ABSTRACT
Respiratory monitoring is used in medical applications to detect abnormal breathing conditions. In sleep studies, respiratory monitoring helps detect disorders such as obstructed breathing and sleep apnea. Respiratory monitoring methods either place sensors on the patient’s body, causing discomfort and altering natural breathing, or they measure respiration remotely at the cost of accuracy. We present a method of non-contact analysis that monitors respiration directly and remotely. We place a thin medium perpendicular to the individual’s face, and record the heat signature from their breath on the medium using a thermal camera. We then use image processing to extract respiratory behaviors.

INTRODUCTION
Respiratory monitoring techniques are often a tradeoff between accuracy and patient comfort. Contact methods provide accurate results, but require direct contact with the patient’s body, which results in discomfort and unnatural breathing behaviors. Popular contact methods include:
- ECG electrodes on the patient’s body [5]
- Thermistors in the patient’s nose [7]
- Abdominal strain-gauge transducer [5]
- Polysomnography [2]

Non-contact methods have the opposite problem: they provide a comfortable experience, but are less accurate. These methods often utilize remote sensors such as:
- Cameras [8][10]
- Volumetric sensors [9]
- Microphones [6]
- Radar [3]

We propose a method of respiratory analysis that is non-contact, but gives more accurate results than other contact methods by measuring respiration directly. We explore various material properties, such as:
- Thermal conductivity
- Sensitivity to heat
- Size and shape
- Cost

We compare cotton, linen, and standard copy paper as medium materials. These materials have similar thermal properties, but we chose copy paper because it is:
- The most thermally sparse and has the finest textures and smoothest surface.
- Easily and evenly fixed
- Common, inexpensive, and widely available.

RESULTS (cont.)
We conducted 68 second trials for each experimental setup and recorded the BPM statistics for each trial. In the fan experiment, the fan is set to a constant 10 RPM. For the human experiment, we process both the side thermal view and the medium thermal view in the same way to see how both data sets correlate.

CONCLUSION
This method of non-contact respiration rate monitoring measures respiration directly, yet conforms to it at an affordable price, and provides other information such as nose to mouth distribution and breathing strength. This method is widely applicable to many clinical applications. The proposed technique represents a novel approach to respiration monitoring, providing a comprehensive and accurate analysis of breathing behavior while keeping the patient comfortable and preserving natural breathing.

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REFERENCES
[3] B. J. Deh and M. T. Khodakarami. Thermographic and other information such as nose to mouth distribution and breathing strength. This method is widely applicable to many clinical applications. The proposed technique represents a novel approach to respiration monitoring, providing a comprehensive and accurate analysis of breathing behavior while keeping the patient comfortable and preserving natural breathing.

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