NATIONAL RESEARCH FOUNDATION

LIST OF AWARDED CENTRAL GAP FUND PROJECTS THROUGH COVID-19 CHALLENGE

Title	Project Lead	Host Institution
Safety and efficacy assessments of UVC disinfection	Ong Qunxiang	Singapore Bioimaging Consortium
Transforming vision evaluation and dilation in the care of ophthalmic patients	Gavin Tan	Singapore Eye Research Institute
An accelerated diagnostic protocol using AITriage for risk stratification of chest pain patients in the emergency department during COVID-19 outbreak	Marcus Ong Eng Hock	SGH
Digital Hygiene Map for Indoor Space Management	Benjamin Ma	NYP
Smart inventory monitoring rack @ hospital wards	Raymond Yeo	RP
Digital Immunity Passport (DIP)	Simon Gordon	SGInnovate
Coupling UVC lamps and occupancy sensing for extensive disinfection in built-environment	Asit Kumar Mishra	Berkeley Education Alliance for Research in Singapore (BEARS)
Improving and monitoring the effectiveness of social distancing policies in institutes of higher learning	Rajesh Krishna Balan	SMU
Smart self-disinfecting lift	Shruti Pilare	TP
Scale-out & Scale-up: Low-resource, Amplification-free Virus Quantification Assays	David Yeo	Bioprocessing Technology Institute
Personal Wireless Pulse Oximetry for Deployment in Foreign Worker Dormitories	John Ho	NUS
Development of low cost and easily implementable Dilution Air Processing Unit (DAPU) for reduced transmission of airborne infectious diseases	Papia Sultana	RP
LOUD - Voice over Mask amplification system	Benny Tan	TP

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Feasibility study to investigate contactless health coaching for older adults	Theng Yin Leng	NTU
Artificial Intelligence-guided smartphone app for self-mid-turbinates swabbing workflow in COVID19 mass monitoring	David Leong	NUS
GourmetGrip: Hybrid Robotic Gripper System for Automated Food Assembly	Yeow Chen Hua, Raye	NUS
Boosting medical cohort analysis for COVID-19 studies	OOI Beng Chin	SGInnovate

Safety and efficacy assessments of UVC disinfection

Executive Summary

In the ‘new’ normal, quick and non-contact disinfection methods are required to replace laborious and inefficient manual wiping down. Existing UV germicidal irradation (UVGI) systems using UVC mercury lamps are energy-inefficient and present as human health hazards. In 2017, the Minimata Convention on mercury entered into force with the stated goal of phasing out mercury in everyday products. While UVC LED is an efficient alternative, there are no disinfection guidelines and the industries are currently seeking for such information. In this proposal, we aim to establish a guideline to allow for a quick, safe and effective disinfection using UVC LEDs. Detailed biological and chemical characterization will be performed to identify the optimal UVC dose and “safety distance” at which human exposure should be avoided. With this established, the team will actively disseminate such solution to the public.

Transforming vision evaluation and dilation in the care of Ophthalmic patients

Executive Summary

We aim to develop a platform agnostic, mobile device based app that can enable young and old patients with current follow up with a stable eye condition to perform self-actuated visual acuity which is repeatable, accurate, and comparable to the current standards of clinical care. If vision assessment is reliable and shows no significant drop from the previous visit to their eye doctor, then the app can advise for further self-administered procedures to improve the efficiency of each clinic visit.

In order to ensure accurate self-performed assessment of visual acuity, we must develop an app with the following requirements: 1) An easy to use interface understandable and usable with minimal instruction and effort; 2) able to perform self-calibration automatically based on a variety of mobile device to ensure accurate sizing of the optotypes presented to the patient for assessment, 3) able to automatically ensure correct distancing to maintenance accuracy of the angle of vision measure, 4) able to assess whether the correct eye is being evaluated, and 5) it must be capable of allowing intuitive response to the vision testing (I.e. speech recognition) to enable self-evaluation without external assistance.

An accelerated diagnostic protocol using AITriage for risk stratification of chest pain patients in the emergency department during COVID-19 outbreak

Executive Summary

Chest pain is a common presenting symptom in emergency department (ED). Many patients are well, but a subset of patients will go on to have a Major Adverse Cardiac Event (MACE), which can result in sudden death. Currently, assessing chest pain patients may take several hours, due to delays with overcrowding, waiting for laboratory results and other tests. Usually, patients with non-diagnostic initial electrocardiograms (ECG) are put through a prolonged period of evaluation (8 hours or more) with serial ECGs and blood tests required. This becomes a constraint to the busy ED where manpower and resources are extremely limited during COVID-19 outbreak. In addition, it is no longer possible to observe patients for prolonged periods in the ED as it increases their risk of exposure to COVID-19.

It is essential to promptly and accurately risk stratify these patients to improve ED efficiency. This will allow allocation of appropriate resources and interventions to high risk chest-pain patients and safe discharge of low risk patients. AITRIAGE™ is a system designed for the rapid and objective stratification of chest pain patients by assessing the risk of 30-day MACE and the whole triage takes only 6-7 minutes while only one laboratory test is needed for low risk patients before safe discharging. The accelerated diagnostic protocol (ADP) using AITRIAGE could significantly shorten the assessment duration for low risk patients from 8-12 hours to less than 2 hours.

Digital Hygiene Map for Indoor Space Management

Executive Summary

The COVID-19 pandemic will fundamentally reshape our way of life for the foreseeable future. Studies have shown that sharing of indoor space is a major infection risk. In Singapore, many of us spend upward of 90% of our time indoors, consequently for an increased risk via contact with contaminated surfaces and inhalation from the air. Cleaning and disinfection of shared public places (such as shopping mall, library, etc.) becomes the frontline in the fight against the virus.

While sharing of indoor spaces is still inevitable in the post-pandemic state, we will need new tools to visualize and manage shared indoor spaces in the context of COVID-19. The objective of this project is to develop a lightweight, browser-based, readily deployable and easily integrable digital hygiene map for indoor spaces. The map represents the hygiene level of places as heatmap overlaid on top of floorplan. The heatmap is modelled using multiple inputs, for example, human traffic count in spatial and temporal domain, time passed since last cleaning/disinfection, etc. The map gives an instant overview to the estate manager where the potential hotspots are. Cleaners or disinfection robots can be sent to clean up the place in a pre-emptive way.

Smart inventory monitoring rack @ hospital wards

Executive Summary

Hospital wards are not places one would like to visit if there are no compelling reasons. It is especially true during COVID-19 times as we want to safeguard our love ones. This project will help to reduce unnecessary trips for medical supply vendors to the hospital wards.

The project had originally started off in Jul 2019 to help improve the medical supply vendor replenishment efficiency and medical supply availability. The project's principle had been validated by industry partners in the healthcare sector to warrant a trial at the hospital ward scheduled in Feb 2020. With the outbreak of COVID-19, the project was delayed as the entire healthcare sector went into overdrive to arrest the COVID-19 outbreak.

Digital Immunity Passport (DIP)

Executive Summary

COVID-19 is extremely infectious, and we potentially may never eradicate the virus. For the foreseeable future there will be a low risk group of people who have recently tested negatively and / or have immunity to C-19 (through recovery or vaccination). Being able to identify and verify this low risk group of people allows better population health and manpower management, and lower risk travel.

Singapore has no existing system to 1) allow individuals to identify themselves as COVID-19 free or immunized (i.e. low risk) and 2) allow instant verification of this status by manpower or immigration officers.

We propose the use of blockchain to create a “digital twin” of an individual’s test results, discharge records due to recovery, vaccination or immunity records which can quickly and verifiably identify themselves as part of a low risk group: The system would allow:

- Instant identification and verification of an individual’s risk status via mobile app
- Flexible policymaking with regards to manpower management and travellers
- No requirement for open connections to a centralised server decreasing risk associated with cyberattacks and data theft
- No requirement to integrate the many different databases containing medical records to provide verification

The core technology has already been deployed for MoE and GovTech and can be rapidly repurposed and deployed for C-19 specific use cases with low technical risk. We have strong government stakeholder support.

Coupling UVC lamps and occupancy sensing for extensive disinfection in built-environment

Executive Summary

The COVID19 pandemic has sharply changed how we live. As we move towards resuming regular activities in this changed reality, we desire assurances of safe workspaces. Periodic disinfection of touch surfaces in workspaces is recommended as one of the means of combating the disease.

This proposal will enhance disinfection of workplaces, in a minimally invasive, automated manner, without placing any humans (the cleaners) at risk of harmful exposure. For this, we propose the use of ultraviolet (UVC) light, coupling its operation with occupancy detection sensors and in-house developed algorithms to protect harmful exposures. Through this coupling, we would be using the UVC lights at specific periods of the work-day, in the absence of people. Through the UVC lighting, we can not only decontaminate surfaces, but also deactivate pathogen distributed in the air.

The system, being independent of human workers, can be used multiple times throughout the day considering the long durations this virus can survive on surfaces. This automated disinfection system we propose would have components targeting the space in the upper reaches of a room and the occupied space, separately, to effectively reduce the risk of workspace spread of infection, as we adapt to living in this new normal.

Improving and monitoring the effectiveness of social distancing policies in institutes of higher learning

Executive Summary

As part of the new “Living with COVID” plan, all universities will be implementing various social distancing policies when semester restarts in August 2020. However, how do you measure the effectiveness of these policies and improve them to achieve the right balance of effectiveness and safety? We plan to retrieve data directly from the WiFi infrastructure used on university campuses and use that to build a visual dashboard that will show, with a two to three hour latency, the current occupancy levels of every part of campus as well as the mobility patterns of people on campus.

Privacy will be preserved as we will never identify individual users and all analysis will be done at aggregate levels. This analysis will allow decision makers to understand if their policies are achieving the safe social distancing goals as well as allow them to understand this has on campus life and student/staff mobility patterns.

Smart self-disinfecting lift

Executive Summary

Virus like COVID-19 can be easily spread in common places, walls and surfaces, especially in lift (being a small enclosed space with high footfall). Lift is also the first entry point of public interaction such that we promptly detect sick person and spread awareness messages.

Our solution shall intelligently, automatically and safely disinfect the lift:

1) By automatically and periodically using UVC; or

2) When a sick person is detected using the lift and to do so:

   - Thermal scanner to identify if a person is feverish; and/or

   - Facial recognition/video analytics to detect if someone is coughing, sneezing or present other sickly symptoms

     (With the detection of sick person, our solution can also remind the sickly to stay safe and well.)

Smart Sensors and AI are used to detect if the lift is empty before disinfecting.

Coupled with data analytics, town councils and government can also be aware of other useful insights such as high occurrence of disinfecting activity, sick person in a particular block or precinct, to predict other diseases like dengue fever, for better dwelling management.

Compared to the current use of disinfectant coating (done manually every 3 months), our solution is more efficient, smarter to enable a smart and safe living.

Scale-out & Scale-up: Low-resource, Amplification-free Virus Quantification Assays

Executive Summary

‘Hammer’ or ‘dance’ are 2 categories of governmental control measures for COVID-19: ‘Hammer’ being highly restrictive, while ‘Dance’ policies are minimally restrictive.

While 'Hammer' policies effectively reduce virus spread, they cripple the economy. Conversely, 'dance' policies keep the economy running, but run the risk of new disease 'hotspots' arising due to lax control. For ‘dance’ policies to be effective, public health authorities strongly advocate proactive COVID-19 testing for an up-to-date picture of community health. For example, portable tests could identify and restrict movement of infectious persons, stamping out ‘hotspots’ before they spiral out of control.

Unfortunately, current PCR testing competency falls short: it is resource-heavy with potential bottlenecks (operator, utilities, supplies, equipment) performed at central laboratories. Furthermore, ‘turnaround’ from sample submission to receiving results takes more than 2 days. At the current testing rate of ~10,000/day, Singaporeans are only tested once every 600 days on average!

Our proposal alleviates operator and equipment scale issues by developing easy-to-use, portable and highly sensitive fluorescence tests to determine an individual’s infectiousness within 25 minutes. Such tests enhance control over community movement, can rapidly ramp up testing capacity and prepares Singapore for emerging infectious diseases. Now, all Singaporeans may safely ‘dance’ in the ‘new COVID-19 normal’.

Personal wireless pulse oximetry for deployment in foreign worker dormitories

Executive Summary

In Singapore, the vast majority of COVID-19 cases to date are foreign workers residing in worker dormitories. Monitoring their health is essential for effective screening and management of COVID-19. Pulse oximetry is among the most essential techniques for monitoring and screening COVID patients, but its use in the dormitory setting poses major challenges in risk to healthcare workers, patient compliance, and aggregation of data in clinically useful formats. To address these challenges, we aim to deploy a wireless system to collect blood oxygen saturation and heart-rate measurements from personal pulse oximeters and display the data at a central device. The system consists of wireless nodes that can be placed in each room to acquire data from commercial pulse oximeters via Bluetooth, and transmit the data via Wi-Fi to a central display where patients can be virtually monitored without in-person interactions.

We have partnered with Temasek, which has procured over 10,000 Bluetooth-enabled pulse oximeters, to deploy the wireless system in a foreign worker dormitory. We will begin trials in an empty dormitory setting in a selected location on May 25 and plan to conduct a pilot with 750 negative-tested foreign workers early June. Our team combines has prior experience deploying wireless telemedicine systems in clinical settings. This grant will enable us to adapt and deploy this tested technology for monitoring COVID-19 patients in the dormitory setting.

Development of Dilution Air Processing Unit (DAPU) for isolation facility within buildings to reduce the spread of airborne infectious diseases

Executive Summary

Reopening of businesses may necessitate the allocation of isolation areas such as sick bays, waiting rooms within workplaces or business premises to curb the second wave of COVID-19. These isolation areas will require to have 100% fresh air with zero recirculation from the room with the ease of retrofit and at lower cost. Simulation tools may be helpful to perform faster set up and to review the risk of virus propagation from the isolation areas to the free areas.

Proposed Dilution Air Processing Unit (DAPU) can be retrofitted easily with relative low cost and shorter period using the CFD simulation tool for planning and rectification of potential problem. This easily implementable and workable solution will help to protect business disruptions ensuring higher percentage of fresh and clean air at lower energy cost. it will help to ensure improved living standard, boosted immune system for the occupants and help to return to new normal amidst pandemic.

LOUD - Voice over Mask amplification system

Executive Summary

Surgical masks and blood shields worn by anaesthesiologists and surgeons in hospital operating rooms may negatively impact speech communication and put patients at risk.

This proposal solves inaudibility of speech communication in doctors and nurses during surgery when they need to wear protective masks and shields. By installing a pin attached button size digital microphone and speaker to the mask, speech communication from the user is improved, amplified and highly audible. The unit can be easily installed using an applicator, cleaned and sanitized before repeated use. It’s cheap to manufacture and replace.

Feasibility study to investigate contactless health coaching for older adults

Executive Summary

Based on previous works in the Volunteer Management System (VMS) and Uberising Coaches for Health Services and Knowledge (UCHESK) prototype, the team proposes to customise VMS and UCHESK for the COVID-19 situation with no face-to-face meetings between the health coaches and older adults.

The project aims to achieve the following:

1. Customise the VMS for health coach allocation for health coaching sessions with older adults.

2. Customise UCHESK prototype with guided coaching, contactless delivery of health coaching sessions via telecommuting software (e.g. ZOOM) and two-way evaluation (from health coach and older adults).

3. Conduct study to evaluate the feasibility of contactless health coaching sessions with older adults.

Artificial Intelligence-guided smartphone app for self-mid-turbinates swabbing workflow in COVID19 mass monitoring

Executive Summary

Samples collection precede testing of nasal samples in the diagnosis of COVID19 infection in human subjects. Current gold-standard nasopharyngeal swabbing while highly sensitive in collecting the samples, comes at a cost of potentially infecting the healthcare professionals performing the procedure and causing discomfort and pain to the patient.

Nasopharyngeal swab is too tedious to be implemented for large scale community monitoring. Self-swabbing (without healthcare professional) at a community level might be a promising alternative through using a less invasive and less painful FDA swabbing method from the mid-turbinates (MT). However, self-MT swabbing is still open to uncertainties in terms of whether the self-swabbing was performed properly in the hands of untrained self-swabbing subjects to give diagnostically meaningful results.

Here, we proposed a smartphone app called SwabEasyTogether that combines video analytics of the self-swabbing process and artificial intelligence engines to monitor the self-swabbing process in real-time and feedback to the user for the MT-swabbing procedure compliance. SwabEasyTogether can immediately resolve the uncertainties and shortcomings of self-MT swabbing and perfectly complements its implementation in community monitoring.

GourmetGrip: Hybrid Robotic Gripper System for Automated Food Assembly

Executive Summary

Continual economic expansion, involving manpower and productivity growth, is of key importance to Singapore. Given our ageing population, low birth rates, shrinking workforce, and the current COVID-19 situation requiring safe distancing and split-team arrangements, there is a crucial need to raise productivity growth through automation, particularly assembly of delicate odd-shaped items e.g. food.

We are currently developing a hybrid robotic gripper system to automate food assembly based on in-flight catering requirements with SATS (see videos above). Through this project, we have acquired valuable experience in food gripping technologies, and will be well-equipped to pivot this experience towards hospital food assembly for patients, healthcare staff and volunteers during this evolving COVID-19 situation.

Current manual food assembly processes face pain points, specifically food safety, irregular food shapes and manpower availability. In this project, we will refine our gripper design based on the shape, size and stiffness requirements of the hospital food items, and food trays/boxes. We will also train our computer vision module to recognize the food items, and reconfigure the gripper posture accordingly to optimize pick-and-place. Our intent is to automate the food assembly process for the full range of hospital food items, thereby increasing productivity, food safety and around-the-clock assembly.

Boosting medical cohort analysis for COVID-19 studies

Executive Summary

Along with the evolving research on COVID-19, the long-term effectiveness of various interventions, trials and policies is hard to quantify and monitor in a timely manner.

This project proposes an integrated Cohort Online analytical processing system, COOL, to facilitate extraction of insights from data for COVID-19 researchers. COOL will be launched as a cloud service and made available to doctors and researchers in Singapore free of charge as a handy analytical tool to accelerate COVID-19 studies for medication, drug development, disease correlation, effectiveness of social and economic policies.