DATA NOTE

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Upper body thermal images and associated clinical data from a pilot cohort study of COVID-19

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Abstract

Objectives The data was collected for a cohort study to assess the capability of thermal videos in the detection of SARS-CoV-2. Using this data, a published study applied machine learning to analyze thermal image features for Covid-19 detection.

Data description The study recorded a set of measurements from 252 participants over 18 years of age requesting a SARS-CoV-2 PCR (polymerase chain reaction) test at the Hospital Zambrano-Hellion in Nuevo León, México. Data for PCR results, demographics, vital signs, food intake, activities and lifestyle factors, recently taken medications, respiratory and general symptoms, and a thermal video session where the volunteers performed a simple breathhold in four different positions were collected. Vital signs recorded include axillary temperature, blood pressure, heart rate, and oxygen saturation. Each thermal video is split into 4 scenes, corresponding to front, back, left and right sides, and is available in MPEG-4 format to facilitate inclusion into pipelines for image processing. Raw JPEG images of the background between subjects are included to register variations in room temperatures.

Keywords Covid-19, Thermal imaging, Thermal videos, Respiratory disease, Demographic data

Objective

COVID-19 is a respiratory disease caused by the coronavirus SARS-CoV-2 [1]. The respiratory illness may cause acute respiratory distress syndrome (ARDS) characterized by pulmonary infiltrates and hypoxemia, where dry cough, fever, and fatigue are the main symptoms [2, 3].

Imaging methods such as computed tomography [4, 5] have been proposed as an alternative diagnostic tool

for the SARS-CoV-2 coronavirus. Nevertheless, many of these methods may not be feasible for mass screening. CT uses ionizing radiation, requires unique installations and a complicated process that limits the number of possible tests per equipment, and the economic costs can be prohibitively high for screening a large population. Although thermal imaging is a cost-effective method used often in industry [6–8], to our knowledge, thermal imaging and specifically thermal videos have not been comprehensively investigated as an alternative diagnostic tool for COVID-19. Infrared videos can be useful for COVID-19 detection because SARS-CoV-2 infection in viremia stages is characterized by body temperature changes and breathing patterns [9]. Thus, video recording of body temperatures could theoretically be used as

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an alternative, cheap, and massive screening method for detection at an early stage of the disease.

The data was collected for use in a prospective study regarding the use of thermal data for Covid-19 detection, and was used in a publication titled "COVID-19 classification using thermal images" [10].

The database includes general patient and demographic information that could be of use in additional studies for associations in temperature patterns; for instance, assessing symptoms and physiological responses to medications or lifestyle factors.

Data description

The study cohort comprises 252 volunteer subjects over 18 years old requesting a PCR test for SARS-CoV-2 at the TecSalud Zambrano-Hellion Hospital, Nuevo León, México in 2020. Individuals unable to hold a deep breath for at least 10 s were excluded. Table1 (Data file 5) shows the data fields collected. Vital signs were obtained using a Welch-Allyn 71WT monitor.

Thermal image acquisition

Thermal videos were acquired at five frames per second, using a TI-128 Digital Thermal Imaging Camera from Omega Engineering Inc. (Norwalk, CT, USA). The camera was connected via USB to a computer running a Microsoft Windows operating system, and drivers and the Omega TI Analyzer version 4.1.8.6875 acquisition software were obtained and installed as per provider instructions.

Before recording, glasses, masks, caps, and t-shirts were removed. Undergarments and jewelry were not removed. Participants were recorded with raised arms, taking a breath, holding for 10 s, and again with their arms down. They then turned clockwise 90 degrees 3 times to repeat the process from the left, back, and right sides. For de-identification reasons, left and right side and raw videos were removed from the repository. Nevertheless, this information can be provided upon request. Background images were taken before or after each procedure to record variations in room temperatures.

Image pre-processing

Raw background snapshots are included in this repository without any processing. In addition, we carefully split each video into four scenes corresponding to the front, left, back, and right sides and converted them to MPEG-4 format to facilitate their inclusion into pipelines for the image processing scientific community. For de-identification reasons, left and right side and raw videos were removed from the repository. Nevertheless, this information can be available upon request.

COVID-19 PCR diagnosis

Nasopharyngeal swabs were taken by qualified personnel and deposited in a vital transport medium following standard procedures. The PCR testing was performed by the Clinical Laboratory from the San José Hospital and included TaqMan 2019-nCoV Assay Kit v1 & v2 from ThermoFisher. The PCR results yielded 59 PCR positives, 192 PCR negatives, and 1 not reported.

Generating position files

The average duration of each video is 81 s (standard deviation of 19). Each thermal video was inspected to determine the interval for body positions. Each IRS video segment was then converted into a standardized black-and-white MP4 video whose gray levels were standardized between 62 and 102-degrees Fahrenheit. Four additional files were generated for each body position. The mean and standard deviation for the duration for each scene are 13.7 (3.5), 12.5 (3.4), 12.4 (3.5), and 12.1 (3.2) seconds for the *front, left, back,* and *right* respectively. Around 30 s of changing positions were manually

Table 1 Overview of data files/data sets

Label	Name of data file/data set	File types (file extension)	Data repository and identifier (DOI or accession number)
Data set 1	background_jpg	Image Files (.jpg)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Data set 2	matlab_scripts	Matlab Scripts (.m)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Data set 3	termal_avi_data	Video Files (.avi), Matlab Scripts (.m)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Data set 4	termal_mpg_data	Video Files (.mp4)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Data file 1	LICENSE	Text file (.txt)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Data file 2	MEXICAN-DATA-ACCESS-FORM-ThermalCovid19	Word (.docx)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Data file 3	MEXICAN-NON-DISCLOSURE-AGREEMENT	Word (.docx)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Data file 4	SHA256SUMS.txt	Text file (.txt)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Datafile 5	subject_description	Excel (.csv)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]
Datafile 6	survey_template_datos_termico	PDF (.pdf)	PhysioNet (https://doi.org/10.13026/wfr2-5973) [11]

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removed, facilitating use, and standardizing future comparisons.

Corrections

We noted variations in focus, thermal miss-calibration, frame rate, and camera orientation. For focus correction, we post-process each video frame and apply a deblurring operation. For frame rate, video clips with a frame rate higher than five frames per second were downsampled to five frames per second. Thermal variations were accounted for by monitoring the background temperature and body temperature for each frame. We then applied a linear transformation on each frame to enforce that all frames showed the same background and body temperature. Camera orientation was standardized. The final corrected video was stored in AVI format.

Limitations

While care was taken to minimize artifacts, some subjects were nevertheless out of focus or moved during the acquisition period, and the camera error is expected to have some degree of interference in the results. Specifically, the measurement accuracy of the camera corresponds to ± 2 ℃ or $\pm 2\%$ at environmental temperatures 10 ℃ to 35 ℃, while among the participants the temperature variance during the video capture was < 1.75 ℃ and 1.4 ℃ for negative and positive participants, respectively, with the median around 0.55 ℃ in both cases. Because this observational study has a small sample size, conclusions drawn from the data may be implemented as part of data exploration and proof-of-concept, and validated with a larger database for generalization. Final considerations for the use of this data include an imbalance between male and female subjects recorded, and inter-subject variations such as facial hair and jewelry.

Abbreviations
WHO   World Health Organization
PCR   Polymerase chain reaction
CT   Computed tomography

Author contributions
RB and AY originally conceptualized the study. The current study was designed by RB, AY, GTA, JGTP, SCH, and VT. The clinical protocol for the Institutional review board was written and managed by JGTP, SCH., and VT. Donor enrolment and consent was performed by AATF, CADG, MLH, and ACES, who also registered clinical and demographic data and recorded the thermal images under the coordination and supervision of VT. Covid-19 tests and results were supervised and provided by ROL. The manuscript was originally drafted by VT, corrected by JGTP, and the final draft was prepared by SRZ. The manuscript was revised, amended, and approved by all authors.

Availability of data and materials
The data described in this Data note can be freely and openly accessed on PhysioNet under https://doi.org/https://doi.org/10.13026/wfr2-5973. Access to the data record will require registration with PhysioNet and compliance with a data use agreement. Please see Table 1 and reference [11] for details and links to the data.

Declarations

Ethics approval and consent to participate
All methods were carried out in accordance with relevant guidelines and regulations. The study was approved by the institutional review board code of the School of Medicine at Tecnológico de Monterrey corresponding to study ID "P000402-TERMAL-COVID 19-CI-CR001 / Termal-COVID 19" entitled "Estudio Piloto del Poder Discriminante de los Patrones Termográficos Y Sintomáticos entre Pacientes Positivos de Covid-19 Contra Pacientes Negativos de Covid-19". Permission to publish was granted by the institutional review board. Study participants were informed of all steps in the procedure and the visual aspects of the final thermal images (avoiding human visible light colors, face identification, and body details). All participants provided written informed consent, which included access to PCR reports.

Consent for publication
All participants provided written consent for use of the data.

Competing interests
The authors declare that they have no competing interests.

References
1. Wu F, et al. A new coronavirus associated with human respiratory disease in China. Nature. 2020. https://doi.org/10.1038/s41586-020-2008-3.
2. Zhou P, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature. 2020. https://doi.org/10.1038/s41586-020-2012-7.
3. Guan W, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med. 2020. https://doi.org/10.1056/NEJMoa2002032.
4. Wang S, et al. A deep learning algorithm using CT images to screen for Corona Virus Disease (COVID-19). medRxiv. 2020. https://doi.org/10.1101/2020.02.14.20023028.
5. Mei X, et al. Artificial intelligence–enabled rapid diagnosis of patients with COVID-19. Nat Med. 2020. https://doi.org/10.1038/s41591-020-0931-3.
6. Ring EFJ, Ammer K. Infrared thermal imaging in medicine. Physiol Meas. 2012. https://doi.org/10.1088/0967-3334/33/3/R33.
7. Foudazi A, Edwards CA, Ghasr MT, Donnell KM. Active microwave thermography for defect detection of CFRP-strengthened cement-based materials. IEEE Trans Instrum Meas. 2016. https://doi.org/10.1109/TIM.2016.2596080.
8. Arora N, et al. Effectiveness of a noninvasive digital infrared thermal imaging system in the detection of breast cancer. Am J Surg. 2008. https://doi.org/10.1016/j.amjsurg.2008.06.015.
9. Evertsen J, Baumgardner DJ, Regnery A, Banerjee I. Diagnosis and management of pneumonia and bronchitis in outpatient primary care practices. Prim Care Respir J. 2010. https://doi.org/10.4104/pcrj.2010.00024.

10. Canales Fiscal MR, Treviño V, Ramírez-Treviño LJ, Ortiz-López R, Cardona Huerta S, Lara-Díaz VJ, Tamez-Peña JG. COVID-19 classification using thermal images. J Biomed Opt. 2022;27(5):056003. https://doi.org/10.1117/1.JBO.27.5.056003.

11. Tamez-Peña J, Yala A, Cardona S, Ortiz-Lopez R, Trevino V. Upper body thermal images and associated clinical data from a pilot cohort study of COVID-19 version 11. 2021. PhysioNet. https://doi.org/10.13026/wfr2-5973.

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