Thermique: An Integrated AI-based Temperature Sensing and Management System to Hold Back Covid-19 Contamination

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In the advent of a global pandemic, the necessity for early COVID-19 suspect detection and quarantine is of paramount importance. Medical research indicates that a high fever provides a general litmus of whether or not a person is infected with Coronavirus. Thermal imaging can provide a contactless screening procedure that enables detection of infected personnel. In this paper, such a solution, named Thermique, is proposed. It is a cheap, easy to mass-produce AI enabled thermal screening solution that combines facial detection, instant temperature scanning and RFID logging, while providing an integrated defense against the spread of COVID-19 in a particular facility.

Research Area:
Thermique is an AI-integrated temperature sensing and management system in order to reduce the spread of COVID-19. For extracting accurate temperature from the facial area of a human, Artificial Intelligence and computer vision was used. Use of thermal images and radiometric sensors extend the research work into Digital Image Processing. Interfacing of microcontrollers and single board computers used in this project can aspire towards Robotics.

Goals/Objectives:
With an aim to stop the spread of the coronavirus from an infected person, Project Thermique is a smarter way to monitor the entrance of an institute, official space, or any organization. It provides facial detection, real-time temperature scanning around the forehead, RFID scan and timestamp logging, and an automated attendance system, all in a neat package to avoid all means of contamination [1]. This project is designed as a budget-friendly and mass-producible alternative compared to other products existing in the market [2]-[3].

Methodology:
Users will stand before a scanning device & bring their faces in the appropriate position within the camera feed. An AI will detect the facial boundaries, and identify the region to be scanned. To determine facial boundaries, two camera modules are used - Lepton 3.5, for thermal feed, and Pi-Cam, which provides a regular camera feed. The regular camera feed is processed by an AI based on deep convolutional neural network (CNN) architecture available in an open source library called FaceNet (developed by Google) and the face position is then determined [4]. The face is bounded within a rectangular region. Then the two camera feeds are superimposed, which eventually marks the face position within the thermal feed.

The scanning process is initiated when the user scans the RFID card. Upon scanning with the RFID card, the system will determine the maximum temperature across the marked region of thermal feed and store it against the RFID data along with the timestamp of scanning.

The entry is stored in a database monitored by administrators. The administrators will be notified if the thermal reading indicates that the user is a suspect of corona-patient. The threshold value for the temperature is updated to be in accordance with the recent medical research on COVID-19 [5].
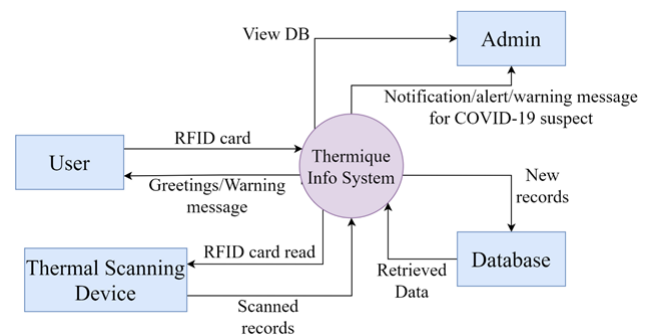

Figure-1: Context diagram for *Thermique* system

Table-1: Sample data from thermal records database

Person ID	Temperature (°F)	Date (YYYY-MM-DD)	Time (H:M:S)	Gate No.
7234579	97.934	2020-09-03	11:39:43	1
877284	98.768	2020-09-03	12:00:29	1
7257057	97.214	2020-09-03	12:09:19	1
829422	99.05	2020-10-03	12:11:21	1

Result And Analysis:

A test was conducted with 15 participants to verify the accuracy and reliability of the system. Table-1 shows a sample from the test operated in a controlled environment. The body temperature of the participants were also measured with a thermometer, and it was observed that the thermal reading of the system deviated from the thermometer reading by 1.13°F on average.

The body temperature of a person can be detected in an automated way without having the risk of contagion via contact. The primary symptom of corona-infection is fever. The ideal body temperature for a human being is 98.4°F and a person identified with a temperature higher than this is likely to be a suspect of corona-infection will be isolated to control the spread of disease. The system is very robust. It is user friendly and takes little time to detect faces and measure temperature. There is an error of ±5°C in the radiometric Lepton module, which is planned to be minimized with help of other devices in future[6].

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