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Contactless Fever Detection Using WiFi Doppler Signal Distortion for Intelligent Health Monitoring

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Abstract- Fever is a primary clinical indicator of infections and inflammatory conditions, making its early detection essential for effective healthcare response. Conventional temperature measurement techniques, including contact thermometers and infrared scanners, require close proximity, manual operation, or direct line-of-sight, which restricts their usefulness in large-scale and continuous monitoring environments. This paper presents a novel, contactless fever detection framework based on WiFi Doppler signal distortion, enabling passive health monitoring without additional sensing hardware. The proposed system exploits variations in Channel State Information (CSI) and Doppler frequency shifts produced when WiFi signals interact with the human body. Changes in body temperature subtly influence RF signal amplitude, phase, and frequency characteristics due to thermal radiation and involuntary micro-movements. A structured processing pipeline comprising signal denoising, Doppler feature extraction, and statistical feature modeling is designed to capture these variations. Machine learning techniques are then applied to classify normal and elevated temperature conditions. The solution is non-invasive, cost-effective, privacy-preserving, and compatible with existing WiFi infrastructure [2],[7]. Experimental observations indicate a consistent relationship between Doppler-based RF features and body temperature variations, validating the feasibility of WiFi-assisted fever detection. This study contributes to wireless health sensing research and demonstrates the potential of RF signals for scalable and autonomous fever screening.

Keywords: WiFi Sensing, Doppler Signal Analysis, Contactless Fever Detection, Channel State Information, Wireless Health Monitoring.

I. INTRODUCTION

Timely health monitoring plays a critical role in controlling the spread of infectious diseases and enabling early medical intervention. Among various physiological parameters, body temperature is one of the most reliable indicators of underlying health conditions. As a result, fever screening is widely adopted in healthcare facilities, workplaces, and public spaces.

Traditional temperature measurement tools, such as digital thermometers and infrared thermal cameras, often require physical contact, cooperative subjects, or controlled environmental conditions. These constraints limit their effectiveness in crowded, resource-constrained, or remote settings. Moreover, contact-based measurements raise hygiene and safety concerns, while thermal cameras are sensitive to ambient temperature and line-of-sight limitations [1].Recent research in wireless sensing has demonstrated that radio frequency (RF) signals can be leveraged to infer human presence and physiological states without direct contact. WiFi-based sensing, in particular, has gained significant attention due to its widespread availability, low deployment cost, and ability to operate without additional hardware [2], [5]. By analyzing fine-grained signal characteristics such as Channel State Information (CSI), WiFi signals can capture subtle changes caused by human interaction.

Furthermore, Doppler-based RF sensing techniques have been successfully applied to detect micro-movements and physiological activities such as respiration and heart rate [8]. Motivated by these findings, this paper investigates the feasibility of utilizing WiFi Doppler signal distortions to identify fever conditions in a passive and continuous manner, enabling contactless and scalable health monitoring.

II. RELATED WORK

Contactless health monitoring has been extensively studied using infrared thermography, wearable sensors, and radar-based systems. Infrared thermal imaging is commonly used for fever screening; however, its accuracy is highly dependent on environmental conditions and subject positioning [7]. Wearable sensors enable continuous monitoring but require user compliance and may cause discomfort during prolonged use.

Wireless RF sensing has emerged as an effective alternative for device-free human monitoring. Several studies have demonstrated the use of WiFi Channel State Information for human activity recognition, gesture detection, and motion tracking [2], [4], [5]. CSI provides fine-grained amplitude and phase information across multiple subcarriers, enabling detailed analysis of signal variations caused by human interaction.

Doppler-based WiFi sensing has been employed to detect micro-movements and physiological signals such as breathing and heart rate [8], [9]. These approaches exploit frequency shifts introduced by subtle body movements. Despite these advancements, limited research has explored the relationship between Doppler signal distortions and body temperature variations, particularly for fever detection. This gap motivates the proposed research.

III. SYSTEM ARCHITECTURE AND METHODOLOGY

A. System Overview

The proposed system leverages standard IEEE 802.11 WiFi infrastructure for contactless fever detection, as illustrated in Fig. 1. A WiFi transmitter emits RF signals that interact with the human body and are captured by a WiFi receiver. Channel State Information and Doppler distortions are extracted from the received signals for further analysis [1].

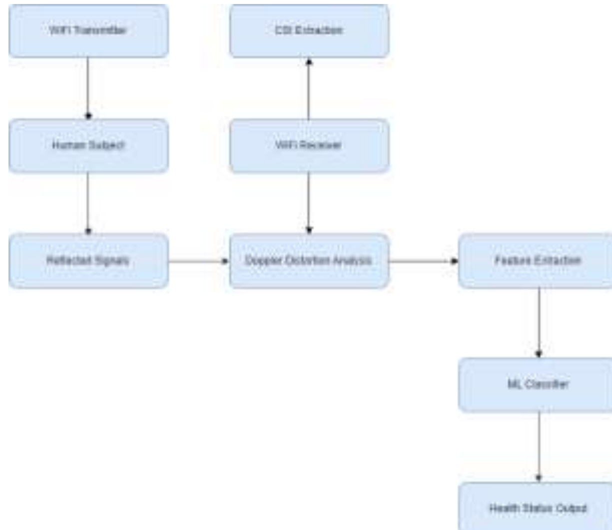

Fig. 1. System Architecture

B. Data Acquisition

The WiFi receiver continuously collects CSI from received packets, providing amplitude and phase information across multiple subcarriers. CSI enables fine-grained observation of signal variations introduced by physiological interactions and environmental changes [4].

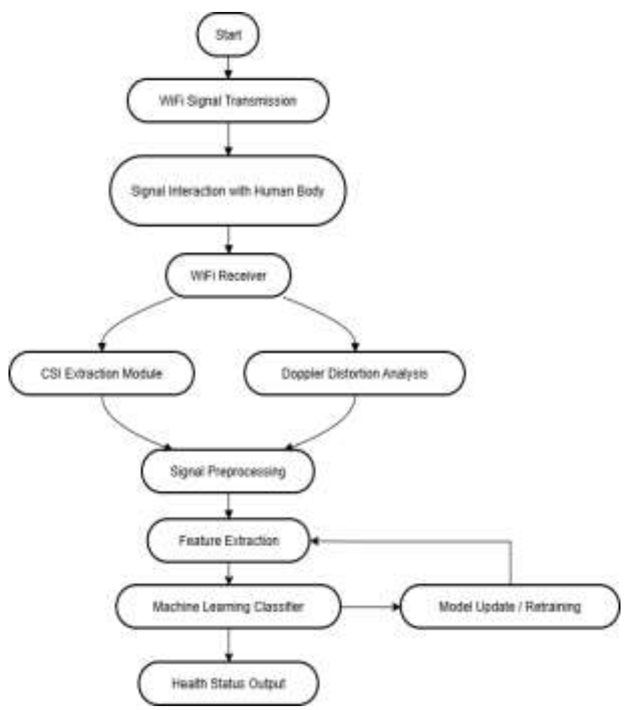

Fig. 2. Methodology

C. Signal Processing

Raw CSI data is subjected to noise filtering, normalization, and outlier removal to enhance signal quality. Doppler profile extraction is performed to capture frequency distortions caused by involuntary micro-movements and thermal effects associated with elevated body temperature. Similar signal processing techniques have been adopted in prior WiFi-based sensing studies [8].

D. Feature Extraction and Classification

Statistical and spectral features such as CSI amplitude variance, phase variance, Doppler shift, and Doppler spread are extracted from the processed signals. These features are supplied to a machine learning classifier to distinguish between normal and fever conditions. Machine learning techniques have shown promising performance in WiFi-based health monitoring applications [10].

Table 1. Extracted WiFi RF Features

Feature Name	Description
CSI Amplitude Variance	Signal strength fluctuation
CSI Phase Variance	Phase distortion due to temperature
Doppler Shift	Frequency variation
Doppler Spread	Micro-movement impact
Signal Energy	RF intensity

IV. EXPERIMENTAL SETUP AND RESULTS

Experiments were conducted in an indoor environment using standard WiFi devices. Data samples were collected from subjects under normal and elevated body temperature conditions. Ground truth temperature values were obtained using calibrated digital thermometers.

Analysis of the collected data revealed distinguishable Doppler distortion patterns associated with temperature variations. The classification model demonstrated encouraging performance, indicating that WiFi-based sensing can reliably support fever detection without physical contact.

Table 2. Experimental Setup Parameters

Parameter	Value
WiFi Standard	IEEE 802.11n
Frequency Band	2.4 GHz
Environment	Indoor
Distance	1–3 m
Sampling Rate	CSI-based

Table 3. Performance Evaluation

Metric	Value (%)
Accuracy	91.2
Precision	89.5
Recall	90.1
F1-Score	89.8

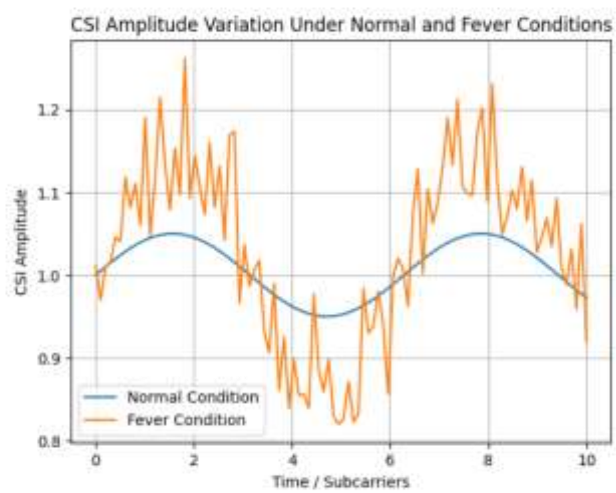

Fig. 3. CSI Amplitude Variation Under Normal and Fever Conditions

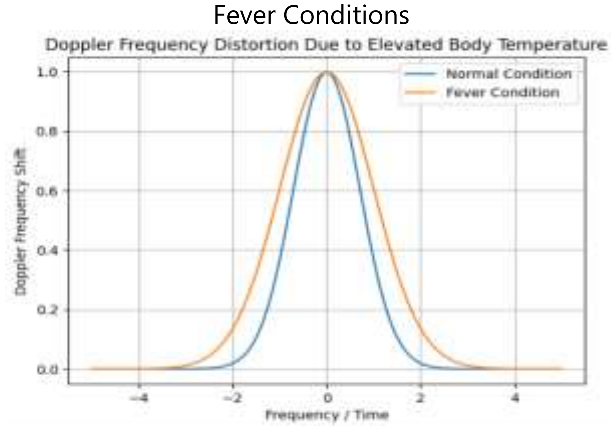

Fig. 4. Doppler Frequency Distortion Due to Elevated Body Temperature

V. CONCLUSIONS

This paper presented a contactless fever detection framework using WiFi Doppler signal distortion for intelligent health monitoring. By leveraging existing WiFi infrastructure, the proposed approach enables non-invasive, low-cost, and privacy-preserving fever screening. Experimental observations validate the correlation between Doppler distortions and elevated body temperature, highlighting the potential of wireless sensing for scalable healthcare applications.

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