collaborators are listed below and we are currently working together to submit a joint proposal to NSF SCH and NIH NIDDK:
   - Prof. Ali Cinar (Illinois Institute of Technology)
   - Prof. Adi Saleh (UCSF) and Prof. Jenise Wong (UCSF): Founders of TidePool (a cloud-based, open-source, not-for-profit diabetes data management company)
   - Haishi Bai (Microsoft): Principal software engineer and technical advisor to Azure CTO
2. **A Microservices-enabled Event-driven Statechart Approach for Clinical Decision Support**
   This is a pending NIH R21 grant. For more information, please find the attached PDF.

GRANT/RESEARH SUPPORT

Active

08/17 - 07/19 Award #1723483 (Shin)

National Science Foundation (Smart and Connected Health)

"Distributed and Adaptive Personalized Medicine"

The use of clinical data is at the core of medical practice today and, while various mathematical and computational approaches have been developed, conventional approaches are not geared towards individual patients or the dynamics of constantly changing clinical data. Inspired by studies of multi-cellular dynamics, this project explores distributed and adaptive personalized medicine which collectively learns from an individual's clinical data in real time through localized interactions. To make these efforts possible and scalable, this project will exploit a microservice (actor model)-enabled cloud cyberinfrastructure for increased accessibility, adaptability, interoperability, extensibility, scalability and sustainability. In addition, the result of this project, including the mathematical framework, can be applied to other domains, such as education, energy, telecommunications, and transportation. It will also be disseminated to academia through publications, seminars, workshops, and a MOOC to integrate the results of this work into interdisciplinary biomedical informatics research. All tools and documentation will be made available on GitHub so that a sustainable community can be formed around the project.

Role: PI

Total costs: $288,056

In Preparation

“A Microservices-enabled Event-driven Statechart Approach for Clinical Decision Support”

Health care practitioners often face a myriad of challenges simultaneously, including making difficult diagnoses, avoiding medical errors, ensuring the highest quality of care, maximizing efficacy, and reducing the financial burden. The processing power and speed of computers can help them to solve these problems and many computer-based clinical decision support tools and approaches have been developed over the past 50 years. However, it is surprising that these innovations have not led to their broad adoption. Deploying simple forms of clinical decision support such as an “if … then” logic (e.g., IF serum sodium is less than 125 mEq/L THEN initiate the differential diagnostic process of hyponatremia) in a single computer is straightforward. The real challenges arise not from the single use of a simple logic but from (1) how the logic can interoperate with other logic components or other patient data, forming a complex and dynamic interconnected logic system, (2) how it can be event-driven and reacts promptly to newly available data without human intervention, (3) how the knowledge underlying the logic can be easily updated, (4) how it can be deployed in other applications or in other system platforms, (5) how it can be widely available and scalable. Inspired by the PI’s previous work that uses the statechart approach to study the gene network dynamics, this project will explore the use of statecharts as an efficient and systematic way of building a complex and dynamic logic-based decision support system. A statechart can decompose a complex finite state machine into a system of simple two-state finite state machines that exhibits modularity, nested hierarchy, and concurrency. This approach can substantially decrease the complexity inherent to conventional finite state machines. For this project, every “if … then” logic will be represented as a simple two-state finite state machine microservice. Since each microservice is independent, the logic can be readily updated when the underlying knowledge changes. Furthermore, its loosely-coupled nature enables independent scaling. Proposed two-state finite state machine microservices can asynchronously communicate with each other across the internet via popular REST (REpresentational State Transfer) endpoints to form a distributed asynchronous statechart that exhibits modularity, nested hierarchy, and concurrency. The event-driven feature will be facilitated by a fully-managed event routing broker service (such as Azure Event Grid) that implements the publish/subscribe messaging paradigm between services across the internet.
Role: PI

Completed

06/15 - 05/18 Academic Plan (Multi-PI: Rajasekaran, Ramprasad, Shin)
University of Connecticut
“A Cloud-enabled HPC Infrastructure for Materials Genomics, Big Data and Big Compute Sciences”
The major goal of this project is to build a high-performance on-campus cloud infrastructure aimed at Big Data and Big Compute Science, including materials genomics, computational systems biology, and biologically-inspired cloud computing.
Role: PI
Total costs: $1,400,000 (equipment grant)

06/15 - 05/16 MS-AZR-0036P (Shin)

Microsoft Azure Research Award

"Cloud-enabled Smart Microscopes for Biomedical Imaging"

Biological imaging enabled by advances in microscopy and software (e.g., image processing) has played an important role in biological research. µManager is an open-source, cross-platform desktop application, to control a wide variety of motorized microscopes, cameras, stages, illuminators, and other microscope accessories. This project will develop a cloud-enabled smart microscope solution that integrates µManager applications to achieve automated and advanced image acquisition, processing, and analysis.

Role: PI

Total costs: $20,000 (cloud resource credit)

09/14 - 08/15 MS-AZR-0036P (Shin)

Microsoft Azure Research Award

"Engineering as a Service (EaaS) for Complex Intelligent Systems"

This project will develop a community-driven open source Service-Oriented Architecture (SOA) that provides computational engineering components/tools as web services, "Engineering as a Service (EaaS)", for the study of complex intelligent systems. This proof-of-concept EaaS will enable engineers, scientists, and students to develop customized complex web applications/services using interoperable, reusable building blocks. Furthermore, EaaS will be integrated with popular engineering software development environments such MATLAB or LabVIEW. This integration will eventually lead to the Internet of Things (IoT) or cloud-enabled cyber-physical systems.

Role: PI

Total costs: $50,000 (cloud resource credit)

TEACHING INTERESTS

The two most important terms about my teaching philosophy are "fundamentals" and "integration". Today, diverse fields of science and engineering are converging. When we attempt to make connections between these heterogeneous fields, which is often not trivial and requires substantial efforts and creativity, understanding the fundamentals becomes critical. In this context, I have a passion to educate students to acquire the capability of integrating fundamental knowledge of various disciplines with creativity. That is why I've developed highly interdisciplinary computational and systems medicine/biology courses, "Computational Foundations of Systems Biology" and "Computational Modeling/BioMEMS for Systems Biology", at the University of Connecticut. The course materials are composed of fundamental concepts and principles from biology, medicine, mathematics, physics, computer science, and engineering. The key objectives of these courses are to understand the dynamics of multi-scale biological and healthcare systems, ranging from gene networks to endocrinology and distributed patients, and to use the learned knowledge and insights to create new medical diagnosis and treatment approaches. The courses also introduce emerging standards/technologies such as FHIR (Fast Healthcare Interoperability Resources), Cloud Computing, Microservices, Internet of Things, Web of Things, and Edge Computing in the context of practical applications. I'm also deeply interested in innovating outreach activities through MOOC (Massively Open Online Course) development. In this respect, with the generous support from IEEE and edX, my course titled "Introduction to Systems Biology" was developed in 2016 (currently not available due to revisions) which was geared toward secondary/high school STEM educators and students. The total number of enrollment for the spring 2016 session was 3,374.

Courses Developed

1. Computational Foundations of Systems Biology (UConn BME 4985/BME 6086/CSE 4095/CSE 5095)
The use of computers has become critical in many fields of science and engineering. In this course students will be introduced to computational systems biology which focuses on studying the dynamics and intelligent features (e.g., adaptation and robustness) of biological systems. It will be emphasized the tools and methods of computational systems biology come from other computation-oriented fields such as computational physics, digital signal processing, control engineering, and digital logic. Students will also learn skills in programming using MATLAB, LabVIEW, and C# in the context of modeling, analyzing, estimating, and controlling real biological systems. Through a variety of assignments and projects, students will obtain a deeper understanding of physical and engineering principles applied to biological systems. Last but not least, students will read and present journal articles on topics covered in class, which will expose them to interdisciplinary approaches and views.

2. Computational Modeling/BioMEMS for Systems Biology (UConn BME 6086/ECE 6095)
Systems biology is a relatively new field, which studies complex interactions within biological systems. Computational modeling plays an important role in the study of systems biology as it can unravel complex dynamics often difficult to appreciate without mathematics. However, considering the complex nature of any biological systems, biological models should always be validated using relevant experiments, and BioMEMS (Biological or Biomedical MicroElectroMechanical Systems) provides an innovative platform for such experimental validation. BioMEMS is the science and technology of constructing devices or systems, using methods inspired from micro or nano-scale fabrication, that are used for processing, delivery, manipulation, analysis,or construction of biological and chemical entities. In this course, students will be introduced to BioMEMS with an emphasis on systems biology applications. Integrating BioMEMS with computational modeling for innovative systems biology research is highly interdisciplinary and requires knowledge and skills for applying molecular biology, chemistry, physics, medicine, engineering, computer science, etc. Through a variety of projects, students will obtain a basic understanding of integrating BioMEMS and computational modeling for systems biology applications.

PEER-REVIEWED PUBLICATIONS

1. Serrano LA, Shin YJ. **"Nanoservices: A New Computing Paradigm for Distributed Real-time Learning, Decision-making, and Control"**. In preparation.
2. Mahrou B, Pirhanov A, Cho Y, Shin YJ. **"Protein Turnover: A Low-pass Filtering Mechanism"**. In preparation.
3. Amin R, Shin YJ. "**Feedback Control Theory for the Study of Stem Cell Lineage Dynamics**". Under review.
4. Shin YJ, Serrano LA. "**Digital Endocrinology"**. Under review.
5. Shin YJ. **"Digital Signal Processing and Control for the Study of Gene Networks"**. Scientific Reports. 2016; 6:24733. PubMed PMID: 27102828.
6. Shin YJ, Mahrou B. "**Modeling Collective Intelligent Decision Making of Multi-cellular Populations**". Conference Proceedings of IEEE Engineering in Medicine and Biology Society. 2014;334-7. PubMed PMID: 25569965.
7. Shin YJ. "**Parallel Computing for Adaptive Multi-cellular Gene Network Modeling"**, Proceedings of the 1st IEEE Global Conference on Signal and Information Processing. 2013; 103-4 (invited article).

8. Bu P., Chen KY, Chen JH, Wang L, Walters J, Shin YJ, Goerger JP, Sun J, Witherspoon M, Rakhilin N, Li J, Yang H, Milsom J, Lee S, Zipfel W, Jin MS, Gu ZH, Lipkin SM, Shen X. "**A microRNA miR-34a Regulated Bimodal Switch Targets Notch in Colon Cancer Stem Cells**", Cell Stem Cell. 2013;12:602-615. PubMed PMID: 23642368.
9. Shin YJ, Chen KY, Sayed AH, Hencey B, Shen X. "**Post-translational Regulation Enables Robust p53 Regulation**". BMC Systems Biology. 2013;7:83. PubMed PMID: 23992617.
10. Shin YJ, Sayed AH, Shen X. **"Adaptive Models for Gene Networks"**. PLoS One. 2012;7(2):e31657. PubMed PMID: 22359614.
11. Shin YJ, Sayed AH, Shen X. **"Using an Adaptive Gene Network Model for Self-Organizing Multi-cellular Behavior"**. Conference Proceedings of IEEE Engineering in Medicine and Biology Society. 2012;5449-53. PubMed PMID: 23367162.
12. Shin YJ, Hencey B, Lipkin SM, Shen X. **"Frequency Domain Analysis Reveals External Periodic Fluctuations Can Generate Sustained p53 Oscillation**". PLoS One. 2011;6(7):e22852. PubMed PMID: 21829536.
13. Shin YJ, Bleris L. **"Linear Control Theory for Gene Network Modeling".** PLoS One. 2010;5(9) PubMed PMID: 20862288.
14. Shin YJ, Lee JB. "**Machine Vision for Digital Microfluidics**". Review of Scientific Instruments. 2010;81(1):014302. PubMed PMID: 20113117.
15. Shin YJ, Nourani M. **"Statecharts for Gene Network Modeling"**. PLoS One. 2010;5(2):e9376. PubMed PMID: 20186343.

OTHER PUBLICATIONS

[Book] Shin YJ. **"Health and Medical Information on the Internet"**, Korea Medical Book Publisher. 1996.