Australian Academy of Science

Australian Government
Department of Industry, Science, Energy and Resources

# Regional Collaborations Programme COVID-19
# Digital Grants project summary template

Outline the project and discuss how the project directly or indirectly contributes to the response to or recovery from the COVID-19 pandemic in the Asia-Pacific region. *No more than two pages*

A) Problem Statement: Coronavirus disease (COVID-19) is a transferable illness that has infected millions of people. As of December 2020, there have been over 65.8 million cases and over 1.5 million deaths reported since the start of the pandemic in Wuhan, China, in December 2019 [1]. Due to this, the current COVID-19 pandemic has imposed significant stress on medical facilities worldwide. No country have envisioned such a need during the early stage of the pandemic. The lack of medical facilities has adversely threatened the quality of COVID-19 patient care monitoring in the hospitals around the world.

B) Proposed Solution: Remote monitoring offers the opportunity to carefully monitor confirmed or suspected COVID-19 cases from an isolated place or at home with minimal clinician intervention. Remote monitoring also allows for the timely identification of worsening symptoms through intelligent predictive alarms. The project will develop an Artificial Intelligent (AI)-based alarm that can predict the sudden deterioration of health due to COVID-19 disease by deploying a remote continuous monitoring setup using Internet of Medical Things (IoMT) that will stream data from a range of biophysical markers to Cloud.

C) Background: Remote isolated monitoring using IoMT helps to reduce the workload and the risk to the healthcare workers in hospitals. Additionally, it may decrease the number of hospital visits and admissions during COVID-19 times, thereby reducing the use of scarce resources, optimizing health care capacity, and minimizing the risk of viral transmission. Continuous monitoring show lower mortality rates in Jiangsu province, China, where an early warning system based on monitoring of respiratory rate (>30bpm), SpO2 (<93%) and heart rate (>120bpm) was deployed. A cure rate of 96.67% was attributed to the early warning system [2]. During this pandemic, the Department of Health and Human Services in Victoria, Australia recommended elderly patients in residential care facilities be monitored 4/24 for temperature (>38.5), persistent tachycardia, respiratory rate (>30 bpm), BP (< 90 mmHg systolic, < 60 diastolic) and SpO2 (< 90%) in the isolated room to detect any risk of sudden health deterioration [3].

However, an effective deployment of remote isolated monitoring depends heavy on the generation of smart alarms. Studies have demonstrated that the generation of smart alarms during the monitoring of patients is critical for the early detection of deterioration in patients' health that leads to proactive treatments to reduce the risk of mortality [4]. Although there are a considerable number of existing methods identified in the literature for clinical alarm generation, they typically raise alarms depending on the pre-set values results in frequent alarms and not designed for current COVID-19 and real-time remote monitoring. In most cases, the majority of these alarms are non-actionable because they may have crossed the pre-set parameter limits but have minimal clinical significance – these alarms are knowns as false positives or false alarms [5]. Due to frequent false alarms, clinicians become less sensitive towards patients' alarms, and neglect any possible dangerous situations resulting in "alarm fatigue" at times [4,5]. In the current pandemic situation, frequent false alarms are more dangerous because they require frequent manual intervention of clinicians that might risk their safety and any neglect of alarms by clinicians can cause sudden deterioration in patients' health or even death. The main focus of the project is to design and implement clinical alarms for confirmed or suspected COVID-19 cases that is triggered 'right on time' and accurate so that treatment can be started promptly.

D) Project Description: According to the World Health Organisation, most people with COVID-19 develop only mild (40%) or moderate (40%) disease, approximately 15% develop severe disease that requires oxygen support, and 5% have critical disease with other medical complications [6]. This project will establish a trial in India for data collection and a novel artificial intelligence algorithm will be developed in collaboration, by following the following activities:

1. The project will commence in April 2021. Ethics applications will be prepared and submitted prior to commencement. In the first 2 months, a pilot monitoring of suspected or confirmed mild COVID-19 patients will be established in India with an existing remote monitoring kit.
2. The pilot will have the implementation of the software to automate data collection, embed the pre-set algorithms with the baseline value as recommended in [6] (respiratory rate > 30 breaths/min, SpO2 < 90% and temperature > 38.5oC), and generate reports.
3. The lead CI Balasubramanian has immense expertise in real-time data streams from IoMT work along with the Indian CI Menon to design and develop an AI-based algorithm to raise an alarm.
4. A novel AI-based predictive algorithm will be developed using machine learning techniques with vital signs samples collected from 1 and 2 to predict the deterioration of health due to COVID-19.
5. The novel AI-based algorithms will be used to predict COVID-19 by setting up extended monitoring in India with confirmed moderate COVID-19 patients thereby building up a unique dataset for AI training and performing a much-needed public health service to raise 'right on time' alarm for deteriorating COVID-19 patients.
6. The last month will be devoted to the write-up of papers, analyzing quantitative and qualitative data collected during the trials.

While India has strictly imposed lockdown rules to avoid the spread of COVID-19 they have had to relax the rules to sustain her economy. The spread of COVID-19 is inevitable but minimising the number of deaths is possible by monitoring suspected or confirmed COVID-19 cases at home or for those in isolation. The current pandemic has overburdened the Indian government hospital setup and the community considerably, the average cost of a hospital bed per day for COVID-19 monitoring in India is reported to be 150 AUD compared to the average salary of 70% of Indians is less than 200 AUD per month. The existing healthcare setup requires novel, alternative COVID-19 monitoring opportunities with early smart intervention. The deployed remote monitoring with AI-based alarms can influence the clinicians to shift the patients to hospitals only based on their deteriorating health condition and can drastically reduce the hospitalization cost not only in India but in the growing economic countries across the Asia-Pacific region.
E) Project Team: CI Balasubramanian has expertise in the development of a scalable IoT architecture for the secure transmission of IoMT data that led to the Anidra spin-out he founded. CI Menon has expertise in IoMT, genetic algorithms, machine learning techniques and mobile health applications. The CIs have already established collaborations through joint publications and clinical approval/development of a smart, remote patient monitoring in Australia and in India. The CI Balasubramanian has applied the IoMT architecture to remote vital signs monitoring in one of the private hospitals in India with AI-based early warning scores. Both Australian and Indian CIs have the right combination of expertise ranging from IoMT, Cloud and AI to complete the project. The team have established clinical partners in India to carry out the trial. The Project funds will be used to develop code to train the AI algorithms and for the cloud infrastructure for the project.
References:
1. WHO, 'COVID-19 Weekly Epidemiological Update', 2020. [Online]. Available: https://www.who.int/publications/m/item/weekly-epidemiological-update-8-december-2020. [Accessed: 8- Dec- 2020].
2. Sun Q, Qiu H, Huang M, Yang Y. Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province. Ann Intensive Care. 2020 Mar 18;10(1):33. doi: 10.1186/s13613-020-00650-2. PMID: 32189136; PMCID: PMC7080931.
3. State Government of Victoria. (2020). [Online]. Available: https://www.dhhs.vic.gov.au/aged-care-sector-coronavirus-disease-covid-19. [Accessed: 6- Dec- 2020].
4. Bell, L., Monitor alarm fatigue. American Journal of Critical Care, 2010. 19(1): p. 38.
5. Christensen, M., et al., Alarm setting for the critically ill patient: a descriptive pilot survey of nurses' perceptions of current practice in an Australian Regional Critical Care Unit. Intensive and Critical Care Nursing, 2014. 30(4): p. 204-10.
6. WHO, 'Clinical management of COVID-19', 2020. [Online]. Available: https://www.who.int/publications/i/item/clinical-management-of-covid-19. [Accessed: 6- Dec- 2020].

Describe how the activity will contribute to building linkages in the Asia-Pacific region, and facilitate greater science, research, and innovation collaboration.

*No more than 300 words*

Firstly, the early career researchers CI Balasubramanian & Menon are already collaborating informally in wireless body sensors research. The team proposed and implemented an adaptive and flexible Brain Energized Full Body Exoskeleton (BFBE) for assisting paralysed people using the brain signals captured by the Electroencephalogram (EEG) sensors. CI Balasubramanian has a decade of experience in solving real-time issues in remote patient monitoring using body sensors through hospital trial and research, while CI Menon's work in Center of Robotics in machine learning techniques on wireless sensor data has the potential to facilitate greater research and innovation. Any support and seed funding would formalize their collaboration and enable them to establish an Australia-India Healthcare Data Acquisition and Analytics Research Lab (AIDaaL). As both have exhibited potential to bring in researchers, grants and industries collaboration for innovative applied research.

Secondly, the research outcome will facilitate greater science in India as well as in Australia because there is evidence in Australia that the general public have engaged in using remote monitoring to manage the mild to moderate COVID-19 diseases in the community. However, these patients are kept track off using a mobile application that asks them to self-report their symptoms each day. The report is fed into a dashboard monitored by the practice's nurses, who can see whether individual patients are stable or if their symptoms are getting worse and they need to be contacted. The research of AI-based smart alarms to predict the worsening condition of COVID-19 patients will facilitate greater science by automating the detection process with minimal human intervention.

Finally, the provision of COVID-19 disease monitoring in the highly dense populations (in India) will enhance the use of remote monitoring in developing economies in Asia-Pacific by reducing the hospitalization cost.

Describe how intellectual property (IP) may be used and managed in your project and any proposed ownership of IP resulting from the project will be managed.

*No more than 300 words*

It has been agreed that all background intellectual property (IP) will be owned by the respective parties and the new foreground IP will be shared according to respective monitored contributions from partners. Any extension made to partners background IP (by any partner) will be owned by its original IP contributing partner.

Agreements will be reached amongst partners prior to commencement so that background IP is retained by each partner and commercialization of IP developed during the project is shared on the basis of contribution. Wherever possible IP will remain accessible for the public good.

Federation University

20th April 2021

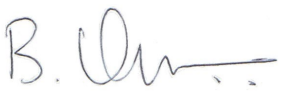
## To Whom It May Concern

This letter is to certify that a collaborative research project proposal titled “Artificial Intelligent based alarm to predict the sudden deterioration of health in COVID-19 patients” submitted by Dr. Venkatakrishnan Balasubramanian, School of Engineering, Information Technology and Physical Sciences, Federation University, Australia and Dr. Varun G Menon, Department of Computer Science and Engineering, SCMS School of Engineering and Technology, India has been approved for the Regional Collaborations Programme COVID-19 Digital Grants funding of $10,000 (GST exclusive) by the Australian Academy of Science and the Department of Industry, Science, Energy and Resources, Australia.

Reference link: https://twitter.com/Science_Academy/status/1379642040607068164

The project will commence in April 2021. The Project Lead Investigator Dr. Balasubramanian along with the Indian Co-Investigator Dr. Menon will work on the real-time data streams from IoMT and design and develop an AI-based algorithm to raise an alarm for COVID-19 patients. A novel AI-based predictive algorithm will be developed using machine learning techniques with vital signs collected from patients to predict the deterioration of health due to COVID-19. The project will end by 31st January 2022.

Yours Sincerely



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