CONTACTLESS VITAL SIGN MONITORING AND RECOGNITION WITH CAMERA AND WI-FI CSI

A Project

Presented to the faculty of the Department of Computer Science

California State University, Sacramento

Submitted in partial satisfaction of
the requirements for the degree of

MASTER OF SCIENCE

in

Computer Science

by

Kavya Gopireddy

SUMMER
2022

PREVIEW

PREVIEW

© 2022

Kavya Gopireddy

ALL RIGHTS RESERVED

CONTACTLESS VITAL SIGN MONITORING AND

RECOGNITION WITH CAMERA AND WI-FI CSI

A Project

by

Kavya Gopireddy

PREVIEW

Approved by:

_____, Committee Chair
Dr. Xuyu Wang

_____, Second Reader
Dr. Yuan Cheng

_____
Date

Student: Kavya Gopireddy

I certify that this student has met the requirements for format contained in the University format manual, and this project is suitable for electronic submission to the library and credit is to be awarded for the project.

_____, Graduate Coordinator _____
Dr. Jinsong Ouyang Date

Department of Computer Science

PREVIEW

Abstract

of

CONTACTLESS VITAL SIGN MONITORING AND RECOGNITION WITH CAMERA AND WI-FI CSI

by

Kavya Gopireddy

PREVIEW

In recent years, contactless monitoring has become the most popular research topic in healthcare monitoring systems. By monitoring vital signs continuously, we will know about our health conditions. We can identify many diseases based on our vital signs. Currently, there are RFID-based, radar-based, WiFi-based, and camera-based techniques to monitor our vital signs. However, these techniques might not provide robust results under certain conditions. For example, camera-based breathing sensing may not work robustly if the room has low brightness. WiFi-based breathing sensing is not robust when there are disturbances in the environment. So, we proposed a model to improve the robustness of vital sign monitoring by combining different sensing techniques.

In this project, we develop a system to monitor our breathing using WiFi CSI data and a camera. Later, we use a neural network model which combines WiFi-based breathing sensing and camera-based breathing sensing to improve the robustness.

This research mainly focuses on extracting breathing data from WiFi CSI. We also use two Raspberry Pi units and a router to obtain the CSI data. We also use a low-resolution camera to capture breathing information through video. For the code, we use Python libraries, and MATLAB.

_____, Committee Chair
Dr. Xuyu Wang

_____
Date

PREVIEW

DEDICATION

To my parents and friends for supporting and encouraging me. This accomplishment would not have been possible without them.

PREVIEW

ACKNOWLEDGEMENTS

I want to express my gratitude to my professor, Dr. Xuyu Wang, for the knowledge, support, and mentorship for the project. He guided me in the right direction with helpful pointers. His knowledge helped me tackle various situations, and honest feedback helped me shape this project towards success.

I am pleased to thank Dr. Yuan Cheng for dedicating his time and insightful suggestions as a second reader. I want to thank Dr. Jinsong Ouyang, Graduate Coordinator, and the Department of Computer Science at California State University, Sacramento, for their continuous administrative support.

I want to thank my family and friends, who have been my strength and support.

PREVIEW

TABLE OF CONTENTS

Page

Dedication vii

Acknowledgements viii

List of Tables xii

List of Figures xiii

Chapter

1. INTRODUCTION 1

2. BACKGROUND AND RELATED WORK 3

2.1. Background on WiFi Channel State Information 3

2.2. Background on Eulerian Video Magnification 4

2.3. Background on Ensemble Learning 5

2.4. Related Work on WiFi Module Setup 5

3. TECHNOLOGIES USED 7

3.1. About the Dataset 7

3.2. Nexmon 7

3.4. CSIKit 8

3.5. Respmon 8

3.6. Raspberry Pi 9

4. SYSTEM DESIGN 10

PREVIEW

4.1. WiFi CSI Module 10

4.2. Camera Module 11

4.3. System Architecture 11

4.4. Labeling the Dataset 12

4.5. WiFi CSI Model Architecture 12

4.6. Camera Model Architecture 14

4.7. Ensemble Model Architecture 14

5. DEVELOPMENT AND IMPLEMENTATION 16

5.1. Installing Nexmon 16

5.2. Collecting Dataset using Raspberry-PI 16

5.3. Extracting Breathing Data from WiFi CSI 17

5.4. Extracting Breathing Signal using Camera 20

6. RESULTS 22

6.1. Breathing Signal from WiFi CSI and Camera. 22

6.2. Prediction using WiFi CSI Model 27

6.3. Prediction using Camera Model 29

6.4. Prediction using Ensemble Model 30

6.5. Effect of Environmental Factors on Breathing Detection 31

7. CONCLUSION 38

PREVIEW

References 39

PREVIEW

LIST OF TABLES

Tables Page

1. WiFi CSI Model Specification 13

2. Camera Model Specification 14

3. Ensemble Model Specification 15

PREVIEW

Reproduced with permission of copyright owner. Further reproduction prohibited without permission.