Non-Invasive Analysis For Health [1]

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[1] Based on the paper "Contactless Health Monitoring: An Overview of Video-based Techniques Utilising Machine/Deep Learning"

Outline

1: Introduce

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- Core Technology: iPPG (imaging Photoplethysmography)
- Our Approach:
  - Apply advanced Machine Learning (ML) and Deep Learning (DL).
  - Goal: To robustly analyze noisy data and accurately extract health metrics.

What is iPPG?

- A non-contact technology that uses a camera to measure vital signs.
- **How it Works:** It detects microscopic skin color changes from a video.
- **The Cause:** These color changes are caused by the pulse (blood volume changing with each heartbeat).
- **The Goal:** To remotely extract signals like heart rate, breathing rate, and blood pressure.

Illustrates

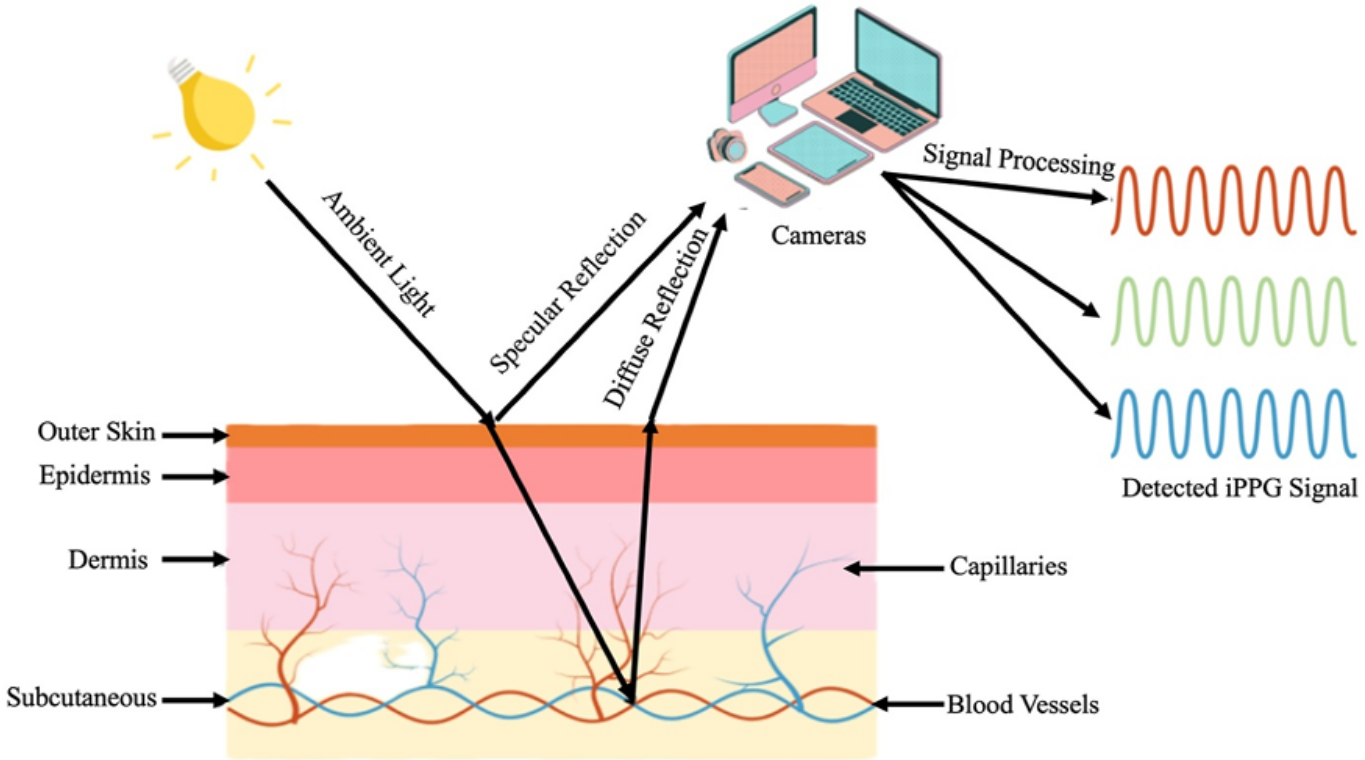
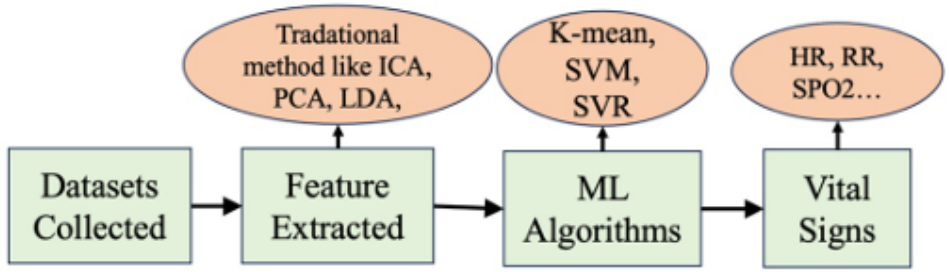
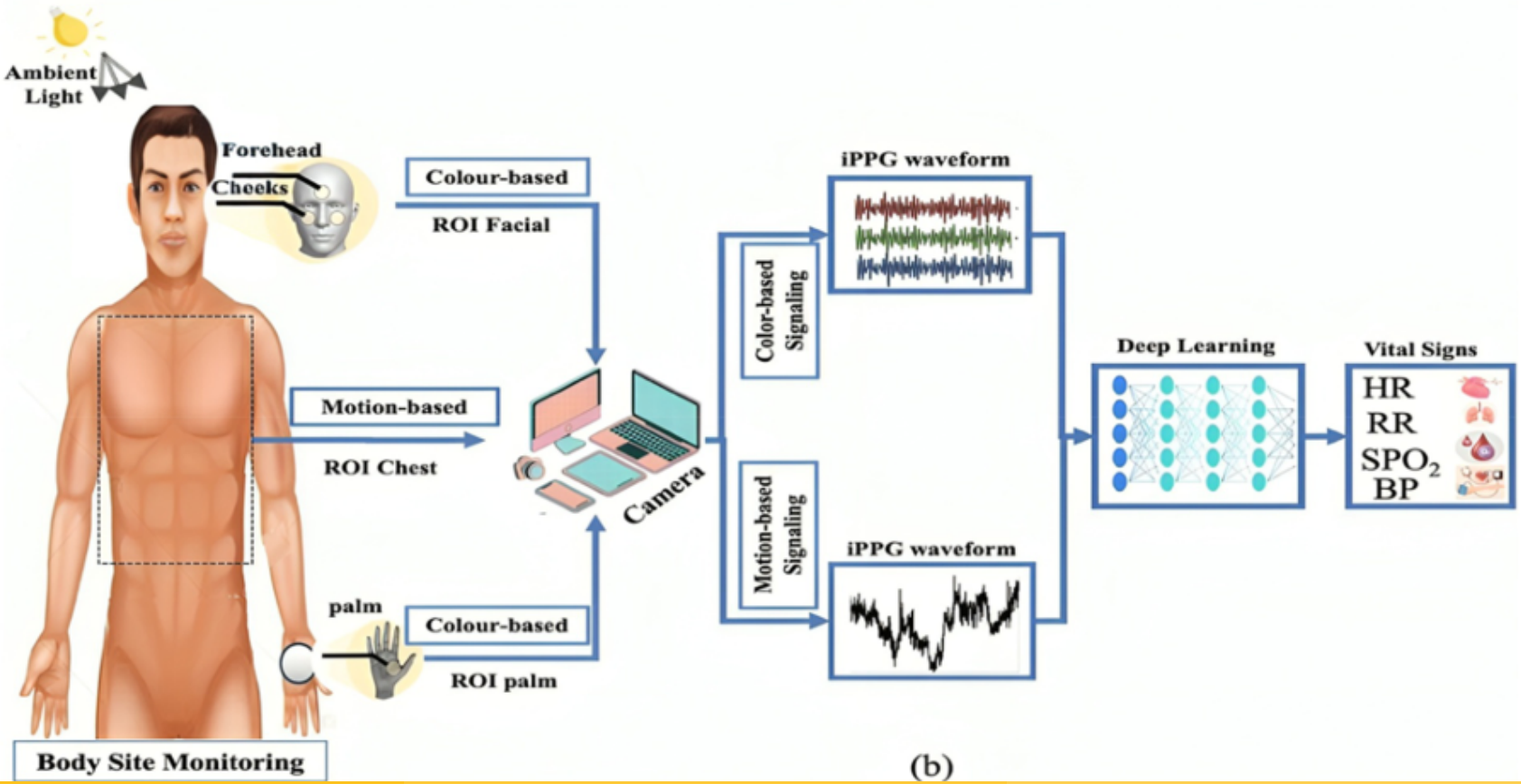


FIGURE 1 | Illustrates the process of extracting the iPPG signal from the three channels (red–green–blue) to acquire vital signs

iPPG Processing: ML vs. DL Approaches



(a)



(b)

2: Heart Rate (HR)

Extract HR based on ML

- Step 1: Region of interest (ROI) selection
- Step 2: ML-Based Signal Processing Pipeline
  - ICA (Independent Component Analysis)
  - LR (Linear Regression)
  - Bayesian approach
  - Random Forest (RF) & K-means
  - SVM (Support Vector Machine)

Extract HR based on DL

- Step 1: Core Method: End-to-End Learning
- Step 2: Deep Learning Architectures:
  - Hybrid (CNN + RNN)
  - Attention Mechanisms: DeepPhys, MTTS-CAN.
  - Multi-scale Models: MSSTNet, GLISNet.

3. Respiratory Rate (RR)

Extract RR based on ML

- Method 1: Thermal Camera (Nose Tracking)
- Method 2: RGB Camera (Motion Tracking)
- Specific ML Algorithms (for RGB Method):
  - Linear Regression (LR)
  - Random Forest (RF)
  - Binary Decision Tree (DT)
  - Other Classifiers (K-star, Rotation Forest)

Extract RR based on DL

- **Focus:** Using Deep Learning (DL) with standard RGB cameras.
- **Key Insight:** Analyzing pixel motion (movement) is more accurate than analyzing pixel intensity (color changes) for RR.
- DL Techniques:
  - EVM (Eulerian Video Magnification).
  - Optical Flow.
  - Spatiotemporal Architectures: LSTM, 1D-CNN, 3D-CNN.
  - Simultaneous Prediction.
  - Hybrid Models.

Diagram

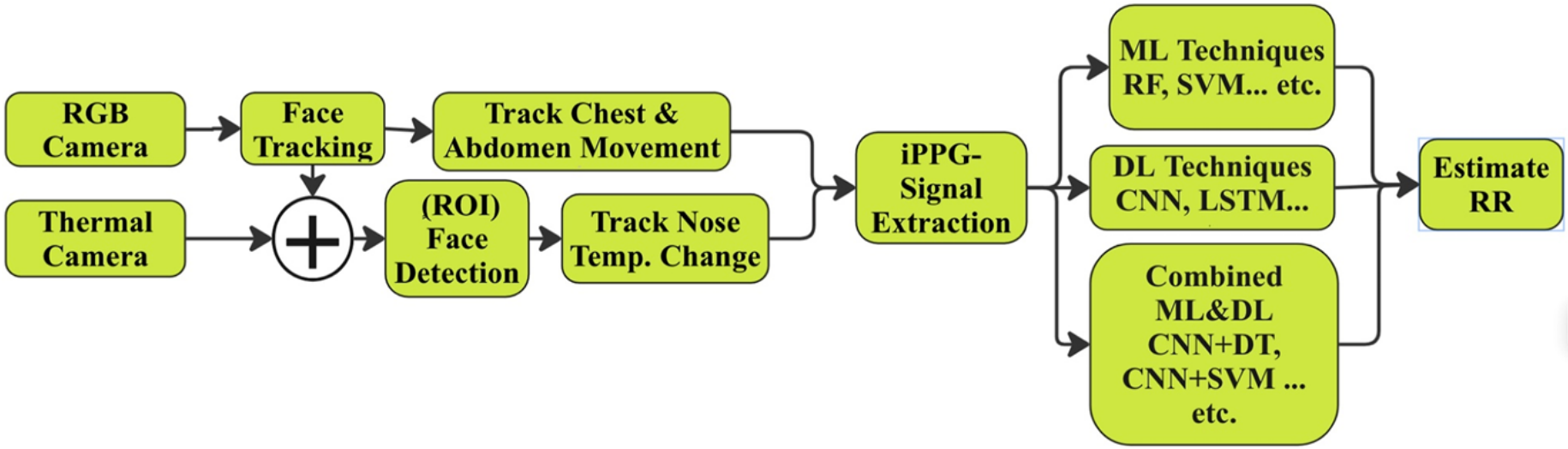


FIGURE 6 | Diagram showing how thermal/colour cameras with ML/DL can predict RR.

4. Body Temperature (BT)

Body Temperature

- Core Technology (Inputs): Thermal Cameras or RGB Cameras
- General Algorithm Workflow:
  1. Face/ROI Detection
  2. Best-ROI Selection
  3. Temperature Extraction Classification.
- Specific ML/DL Algorithm Examples:
  - KNN: Used for classification
  - Logistic Regression: Also used for classification
  - V-TEMP: A novel method designed for RGB cameras. It estimates skin temperature based on the skin's light reflectance properties.
  - Hybrid DL (SSD): A system using an SSD for face detection followed by temperature extraction from the ROI

Illustrates

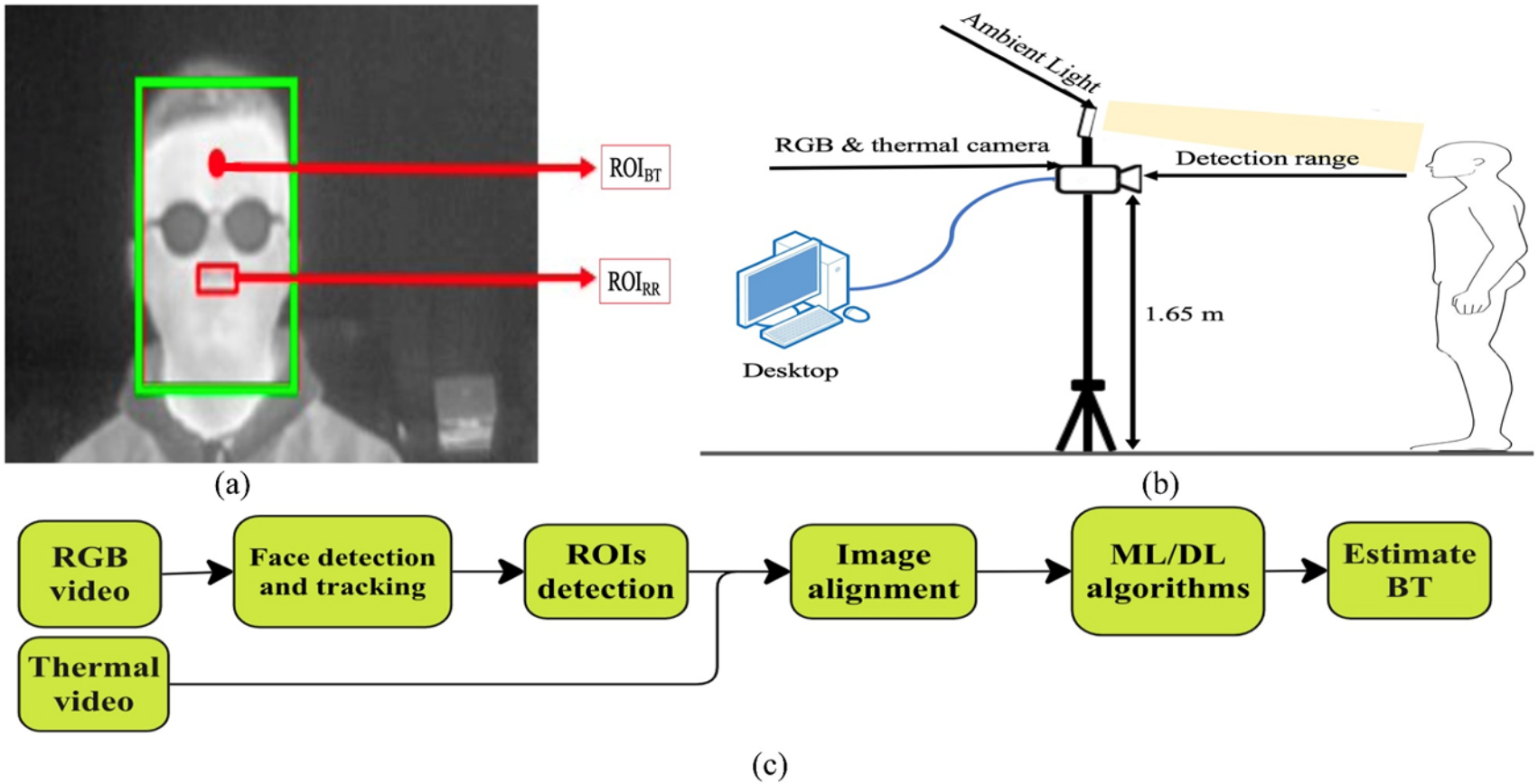


FIGURE 10 | (a) Illustration of vital signs measurement experiment setup [88], (b) locations of ROI (RR) and ROI (BT) on simultaneous thermal image [88] and (c) workflow for BT estimation using RGB camera and thermal cameras.