AN OSF HEALTHCARE, UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN AND UNIVERSITY OF ILLINOIS COLLEGE OF MEDICINE PEORIA COLLABORATION

Spring 2020 Jump ARCHES Grants Focus on Rapid Solutions for COVID-19 Response

For Immediate Release
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Seventeen research projects are sharing nearly $800,000 in funding through the Jump ARCHES research and development program. The Jump Applied Research for Community Health through Engineering and Simulation (Jump ARCHES) program is a partnership between OSF HealthCare and The Grainger College of Engineering at the University of Illinois (U of I) at Urbana-Champaign.

These projects were submitted to an unprecedented special call for Jump ARCHES proposals to address COVID-19, pandemics, and other public health crises through smart health, data analytics, AI, and other technologies. The ARCHES program supports research involving clinicians, engineers, and social scientists from OSF HealthCare, University of Illinois, and U of I College of Medicine in Peoria (UICOMP) to develop technologies and devices that could revolutionize medical training and health care delivery.

A requirement of the grant applications was for solutions that could be deployed quickly, within four to six weeks.

“In this crisis mode where we are all working to leverage Jump Trading Simulation and Education Center and our talents to improve service for patients affected by COVID-19, the synergistic effect of engineering and clinical service breaks down traditional barriers and gets us more quickly to much-needed solutions,” said Dr. John Vozenilek, Vice President and Chief Medical Officer of Jump Simulation Center in Peoria.

“When COVID-19 was declared a pandemic, we felt that it was our responsibility to help researchers find solutions,” said T. Kesh Kesavadas, of the Health Care Engineering Systems Center at U of I at Urbana-Champaign and Engineer-in-Chief of Jump ARCHES.

The 17 projects include:

The COVID-19 Keeping Safe Program
Brent W. Roberts, Department of Psychology, Director of the Center for Social and Behavioral Science, College of LAS, U of I Urbana-Champaign; Dr. Sarah Stewart de Ramirez, Vice President and Chief Medical Officer Clinical Innovation at Jump Trading Simulation and Education and Director Rural-Global Health Studies, UICOMP; Sanjay Patel, Department of Electrical and Computer Engineering, Grainger College of Engineering,; John Paul, College of Media; William Sullivan, Department of Natural Resources and Environmental Science, College of ACES; Nick Allen, U of I at Urbana-Champaign; Roopa Foulger, Vice President of Data Analytics and Lisa Barker, Medical Director of Simulation, Jump Trading Simulation and Education Center, Peoria.

To help communities open back up in the safest way possible, this platform will expand on the OSF Pandemic Health Worker Program for more extensive monitoring of individuals before, during, and after exposure to COVID-19. This platform will be combined with a COVID-19 status app that will document current coronavirus testing and immunological status, a state-of-the-art tracing of exposure to COVID-19 cases, and a set of digital systems to take advantage of and track psychosocial factors that influence exposure risk and psychological well-being.

A Single-Step, 10-minute, Point-of-Care COVID-19 Diagnostic Test Using Activate Cleave & Count (ACC) Technology

Brian Cunningham, Department of Electrical and Computer Engineering, Director of Holonyak Micro and Nanotechnology Lab, Anurup Ganguli,Grainger College of Engineering, U of I at Urbana-Chamapgn; Dr. John Farrell, Medical Director, Infectious Disease Specialist, OSF HealthCare; Taylor Canady, Institute for Genomic Biology and Shreya Ghosh, Cunningham Lab, U of I Urbana-Champaign.

ACC technology takes advantage of the superior specificity of the CRISPR/Cas system to selectively recognize a unique target segment of the SARS-CoV-2 genome. Using newly invented ultrasensitive biosensor technology, this proposal addresses an important gap in the capabilities of any existing method to enable simple and inexpensive point of care COVID-19 diagnostic testing from a nasal swab to accurately and quickly diagnose infected patients.

Converting a Microwave Oven into a Mask Sterilization Unit

Simulation Engineer, Jump Trading Simulation and Education Center; David Ruzic, Department of Nuclear, Plasma, and Radiological Engineering and D. Eitan Barlaz, Department of Chemical and Biomolecular Engineering, U of I at Urbana-Champaign; Levi Wang, College of Veterinary Medicine, Hertz Bai, U of I at Urbana-Champaign

As the COVID-19 outbreak intensifies there is be a need to rapidly sterilize N95 and other face masks used in hospitals, nursing homes, and other locations. This proposal will investigate the effectiveness for sterilization and disinfection to offer additional research to initial reports that indicate microwaves can be an effective microbicide.

Supply-Driven Hospital Resource Planning and Community Engagement for COVID-19 Treatment

Lavanya Marla, Department of Industrial and Enterprise Systems Engineering, Qiong Wang, Department of Industrial and Enterprise Systems Engineering, Grainger College of Engineering; Benjamin Davis, Carle Illinois College of Medicine, U of I at Urbana-Champaign; Dr. Kurt Bloomstead, EMS Medical Director, OSF HealthCare Heart of Mary Medical Center in Urbana

Gaps exist in our understanding of how to simultaneously manage workforce and resource supplies in a pandemic over time. This proposal will develop algorithms for supply-side planning of both health care workforce and supplies tailored to pandemics by integrating resource inventory aspects and behavioral response to messaging. It will also generate knowledge on the right type of information dissemination to the community that models patients' response to help manage demand and not create congestion at hospitals within communities.

Development of a Blood Analysis Technology for Artificial Intelligence-assisted, Point-of-Care Decision Making

Rohit Bhargava, Department of Bioengineering, Director of Cancer Center at Illinois, Grainger College of Engineering, UIUC; Dr. James McGee, Radiation Oncology and Dr.Tulika Chatterjee, Internal Medicine, OSF HealthCare Saint Francis Medical Center and Clinical Medicine, UICOMP.

This project proposes to advance the complete blood count test using infrared (IR) spectroscopic imaging, which simultaneously measures both microscopic morphology and molecular composition. Using AI and data analytics techniques, the team will be able to perform a differential analysis of leukocytes (DIFF) to quantify the immune response of the body, while possibly providing new biochemical information for a more complete picture of the patient’s health and offer early warning of viral infections such as s COVID-19, pandemic flu, or similar health crises.

Testing the Filtration Efficiency of N95 Respirators for Health-Care Employees and Protecting Public Health in Pandemic Flu Emergencies

Vishal Verma, Grainger College of Engineering, U of I at Urbana-Champaign; Dr. Matthew Bramlet, Director of Congenital Cardiac MRI, OSF HealthCare Children's Hospital of Illinois and Clinical Medicine, Director Advanced Image Modeling at Jump Trading Simulation and Education Center, Pediatrics, UICOMP

This project proposes to solve the problem of quality assurance testing for Do-It-Yourself or rapidly made personal protective equipment (PPE). A two-tiered approach would include a robust testing facility that evaluates N95 respirators for their filtration ability and to conduct a fit test on the actual human subject to test the seal and particle removal efficiency.

Data-driven Modeling, Analysis and Simulation of Epidemic Processes: Controlling COVID-*19*

C.L. Beck, Department of Industrial and Enterprise Systems Engineering and M.T. Basar, Department of Electrical and Computer Engineering, Grainger College of Engineering, at U of I Urbana-Champaign; Dr. Joseph Kim, Clinical Medicine, UICOMP

This project proposes to develop a comprehensive data-driven approach to the modeling, analysis, and control of epidemic processes over time-varying networks on multiple layers. This approach considers the impact of mitigation efforts. Ultimately, the project hopes to advance understanding of spread and control of epidemic processes over complex networks, focusing on infectious diseases, but the models can apply to the spread of computer viruses, misinformation, and adversarial processes over complex networks, such as those found in natural and engineered systems.

Maximizing the Informational Value of PCR-based COVID-19 Tests through Optimal Pooled Community Testing

Dr. Hadi Meidan, Department of Civil and Environmental Engineering, Grainger College of Engineering, U of I at Urbana-Champaign; Dr. John Farrell, Medical Director, Infectious Disease Specialist, OSF HealthCare; Dr. Daniel Lakeland, Lakeland Applied Sciences LLC

During the present COVID-19 outbreak, the lack of available testing capacity, and resulting inability to broadly test the community at large scale leaves decision makers with essentially no information about the overall prevalence of the virus in the general community. This study allows for a new concept in community testing, in which an inexpensive screening procedure for thousands of patients can be developed using only one multi-well batch assay.

Healthier Homes: An Assessment of Opportunities to Reduce Risk of Infectious Disease Transmission at Home

Paul Francisco, Applied Research Institute, Grainger College of Engineering, U of I at Urbana-Champaign; Dr. Beth Houser, OSF HealthCare Saint Francis Medical Center

When an individual has become infected (or there is reason for concern that he/she may have be infected) there might be additional measures that can be performed within the home to reduce the risk of transmission to other family members and allow the individual to recover at home (assuming sufficiently mild infection). This study will look at methods for at-home care and ways to reduce viral load and airborne transmission.

Rapid SARS-CoV-2 Detection from Nasal Swab Extracts

Rashid Bashir, Department of Bioengineering, Dean of the Grainger College of Engineering, U of I at Urbana-Champaign; Enrique Valera and Anurup Ganguli, Holonyak Micro and Nanotechnology Lab, Grainger College of Engineering U of I at Urbana-Champaign; Dr. Sarah Stewart de Ramirez, Vice President and Chief Medical Officer for Clinical Innovation OSF HealthCare and Director of Rural Global Medicine, UICOMP

Because PCR-based technologies remain expensive (in terms of instrument capital equipment and reagents), technically challenging, and labor intensive, there is an urgent need for low-cost portable platforms that can

provide fast, accurate, and diagnosis at the point of care. This project proposes building on work already completed to test samples using reagents already developed in the Bashir Lab and a simple optical fluorescence reader (e.g. smartphone), avoiding the necessity of RNA extraction.

Rapid, Contactless Vital Signs Collection Using Computer Vision and Consumer Technologies
Ramavarapu Sreenivas, Department of Bioengineering, Grainger College of Engineering, U of I at Urbana-Champaign; Roopa Foulger, Vice President of Data Analytics and Brent Cross, Simulation Engineer, Jump Trading Simulation and Education Center; Stefan Malmber and Taha Khan, Dectivio, LLC

The goal of the proposal is to develop a computer vision algorithm for rapidly assessing an individual's key vital signs (temperature, heart rate, respiratory rate, and blood pressure) relevant to COVID-19 utilizing a consumer grade camera in the absence of contact or additional sensing elements not readily available (ambient temperature, sound). The algorithm should be appropriately containerized to integrate with on market electronic medical records and telehealth applications including Epic and Vidyo.

Ventilator Duplication Kit *Dr. Matthew Bramlet, Director of Congenital Cardiac MRI, OSF HealthCare Children's Hospital of Illinois and Clinical Medicine, Director Advanced Image Modeling at Jump Trading Simulation and Education Center, Pediatrics, UICOMP; Dr. Jon C. Michel, Director of Critical Care, OSF HealthCare Saint Francis Medical Center; Brad Sutton and; Laura Villafan Roca, Grainger College of Engineering, U of I at Urbana-Champaign.*

The Ventilator Duplication Kit project aims to develop a rapidly deployable kit for using a single ventilator among multiple patients with varying ventilation needs by tailoring the delivered breaths to each individual. Research and development will start with MATLAB physics simulations of the pressure and flow of the ventilator-multi-patient system. The end product will be a system of one-way valves and additive resistive tubing along with flow and pressure monitors for each patient.

Data Driven Analytics to Predict the Dynamics of the COVID 19 Outbreak and the Impact on Healthcare Providers, Resources, and Communities
William Bond, Director of Research, Jump Trading Simulation and Education Center and Clinical Emergency Medicine, UICOMP; Roopa Foulger, Vice President of, Data Analytics, Jump Trading Simulation and Education Center; Dr. Sarah Stewart de Ramirez, Vice President and Chief Medical Officer Clinical Innovation at Jump Trading Simulation and Education and Director Rural-Global Health Studies, UICOMP; Ravi Iyer, Department of Electrical and Computer Engineering and Roy Campbell, Department of Computer Science, Grainger College of Engineering, U of I at Urbana-Champaign

This project proposes to use a novel analytical approach which incorporates artificial intelligence, data analytics, and machine learning to drive solutions to improve outcomes of the COVID-19 virus. Their solutions integrate formal infectious disease spreading models with uncertainty modeling approaches based on fuzzy logic aka computing based on degrees of truth. Additionally, the team will create a visual predictive analytics dashboard which can be used to allocate resources (staffing, equipment, medicine, space/location).

A Rapid and Affordable Virus Test for Early Warning of a Pandemic
Joseph Irudayaraj and Dr. Wen Ran, Department of Bioengineering, Grainger College of Engineering ,U of I at Urbana-Champaign; William Bond, Director of Research, Jump Trading Simulation and Education Center and Clinical Emergency Medicine, UICOMP

This initiative will develop a test kit that extracts nucleic acid sequences from a sample of blood or saliva which are amplified with primers and new technology that can look for biomarkers of the virus using colorimetry so detection by naked eyes is possible. Researchers hope to develop an all-in-one test kit costing no more than $5 USD.

Secure Federated Learning for Collaborative Diagnostics

Sanmi Koyejo and Dakshita Khurana, Department of Computer Science; George Heintz, Health Care Engineering Systems Center, Grainger College of Engineering, U of I at Urbana-Champaign; William Bond, Director of Research, Jump Simulation and Education Center and Clinical Emergency Medicine, UICOMP

Open sharing of medical data is not viable because of data privacy and intellectual property concerns. This proposal leverages modern cryptographic tools to introduce a computational and software features for securely training predictive models using huge data sets distributed over several medical establishments; while ensuring patient privacy. Ultimately, they believe that such privacy-preserving distributed methods are key to rapid identification, risk assessment, prognosis, and diagnosis for community health crises such as the current COVID-19 pandemic.

Proposed Plans for the Fabrication of Personal Protective Equipment (PPE) for Local Health Care Systems; N95 Respirator

Martin Burke, Associate Dean for Research, Carle Illinois College of Medicine, U of I at Urbana-Champaign; Irfan Ahmed, Executive Director, Interdisciplinary Initiatives, Grainger College of Engineering and Assistant Dean for Research and Executive Director, Health Maker Lab, Carle Illinois College of Medicine, U of I Urbana-Champaign; Helen Nguyen, Department of Civil and Environmental Engineering, Grainger College of Engineering

With projected shortages of PPE and respirators, this project set out to develop and fit test a prototype N95 respirator (standard size) and 3D printed end-cap that can accept existing medical respiratory filters, pass a N95 respirator fit test, and be sterilized or sanitized by readily available procedures. This design approach will be to use some medical respiratory filters which are not expected to be in higher demand due to COVID-19 (e.g., filters used with anesthesia). All designs will be published as open source online.