2020 (Updated):

What do I work on?

Human-centered Computing

What does that mean in my case?
I study human behavioral patterns such as ***typing, swiping, walking, talking, observing, or movements while*** wearing or interacting with smart devices such as ***smartwatches, smartphones, tablets, laptops, and some recently launched devices such as smart speakers, smart rings, smart shoes***, etc. in the context of ***Security, Privacy, Forensics, and Health-monitoring.***

What would you gain while working with me as a thesis student?

1. A good amount of practice on how to read, review, and if things turn out well, write research papers.
2. Learn to read and apply statistical, machine learning, and signal processing concepts.
3. A good hands-on experience in analyzing real-world data, developing useful models, and evaluating and reporting the model's performance.
4. If you are interested and things turn out well, you will have a chance to play with some novel devices, develop apps and collect real.l data

What is expected of you as a thesis student?

1. **Perseverance,** is one of the essential virtue that you should have to succeed as a research/thesis student.
2. Passion to read and critically analyze a lot of research papers
3. Should be comfortable or ready to learn probability & statistics, machine learning, and signal processing
4. Interested in fast prototyping of existing systems or newly conceived ideas using readily available tools Python, Numpy, Pandas, Scikit-learn, TensorFlow, Matplotlib, etc.
5. * Develop app for collecting behavioral data from recently launched devices
6. * Opportunity to design your own data collection experiments, collecting data and publishing datasets.

A good thesis while working with me would consist of substantial contribution in one or more of the following areas:

- Novel modalities and dataset
- Novel feature sets
- Novel algorithms for classification
- Novel methodologies for fusion at data, information, and decision,
- Novel performance evaluation metrics
- Novel attack/spoof methods
- Novel app

Sample papers/presentations that students can read:

Research Overview:
https://sites.google.com/view/kumar7/research?authuser=0

Research publications:
https://sites.google.com/view/kumar7/research/publications?authuser=0

Research lab:
https://sites.google.com/view/kumar7/research/research-lab?authuser=0

News coverage:
https://sites.google.com/view/kumar7/innews?authuser=0

For more details about my research, please send me an email at rkumar@haverford.edu

A good intro:
https://psychology.wikia.org/wiki/Biometrics

Behavioral biometrics overview:
https://www.ibia.org/download/datasets/3839/Behavioral

White papers: https://www.ibia.org/resources/white-papers

The Biometric Answer to the Identity Question
https://www.ibia.org/download/datasets/4338/IBIA-Biometric-Answer-Identity-Question-final-web.pdf

Principles for Biometric Data Security and Privacy
https://www.ibia.org/download/datasets/4955/Principles%20for%20Biometric%20Data%20Security%20and%20Privacy.pdf

More resources:

Resources on spoofing/attacking security systems:
https://sites.google.com/site/zahidakhtarhome/Publications
https://pralab.diee.unica.it/sites/default/files/Akhtar_PhD2012.pdf

Latest swiping dataset -- 2000 users!
https://www.mdpi.com/2306-5729/4/2/60

Behavioral biometrics:
https://www.plurilock.com/behavioral-biometrics-guide/

Can we predict people's personality traits (strong, weak, leadership, etc personality) based on the way they walk? Walking patterns captured by sensors might reveal that -- we need someone who is interested in behavioral psychology …
https://www.engadget.com/2019/07/24/study-phone-accelerometers-reveal-personality-traits/
https://www.ubergizmo.com/2019/07/smartphone-accelerometer-predict-personality-traits/

9/15/2019
SMART SHOES:
https://www.prescouter.com/2018/10/smart-shoes-innovations-footwear/
https://www.thesun.co.uk/tech/8381027/google-smart-shoes-sensors-warn-wearer-getting-fat/

Smart ring:
https://mymotiv.com/blog/motiv-ring-biometric-verification/
https://mymotiv.com/online-security/

https://www.wearable-technologies.com/2019/02/are-smart-rings-the-smartwatches-of-the-future/
https://mymotiv.com/blog/motiv-ring-biometric-verification/

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2019:

Area of research:

My research aims to use smart wearable devices such as a smartwatch, smart-ring, smart-shoes, and smartphones in order to solve the following listed problems. These wearable are equipped with different types of sensors that offer powerful ways of capturing critical physiological and behavioral information about their users.

Security: how can the patterns collected via smart wearable be used to verify the identity of its users while they access the protected resources including a smart-car, smart-home, etc. The verification of identity is a two (authorized user or unauthorized user) class problems.

https://biowatchid.com/

https://breakingdefense.com/2019/05/end-of-passwords-disa-tests-walkabout-identity-system/

Forensics: fingerprints have been extensively used physiological patterns in forensics. What about the behavioral patterns for forensics? For example, can a hacker be identified based on keystrokes or mouse movement patterns that they leave?

Privacy: The more we reveal ourselves the more vulnerable we become. Being able to record physiological and behavioral patterns is powerful. However, with more power comes more responsibility. If bad guys get access to these patterns, can they infer information, e.g., health conditions, race, color, gender that we would never like to reveal to those guys?
https://www.researchgate.net/publication/327636017_Predicting_personality_traits_from_touchscreen_based_interactions

https://www.ndss-symposium.org/wp-content/uploads/2018/03/eurousec2017_13_Crager_paper.pdf

https://www.ndss-symposium.org/wp-content/uploads/2018/03/05-stealing-pins-via-mobile-sensors-actual-risk-versus-user-perception.pdf

https://nakedsecurity.sophos.com/2019/07/23/spearphone-researchers-eavesdrop-on-phone-loudspeakers/

https://arxiv.org/pdf/1907.05972.pdf Spearphone: A Speech Privacy Exploit via Accelerometer-Sensed Reverberations from Smartphone Loudspeakers – How using the smartphone in speakerphone mode erodes your privacy

Privacy Implications of Accelerometer Data: A Review of Possible Inferences

https://www.researchgate.net/publication/332386880_Privacy_Implications_of_Accelerometer_Data_A_Review_of_Possible_Inferences

Health monitoring: patterns recorded by the wearable can give a clue about health issues like seizures, Parkinson's, etc. it would be extremely helpful if we could develop systems that will detect these patterns, identify the issues and provide immediate assistance to the individuals with these issues.

Example: Computer keyboard interaction as an indicator of early Parkinson's disease

https://www.nature.com/articles/srep34468

Unobtrusive Human-Computer Interaction: think about the ways we interact with computing devices. Can we introduce a novel method of interaction or improve the existing ones. Or can we introduce methods that would assist people who face difficulties in interacting with the current interaction methodologies?

Miscellaneous information:

Student: passionate about developing systems that can solve social problems, critical thinker, and knowledge seeker

Tools and techniques: Python, Numpy, Pandas, Scikit-learn, TensorFlow, Matplotlib, etc.

Theoretical background: probability and statistics, preliminary knowledge of machine learning, signal processing, robotics, programming, and data analytics would greatly help

End learning goals: in the end, the students would be able to conduct a literature review in any area of research, define a research problem, design apps for data collections, collect data from humans, train, test, and evaluate machine learning models.

End evaluation goals: In the end, a good thesis would consist of substantial contribution in one or more of the following areas:

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Sample papers/presentations that students can read:

- More details on my research: https://drive.google.com/open?id=1Aaq3QbV786tuc8RN7e9yUAKlCxKZCqGy

- Rajesh Kumar; Partha Pratim Kundu; Diksha Shukla; Vir V. Phoha "Continuous User Authentication via Unlabeled Phone Movement Patterns", https://arxiv.org/pdf/1708.04399.pdf

- R Kumar, VV Phoha, R Raina, "Authenticating Users Through Their Arm Movement Patterns", https://arxiv.org/pdf/1603.02211.pdf

- Isaac Griswold-Steiner, Richard Matovu, Abdul Serwadda, "Handwriting Watcher: A Mechanism for Smartwatch-Driven Handwriting Authentication" IJCB https://drive.google.com/open?id=1t8NJXM3J8UBXXb6O1FbMsqm2orWRzHdn

- A Ph.D. thesis in my area: https://brage.bibsys.no/xmlui/bitstream/handle/11250/2388087/Soumik_Mondal_PhD.pdf?sequence=1&isAllowed=y

For more details about my research, students can visit my webpage https://sites.google.com/view/kumar7 and
Write me an email at rajeshjnu2006@gmail.com

Resources on spoofing/attacking security systems:
https://sites.google.com/site/zahidakhtarhome/Publications
https://pralab.diee.unica.it/sites/default/files/Akhtar_PhD2012.pdf

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https://www.ubergizmo.com/2019/07/smartphone-accelerometer-predict-personality-traits/

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https://www.thesun.co.uk/tech/8381027/google-smart-shoes-sensors-warn-wearer-getting-fat/

Smart ring:
https://mymotiv.com/blog/motiv-ring-biometric-verification/
https://mymotiv.com/online-security/
https://www.wearable-technologies.com/2019/02/are-smart-rings-the-smartwatches-of-the-future/
https://mymotiv.com/blog/motiv-ring-biometric-verification/