Academic/Research
Symposium 2021

Modelling and Control Systems Research and Future Prospects

Korkut Bekiroglu

Electrical and Electronic Engineering Technology

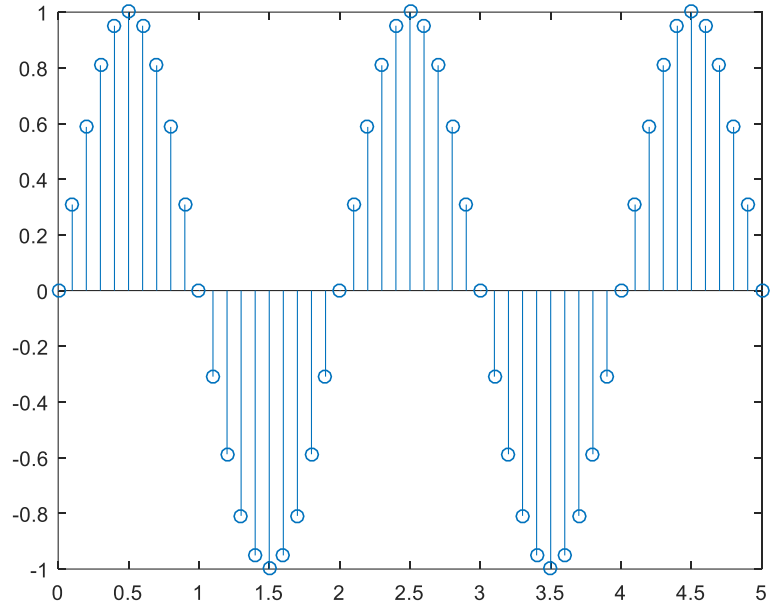
SUNY Polytechnic Institute, NY

System Identification Research

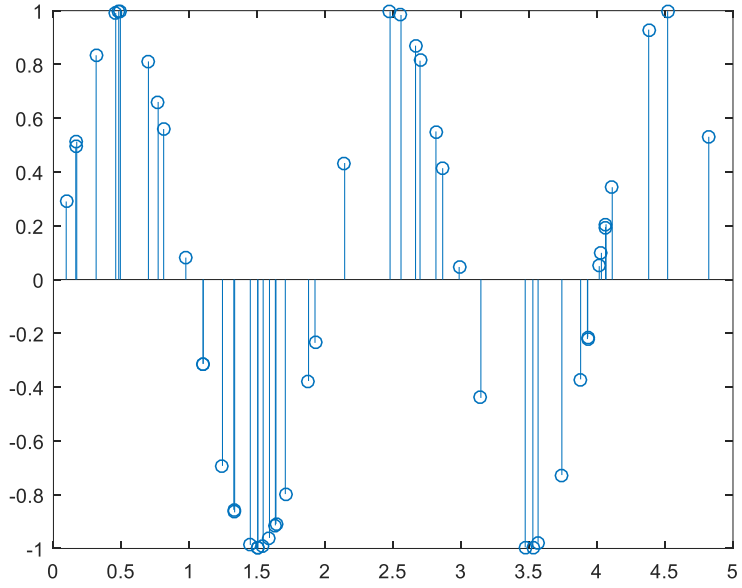
THEORETICAL IMPROVEMENTS

in System Identification

Uniform Sampling - Non-Uniform



Discrete Time Model Id still can be used – Easy to address



Continuous Time Model Id Requires – Difficult problem

- ***Can we use linear model (ODEs)?***
  - Systems are non-linear. Can we approximate behaviour locally with linear models?
  - If yes, what is the order of ODE.
  - Can we do recursive model estimation for sparse (minimal order) systems?
- ***Why sparsity in models is important?***
  - Higher order models limits the capability of controllers.
- ***Does model order has some information about the systems?***
  - Yes, if there is a chance in the model order (system dynamics) in real-time, there might be an anomaly.
  - Implementation in Radar-Ghost problem
  - Room temperature model estimation.

Example: STUDY *on* RADARS (*Target-Ghost Problem*)

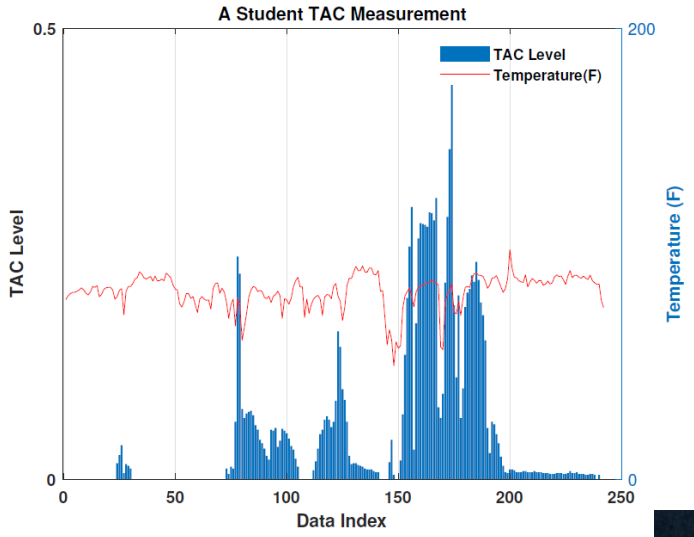
- Rank of Hankel matrices of trajectories is equivalent to the model order.
- Higher order can be ghost?

PREVENTION RESEARCH

System Identification Applications

- Only nine percent of countries have prevention resources (WHO).
  - Example: one death occurs every six seconds because of tobacco use and exposure to tobacco smoke (WHO).
- How to allocate resources for prevention research?
- Can treat behavioral problems such as sedentary behavior, alcohol abuse, stress, and smoking, among others.
- Treating individuals for chronic problems.
- Decrease treatment cost.
- ***NIH funding's for prevention research (2018) - millions***
  - Prevention $8,757m
  - Underage drinking prevention $56m
  - Violence prevention $22
  - …..

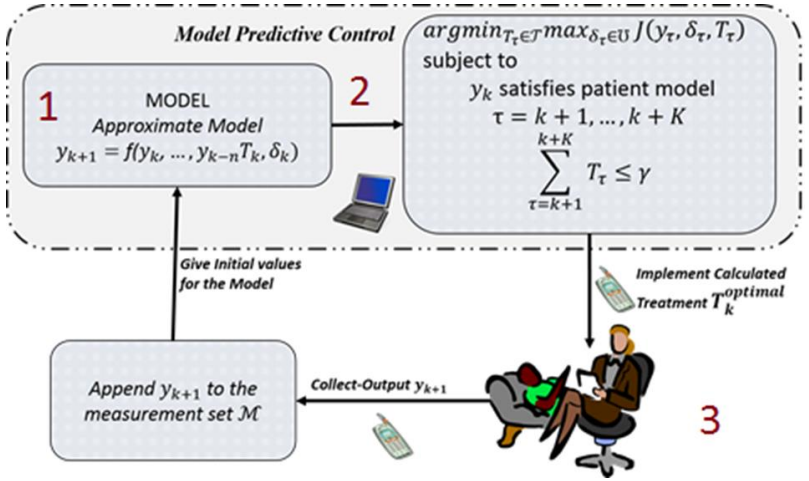
NSF Proposal Under Review: Individualized Modeling of Alcohol Consumption and Intoxication Among Heavy Drinking College Students: Toward Precision Assessment and Prevention



Control Design Research

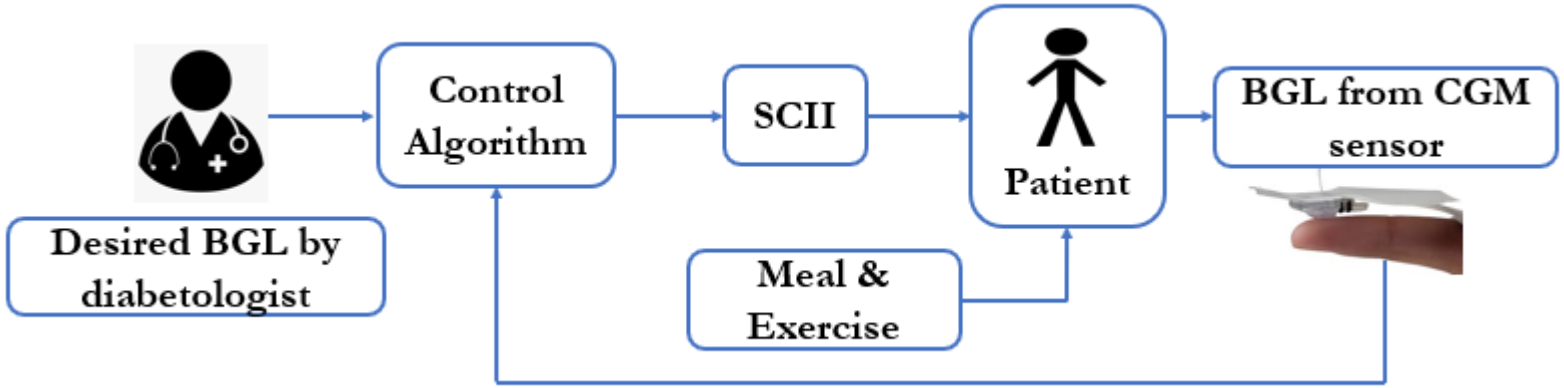
Person Based Adaptive Treatment Design

- ***Challenges:***
  - Model with two type of uncertainties.
  - When and which treatment needs to be given to a specific patient?
- ***Can this be expended for other illnesses?***
  - Methodology: Robust Model Predictive Control
  - Can we support Artificial Pancreas for Type-II diabetes with a behavioral intervention?



Model Predictive Control

$$\min_{\mathbf{T}\in\mathcal{T}} \max_{\substack{\|\tilde{\varepsilon}_k\|_2 \leq \rho \\ \tilde{\mathbf{w}}_k \in \mathcal{W}_k}} (\mathcal{Y}_{k+1} - \theta) X (\mathcal{Y}_{k+1} - \theta)^T$$



A Personalized Artificial Pancreas for Type 2 Diabetes

MULTI-LEVEL OPTIMAL CONTROL (SMART CITY/GRID)

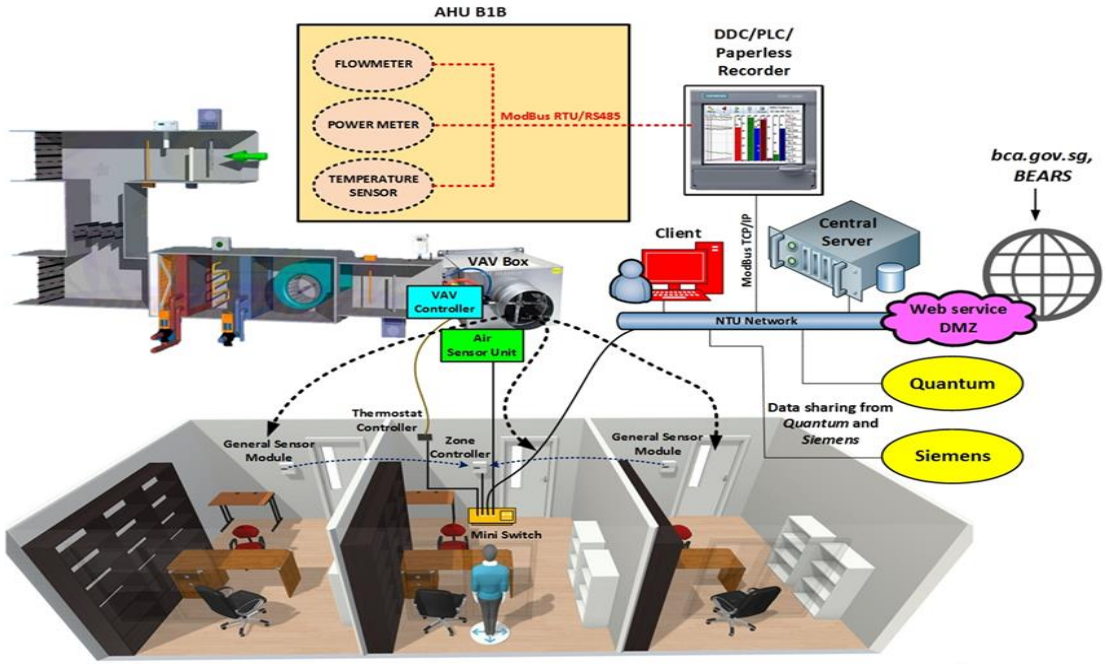
- ***Challenges:***
  - Building monitoring and control.
  - Scalability and implementation issues in controller design.
  - Energy saving?
  - Occupancy interaction
- ***Objectives:***
  - Minimize HVAC energy consumption; · On average, 12-13% energy saving was obtained in real-time testing.
  - Satisfy user comfort requirements;
  - Provide scalability, adaptability and simplicity;
  - Realize the control in simple IoT hardware/software;
  - Real-time model adaptation.
- ***Methodology: Learning based token-scheduling approach***

NSF

Smart & Connected Communities

Cyber-Physical Systems

(S&CC or CPS)



INTERNET oF THINGS (IoT) BASED PAVEMENT MONITORING SYSTEM (VTRC Project)

- ***Specific Innovation:***
  - Low-cost IoT based wireless online structural monitoring systems of asphalt.
- ***Raspberry Pi (Rasp Pi) Module and Wireless Communication/ Internet Connection Layer***
- ***Data Storage/Cloud***
- ***Web Interface***