SYMPTOMsense™

POWERED BY SOUNDPASS™ BIOMETRIC SAFETY SYSTEMS

White Paper

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Introduction

SymptomSense has partnered with the Raisonance group to build on its award-winning vitals scanning platform. The Raisonance is a group of Artificial Intelligence/Machine Learning companies that focus on both biometric safety and healthcare solutions. The company was originally funded by the National Science Foundation to advance the research and development of an initial innovation that uses AI to detect and diagnose the presence of COVID-19 in an individual's cough sound signature – via a mobile phone application.

With NSF's support, the team at Raisonance rapidly advanced this original innovation and now has partnered with SymptomSense to bring this technology to market.

SymptomSense™ Check is a biometric safety system in the form of a mobile app that is designed to transform sound signatures into biometrics using artificial intelligence. SymptomSense™ Check monitors minute differences that take place in an individual's cough signature which indicate that something has changed. The change can be the result of inhaling a noxious chemical, or, from acquiring a cold or other respiratory virus. The product is designed to allow users to conduct self-checks frequently – even multiple times per day. The app pairs with the SymptomSense™ Gateway or Kiosk at workplaces, businesses and educational campuses to scan the QR code generated by the app for each incoming individual. This ensures that everyone entering has been checked for a cough signature change in the previous 4 hours.

The Science

The detection of various health markers using artificial intelligence is an established area of study and product development. Prestigious institutions such as MIT and the University of Cambridge have successfully demonstrated the success of using artificial intelligence to detect the markers in vocalized sounds and coughs. More specifically:

"Prior studies have shown that cough from distinct respiratory syndromes have distinct latent features. These distinct features can be extracted by appropriate signal processing and mathematical transformations of the cough sounds." – Informatics in Medicine Unlocked, ScienceDirect, Volume 20, 2020

"We developed an AI speech processing framework that leverages acoustic biomarker feature extractors to pre-screen for COVID-19 from cough recordings and provide a personalized patient saliency map to longitudinally monitor patients in real-time, non-invasively, and at essentially zero variable cost. Cough recordings are transformed with Mel Frequency Cepstral Coefficient and inputted into a Convolutional Neural Network (CNN) based architecture made up of one Poisson biomarker layer and 3 pre-trained ResNet50's in parallel, outputting a binary pre-screening diagnostic. Our CNN-based models have been trained on 4256 subjects and tested on the remaining 1064 subjects of our dataset. Transfer learning was used to learn biomarker features on larger datasets, previously successfully tested in our Lab on Alzheimer's, which significantly improves the COVID-19 discrimination accuracy of our architecture. Results: When validated with subjects diagnosed using an official test, the model achieves COVID-19 sensitivity of 98.5% with a specificity of 94.2% (AUC: 0.97). For asymptomatic subjects it achieves sensitivity of 100% with a specificity of 83.2%." – MIT Open Voice Medicine Team, 2020

To read more about the validation and research being done on solutions like this, please review the peer-reviewed research below:

Covid-19 Artificial Intelligence Diagnosis Using Only Cough Recordings

Published: 29 September 2020
https://ieeexplore.ieee.org/document/9208795

"Goal: We hypothesized that COVID-19 subjects, especially including asymptomatics, could be accurately discriminated only from a forced-cough cell phone recording using Artificial Intelligence. To train our MIT Open Voice model we built a data collection pipeline of COVID-19 cough recordings through our website (opensigma.mit.edu) between April and May 2020 and created the largest audio COVID-19 cough balanced dataset reported to date with 5,320 subjects.

Methods: We developed an AI speech processing framework that leverages acoustic biomarker feature extractors to pre-screen for COVID-19 from cough recordings, and provide a personalized patient saliency map to longitudinally monitor patients in real-time, non-invasively, and at essentially zero variable cost. Cough recordings are transformed with Mel Frequency Cepstral Coefficient and inputted into a Convolutional Neural Network (CNN) based architecture made up of one Poisson biomarker layer and 3 pre-trained ResNet50's in parallel, outputting a binary pre-screening diagnostic. Our CNN-based models have been trained on 4256 subjects and tested on the remaining 1064 subjects of our dataset. Transfer learning was used to learn biomarker features on larger datasets, previously successfully tested in our Lab on Alzheimer's, which significantly improves the COVID-19 discrimination accuracy of our architecture.

Results: When validated with subjects diagnosed using an official test, the model achieves COVID-19 sensitivity of 98.5% with a specificity of 94.2% (AUC: 0.97). For asymptomatic subjects it achieves sensitivity of 100% with a specificity of 83.2%.

Conclusions: AI techniques can produce a free, non-invasive, real-time, any-time, instantly distributable, large-scale COVID-19 asymptomatic screening tool to augment current approaches in containing the spread of COVID-19. Practical use cases could be for daily screening of students, workers, and public as schools, jobs, and transport reopen, or for pool testing to quickly alert of outbreaks in groups. General speech biomarkers may exist that cover several disease categories, as we demonstrated using the same ones for COVID-19 and Alzheimer's."

AI4COVID-19: AI enabled preliminary diagnosis for COVID-19 from cough samples via an app

Published: 4 May 2020
https://www.sciencedirect.com/science/article/pii/S2352914820303026?via%3Dihub

"Background: The inability to test at scale has become humanity's Achille's heel in the ongoing war against the COVID-19 pandemic. A scalable screening tool would be a game changer. Building on the prior work on cough-based diagnosis of respiratory diseases, we propose, develop and test an Artificial Intelligence (AI)-powered screening solution for COVID-19 infection that is deployable via a smartphone app. The app, named AI4COVID-19 records and sends three 3-s cough sounds to an AI engine running in the cloud, and returns a result within 2 min.

Methods: Cough is a symptom of over thirty non-COVID-19 related medical conditions. This makes the diagnosis of a COVID-19 infection by cough alone an extremely challenging multidisciplinary problem. We address this problem by investigating the distinctness of pathomorphological alterations in the respiratory system induced by COVID-19 infection when compared to other respiratory infections. To overcome the COVID-19 cough training data shortage we exploit transfer learning. To reduce the misdiagnosis risk stemming from the complex dimensionality of the problem, we leverage a multi-pronged mediator centered risk-averse AI architecture.

Results: Results show AI4COVID-19 can distinguish among COVID-19 coughs and several types of non-COVID-19 coughs. The accuracy is promising enough to encourage a large-scale collection of labeled cough data to gauge the generalization capability of AI4COVID-19. AI4COVID-19 is not a clinical grade testing tool. Instead, it offers a screening tool deployable anytime, anywhere, by anyone. It can also be a clinical decision assistance tool used to channel clinical-testing and treatment to those who need it the most, thereby saving more lives."

Clinical Characteristics and Prognostic Factors for Intensive Care Unit Admissions of Patients With COVID-19: Retrospective Study Using Machine Learning and Natural Language Processing

Published: 28 October 2020
https://pubmed.ncbi.nlm.nih.gov/33090964/

"Background: Many factors involved in the onset and clinical course of the ongoing COVID-19 pandemic are still unknown. Although big data analytics and artificial intelligence are widely used in the realms of health and medicine, researchers are only beginning to use these tools to explore the clinical characteristics and predictive factors of patients with COVID-19.

Objective: Our primary objectives are to describe the clinical characteristics and determine the factors that predict intensive care unit (ICU) admission of patients with COVID-19. Determining these factors using a well-defined population can increase our understanding of the real-world epidemiology of the disease.

Methods: We used a combination of classic epidemiological methods, natural language processing (NLP), and machine learning (for predictive modeling) to analyze the electronic health records (EHRs) of patients with COVID-19. We explored the unstructured free text in the EHRs within the Servicio de Salud de Castilla-La Mancha (SESCAM) Health Care Network (Castilla-La Mancha, Spain) from the entire population with available EHRs (1,364,924 patients) from January 1 to March 29, 2020. We extracted related clinical information regarding diagnosis, progression, and outcome for all COVID-19 cases.

Results: A total of 10,504 patients with a clinical or polymerase chain reaction-confirmed diagnosis of COVID-19 were identified; 5519 (52.5%) were male, with a mean age of 58.2 years (SD 19.7). Upon admission, the most common symptoms were cough, fever, and dyspnea; however, all three symptoms occurred in fewer than half of the cases. Overall, 6.1% (83/1353) of hospitalized patients required ICU admission. Using a machine-learning, data-driven algorithm, we identified that a combination of age, fever, and tachypnea was the most parsimonious predictor of ICU admission; patients younger than 56 years, without tachypnea, and temperature <39 degrees Celsius (or >39 °C without respiratory crackles) were not admitted to the ICU. In contrast, patients with COVID-19 aged 40 to 79 years were likely to be admitted to the ICU if they had tachypnea and delayed their visit to the emergency department after being seen in primary care.

Conclusion: Our results show that a combination of easily obtainable clinical variables (age, fever, and tachypnea with or without respiratory crackles) predicts whether patients with COVID-19 will require ICU admission."