AI in Respiratory care

Advancing Spirometry

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AI Importance and Existence in COPD Awareness

Abstract:

Pulmonary function test (PFTs) plays a crucial role in assessing respiratory health. These tests measures parameters such as spirometry, lung volumes, and carbon monoxide diffusion capacity (DLCO). However, interpreting PFT results can be challenging due to inter-rater variability among clinicians and potential inaccuracies. Machine learning (ML) offers promising solutions to enhance PFT interpretation and advance patient care. This variability may be caused by unfamiliarity of the guidelines, lack of training, inadequate understanding of lung physiology, or simply mental lapses. A rules-based automated interpretation system can recapitulate expert's pattern recognition capability and decrease errors. ML can also be used to analyze continuous data or graphics, including the flow-volume loop, the DLCO and the nitrogen washout curves. These analyses can discover novel physiological biomarkers. In the era of wearables and telehealth, particularly with the COVID-19 pandemic restricting PFTs to be done in the clinical laboratories, ML can also be used to combine mobile spirometry results with an individual's clinical profile to deliver precision medicine. There are, however, hurdles in the development and commercialization of the ML-assisted PFT interpretation programs, including the need for high quality representative data, the existence of different formats for data acquisition and sharing in PFT software by different vendors, and the need for collaboration amongst clinicians, biomedical engineers, and information technologists. Hurdles notwithstanding, the new developments would represent significant advances that could be the future of PFT, the oldest test still in use in clinical medicine

Background of the problem

Spirometry test is a subjective test by nature it depends on the effort and the technique applied by the patient during testing.

To this end, if the patient does not blow properly, it means if they do not blow with proper force or abruptly stop exhaling or exhale multiple times – then the same cannot be taken for clinical interpretation.

The spirometry graphs have a particular shape for all these errors depending on the exhale pattern generated.

In the traditional spirometers

A trained clinical physician/pulmonologist is required to see the graphs and arrive at conclusions subjectively.

Alternately, these reports were to be sent to special custom solutions built to analyse these graphs, which delayed reporting and also made them expensive to implement and operate – For e.g. refer Home – ArtiQ.

If the reports returned with errors, the patient would have to revisit the centre and perform the test again with proper technique and/or the physician would have to rely on such reports for making diagnosis.

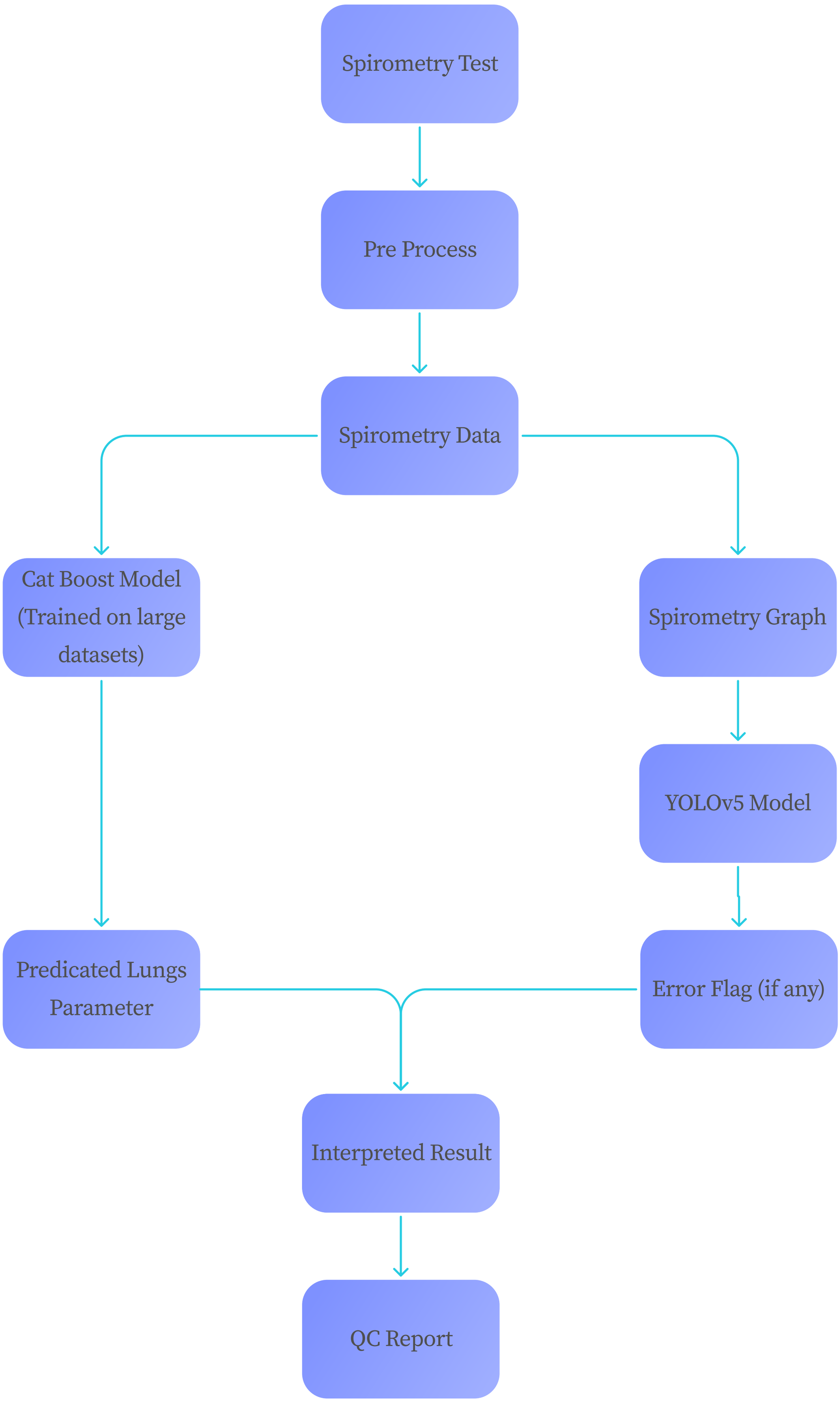
Outcome

With our AI/ML based solution now the Spirometry quality grading report detects these errors in the graphs and the on-ground technician/paramedic can immediately generate this “Spirometry Quality” report and understand whether the patient has performed the test correctly. If not, what was the error and the Areas of Improvement.

Accordingly, the patient can be informed to again perform the test then and there with the necessary improvements in the technique.

Advantages

- Implementation and operation costs for analysing spirometry grading reduced to 0
- First time indigenous Made in India solution
- Better Diagnosis
- Savings in retesting and OPEs


Spirometry Test
Pre Process
Spirometry Data
Cat Boost Model (Trained on large datasets)
Spirometry Graph
YOLOv5 Model
Predicated Lungs Parameter
Error Flag (if any)
Interpreted Result
QC Report

Available Methods:

CatBoost- Empowering Data Interpretation and Value Prediction

CatBoost, a powerful gradient boosting algorithm, has emerged as a game changer in spirometry data interpretation. Its ability to handle categorical data and make accurate predictions is invaluable in analyzing spirometry results. By training CatBoost on diverse datasets, healthcare professionals can effectively predict lung function parameters, such as Total lung capacity (TLC), etc.

This not only streamlines the interpretation process but also aids in early detection of respiratory abnormalities and disease progression.

YOLOv5 - Revolutionizing Graph Interpretation and Error Detection

Graph interpretation in spirometry traditionally relies on manual scrutiny, which can be time-consuming and prone to human error. YOLOv5, an advanced deep learning model for object detection, offers a groundbreaking solution to this challenge. By leveraging YOLOv5's real-time detection capabilities, spirometry graphs can be automatically analyzed with unprecedented speed and accuracy. This enables the identification of user errors, such as coughing, improper technique, or equipment malfunction, ensuring the integrity of spirometry data and minimizing diagnostic inaccuracies

Integration of ML models:

The integration of CatBoost and YOLOv5 in spirometry represents a significant step forward in pulmonary diagnostics. By combining the strengths of these models, healthcare providers can achieve comprehensive insights into lung function while mitigating the risks associated with human error. Furthermore, ongoing advancements in machine learning and deep learning techniques hold promise for further refining spirometry interpretation methodologies. Future endeavorsmay involve the development of hybrid models that synergize the strengths of CatBoost and YOLOv5, paving the way for even more precise and efficient spirometry analysis.

Block diagram

The potential for using ML in PFT interpretation is expanding in several directions. First, ML is being used to better detect technical deficiencies and poor-quality data to avert algorithm misclassifications and alert the interpreters. Second, attempts are being made to combine PFT data with the clinical picture to better diagnose specific disease states. Third, and perhaps most exciting,

ML is being used to analyze continuous data, not just discrete data points, to define new patterns of physiologic dysfunction and links to disease states. Finally, ML can be used to integrate PFT data into the realm of telehealth.

Improving Test Quality

Standard PFTs require properly calibrated equipment, standardized testing procedures, and cooperative patients. Current ERS/ATS standards define test quality using checklists filled out by the technologists. Checklists, however, are poor at assessing many of the nuances associated with good patient effort and subtle machine performance characteristics. ML techniques could aid in assessing the quality of the forced expiratory flow pattern, inert gas washout pattern, panting maneuvers, and breath-holds required during standard PFTs. These possibilities have yet to be developed in any practical fashion

Conclusion:

In the realm of spirometry, the utilization of advanced machine learning models like CatBoost and YOLOv5 marks a paradigm shift towards more accurate, efficient, and reliable diagnostics. By harnessing the power of these technologies, healthcare professionals can elevate the standard of care for patients with respiratory conditions, enabling early detection, personalized treatment strategies, and improved clinical outcomes. Moreover, the implementation of these algorithms facilitates the generation of comprehensive Quality Control (QC) reports, ensuring data integrity and enhancing the overall reliability of spirometry testing. As we continue to innovate and integrate cutting-edge models into pulmonary diagnostics, the future of spirometry holds immense promise for revolutionizing respiratory healthcare and fostering better patient outcomes.

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About us

alveofit® is a cutting-edge company leveraging technology to transform respiratory care, making it accessible and affordable for everyone. Our ecosystem is meticulously designed to enhance the management of respiratory diseases and empower patients to lead symptom-free lives. Through the integration of analytics, IoT, and digital services, alveofit creates innovative products that significantly improve the management of lung health conditions.

Our solutions offer patients real-time access to lung function data, enabling better control over respiratory conditions such as COPD, Asthma, Pulmonary Fibrosis, and Cystic Fibrosis. The alveofit system incorporates a closed-loop care-engagement model that allows physicians to intervene promptly if patient conditions deviate from the expected path.

By facilitating regular monitoring of lung functions and continuous engagement with healthcare providers, alveofit enhances treatment efficacy. Early diagnosis and proactive management reduce the need for emergency hospital visits, improving patient outcomes and quality of life.

Reach out to us at info@alveo.fit