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Wearable devices and IoT applications for symptom detection, infection tracking, and diffusion containment of the COVID-19 pandemic: a survey

Key words: Wearable devices; IoT health-monitoring applications; Medical sensors; COVID-19 pandemic; Symptom detection

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Motivation

- Until a safe and effective vaccine to fight the SARS-CoV-2 virus is developed and available for the global population, preventive measures, such as wearable tracking and monitoring systems supported by Internet of Things (IoT) infrastructures, are valuable tools for containing the pandemic.
- In this review paper, we have analyzed the innovative wearable systems for limiting the virus spread, early detection of the first symptoms of the coronavirus disease COVID-19 infection, and remote monitoring of the health conditions of infected patients during the quarantine.

Contents

- Analysis of sensor-based systems to monitor the principal vital signs, detect symptoms related to COVID-19 early, and alert patients and medical staff.
- Investigation of novel wearable devices to comply with social distancing rules and limit interpersonal contagion (such as smart masks).
- An overview of implantable devices for monitoring the effects of COVID-19 on the cardiovascular system.
- A survey of tracing strategies and technologies for containing the COVID-19 pandemic based on IoT technologies, wearable devices, and cloud computing.
- Critical analysis and comparisons of the different discussed solutions, highlighting their potential and providing new insights for developing innovative tools for facing future pandemics.

Wearable devices and sensors to detect COVID-19 symptoms

Body temperature



Fever Scout (Vivalnk Co.), TempTraq (Blue Spark Technologies, Inc.), and Tucky (E-takescare Co.)

Respiratory and heart activity



Jeong H et al. (2020)

Heart disorder monitoring (HRV)



ECG Alert device (ECG Alert) and WorkSafr wearable device (Cognet Things Inc.)

Body temperature, HR, HRV, body posture, RR, single ECG, fall-detection, activity level



Vital Patch (VitalConnect Co.) and the smart garment, produced by Skiin Co.

Overview of innovative masks for limiting the spread of COVID-19

“Capture up to 99.5% of virus, bacteria, and particles”



PuriCare Wearable Air (LG Group Inc.)

N95 medical-grade, sterilizing case



Project Hazel (Razer Inc.)

“The mask measures the amount of absorbed pollutant, the AQI, RR, and the user’s movement”



Xiaomi Purely Mask (Xiaomi Inc.)

Self-sterilizing filters using a novel graphene-based filter



Guardian G-Volt mask (LIGC Applications Inc.)

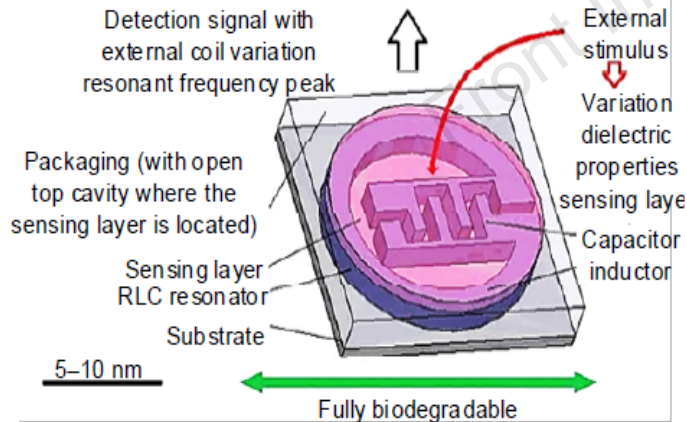
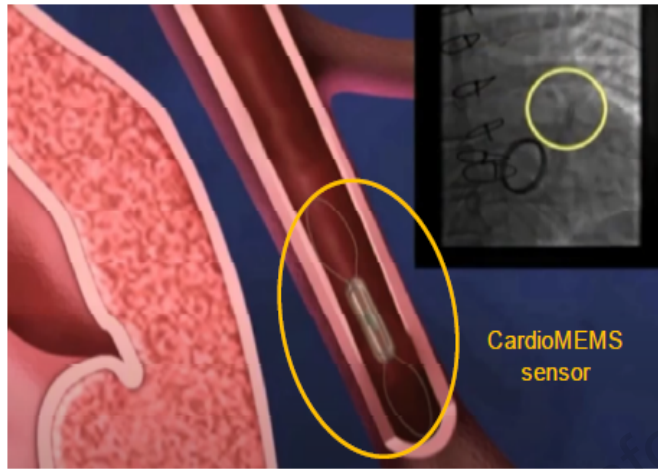
“Detect the presence of the proteases related to the COVID-19 virus in exhaled breath”



(Yim et al., 2020; Labios, 2021)

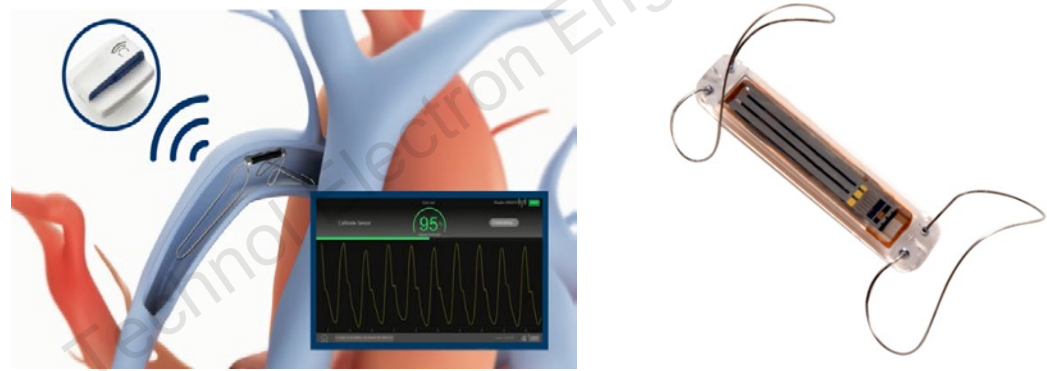
Study of implantable devices for detecting the effects of COVID-19 on the human body

“Detect variations in pulmonary artery pressure, an indicator of heart condition”



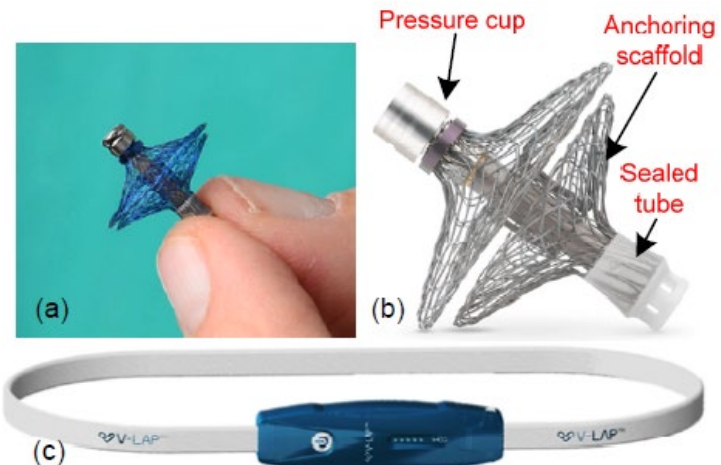
CardioMEMS HF® (Abbott Inc.)

“Designed for HF patients for continuous monitoring of health conditions and remote treatment definition”



Cordella system (Endotronix Inc.)

“Provide detailed information concerning the LAP (left atrial pressure)”



V-LAP™ Vectorious Inc.

Overview of commercial wearable solutions for complying with social distancing rules

“The device is based on RF technology and generates a low-frequency radio bubble around the user.”



The wearable device for social distancing

Close-to-me system (Partitalia Inc.)

“Using Bluetooth frequencies, the device monitors the distance between people and detects movements”



iFeel-You bracelet (Italian Institute of Technology)

“Ultra-wideband (UWB) technology delivers 10 times more accuracy than Bluetooth.”



Safe Spacer™ (Safe Spacer Inc.)

“The hardware section consists of a passive GPS receiver and proximity sensors based on Bluetooth and ultra-wideband radio signal analysis”

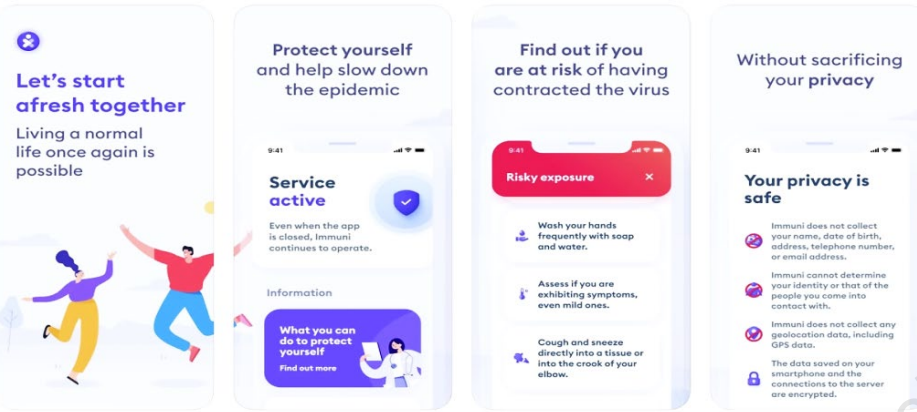


Wearable products (Estimote Co.)

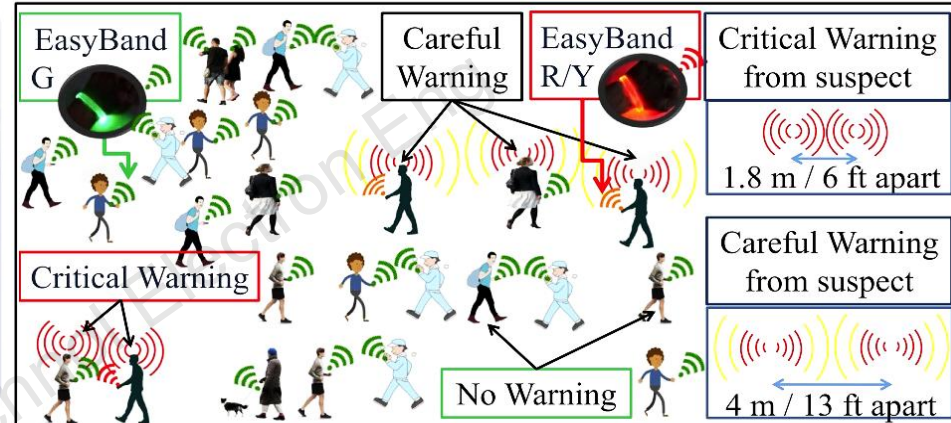
Tracing systems for containing the COVID-19 pandemic

Tracing Apps

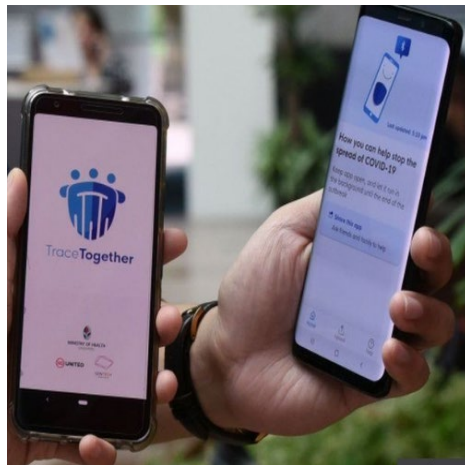
Wearable devices



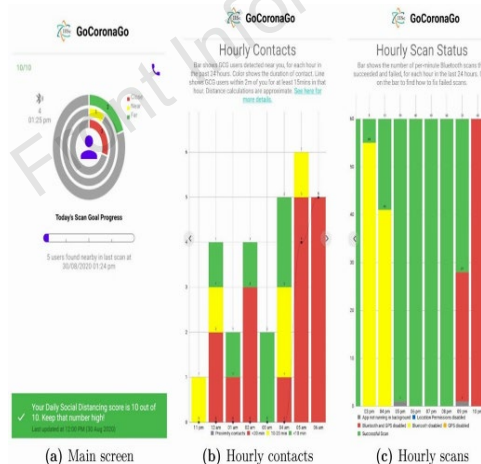
Immuni App



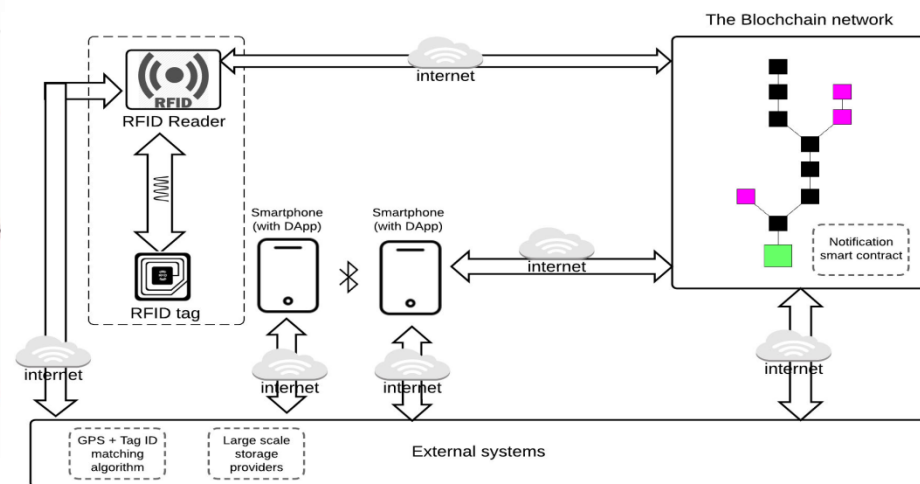
IoT systems for the user's tracing using GPS receivers, microphones, magnetometers, and RFID technology



TraceTogether App



GoCoronaGo App



(Garg et al., 2020)

Conclusions

- Our scientific work focuses on applications based on wearable devices for fighting against the COVID-19 pandemic, including the extremely popular tracing mobile applications.
- An entire section was dedicated to wearable commercial solutions (e.g., smart badge, smart watches, and smart bracelets) for complying with the social distancing rules, mainly in workplaces.
- Several wearable and implantable applications for monitoring the effects of COVID-19 disease on the cardiovascular system were investigated.
- Comparisons and a critical analysis of the different discussed solutions were presented, highlighting their potential and providing new insights for developing innovative tools for facing future pandemics.