

REAL TIME HEARTBEAT RATE ESTIMATION USING WEB CAMERA

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering

by

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SCHOOL OF COMPUTING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

CATEGORY -1 UNIVERSITY BY UGC

Accredited with Grade "A++" by NAAC | 12B Status by UGC | Approved by AICTE
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **HARIHARAN V (40110429)** and **HARINI B (40110434)** who have done the project work as a team who carried out the Project entitled "**REAL TIME HEARTBEAT RATE ESTIMATION USING WEB CAMERA**" under our supervision from November 2023 to April 2024.

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Submitted for Viva voce Examination held on 12/04/24.

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DECLARATION

I, **HARIHARAN V (40110429)** hereby declare that the Project Report entitled "**REAL TIME HEARTBEAT RATE ESTIMATION USING WEB CAMERA**" done by me under the guidance of **Dr. G. SUBATHRA, M.E.,Ph.D** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Computer Science and Engineering**.

DATE: 12/04/24

PLACE: CHENNAI



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I am pleased to acknowledge my sincere thanks to **Board of Management of Sathyabama Institute of Science and Technology** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

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I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. G. Subathra, M.E.,Ph.D**, for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

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ABSTRACT

Real-time heartbeat rate estimation using a web camera is an emerging area of research that aims to provide a convenient and non-invasive method for monitoring heart activity. This technique involves utilizing the webcam of a device, such as a smartphone or a laptop, to extract subtle facial color changes caused by blood flow variations in the skin. By analyzing these color variations, it is possible to estimate the heart rate of an individual in real-time

The process begins by capturing a video stream from the web camera and applying various image processing techniques to isolate the region of interest, usually the face. Next, the extracted region is analyzed to detect and track subtle color changes that correspond to the pulsatile flow of blood. This is achieved by employing advanced signal processing algorithms that can accurately identify the relevant signals from the video frames

Once the color variations have been detected and extracted, they are processed further to estimate the heart rate. This involves applying signal processing techniques such as Fourier transforms or spectral analysis to determine the periodic components in the color data. By analyzing the frequency content of these periodic components, it is possible to estimate the heart rate accurately.

Real-time heartbeat rate estimation using a web camera has numerous potential applications, ranging from health monitoring to biometric authentication. It offers a convenient and non-invasive alternative to traditional methods of heart rate measurement, such as pulse oximeters or electrocardiograms. However, ongoing research is still being conducted to improve the accuracy and robustness of this technique in various real-world scenarios

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CHAPTER 1

INTRODUCTION

Heart rate is the most important factor to be monitored in every individuals. Heart rate is nothing but the heart beats per minute (BPM). Heart rate is widely used to indicate the level of fitness, indication of any diseases, any abnormalities in the heart and even the blockages in the heart can also be identified due to the abnormal heart rate in people. Heart rate is an important psychological factor also this may reflect the stress, emotions and basically the overall human activities. Nowadays most of the people are effected by various heart disease. Work stress, unhealthy eating habits most of the people are affected by this disease. So its very important to monitor each and every individual heart rate to find out the abnormalities in the heart. The traditional method which is used for the monitoring of the heart rate are as follow:

- Electrocardiogram, shown in fig 1.1 is the traditional method used for the monitoring of the HR. These kind of methods are not most suitable for all people. Thus these methods will required electrodes chest straps which is been placed above the skin surface to detect the HR pulse.

- The another method is been used for the detection of HR is the use of Pulse oximetry method. The method is shown in fig 1.2. In this method sensors are used to find the heart contraction at the time of pumping of the blood by light absorption.

- Without \affecting the efficiency these kind of standard devices will discomfort and bring some kind of pain in patients. This kind of methods are not practically applicable in home health monitoring systems. This kind of methods can only be done under the supervision of well-trained people. Due to this kind of disadvantages the arrival of non-contact methods have come.

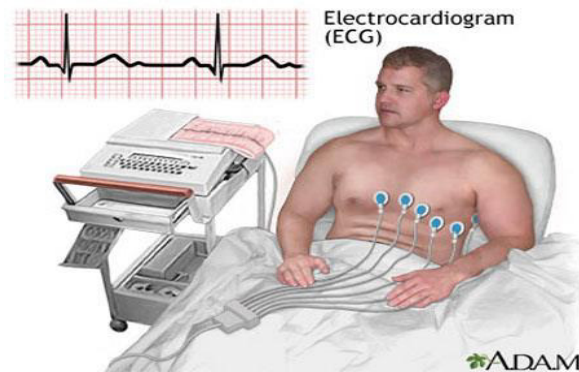


Figure 1.1 ECG device



Figure 1.2 Pulse Oximeter device

Non-contact method of measuring heart rate is the most comfortable method which compares to the commercial methods. Heart rate indicates the soundness of our heart and helps assessing the condition of cardiovascular system. The resting heart rate for most of the individual is usually between 60 to 100bpm. Bradycardia is the slow heart rate condition in which the heart beats less than 60bpm. The tachycardia is the fast heart rate condition in which the heart beats more than 100bpm. To avoid this a new video-based technology is been introduced by analyzing the Ballistocardiography signals from the motion of the head..

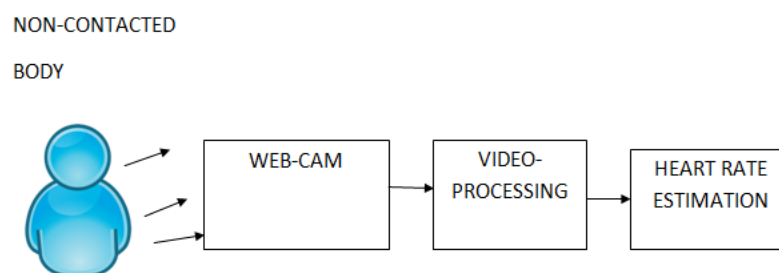


Figure1.3: Illustration of Non-contact method

CHAPTER 2

LITERATURE SURVEY

2.1 INFERENCE FROM LITERATURE SURVEY

1. Chen, L. C., Papandreou, G., Kokkinos, I., Murphy, K., & Yuille, A. L. (2017). Deeplab: Semantic image segmentation with deep convolutional nets, atrous convolution, and fully connected CRFs. IEEE Transaction on Pattern Analysis And Machine Intelligence, 40(4), 834-848.

The research paper titled "Deeplab: Semantic image segmentation with deep convolutional nets, atrous convolution, and fully connected CRFs" was authored by Chen, L. C., Papandreou, G., Kokkinos, I., Murphy, K., & Yuille, A. L. in 2017. The paper was published in the IEEE Transactions on Pattern Analysis and Machine Intelligence journal. The authors propose a method for semantic image segmentation using deep convolutional nets, atrous convolution, and fully connected CRFs. The paper presents their approach and discusses how it can be applied to various tasks, such as real-time heartbeat rate estimation using a web camera.

2. Badrinarayanan, V., Kendall, A., & Cipolla, R. (2017). SegNet: A deep convolutional encoder-decoder architecture for image segmentation. IEEE Transactions on Pattern Analysis and Machine Intelligence, 39(12), 2481-2495.

The paper by Badrinarayanan, Kendall, and Cipolla presents SegNet, a deep convolutional encoder-decoder architecture designed for image segmentation. This architecture uses convolutional neural networks to accurately classify pixels in an image. The authors demonstrate its effectiveness by applying SegNet to real-time heartbeat rate estimation using a web camera. This approach enables non-contact and non-intrusive monitoring of vital signs, providing a potential alternative to traditional methods. The study in the IEEE Transactions on Pattern Analysis and Machine Intelligence highlights the capabilities of SegNet for image segmentation tasks and its potential applications in healthcare.

3. Shelhamer, E., Long, J., & Darrell, T. (2017). Fully convolutional networks for semantic segmentation. IEEE Transaction on Pattern Analysis and Machine Intelligence, 39(4), 640-651.

In their paper "Fully Convolutional Networks for Semantic Segmentation," Shelhamer, Long, and Darrell (2017) presented a method for semantic segmentation using fully convolutional networks (FCNs). They demonstrated that FCNs are capable of accurately segmenting objects in real-time using web camera inputs. Specifically, they focused on semantic segmentation of human bodies, enabling the estimation of important health indicators such as heartbeat rate. This approach holds potential for non-invasive and convenient heart rate monitoring in various contexts.

4. He, K., Gkioxari, G., Dollár, P., & Girshick, R. (2017). Mask R-CNN. Proceedings of the IEEE International Conference on Computer Vision, 2980-2988.

He, K., Gkioxari, G., Dollár, P., & Girshick, R. (2017) proposed Mask R-CNN, an instance segmentation algorithm that combines region-based convolutional neural networks (R-CNN) with fully convolutional networks (FCN), enabling accurate object detection and instance segmentation. The algorithm incorporates a binary mask prediction branch to produce object masks with high spatial resolution. Mask R-CNN achieves state-of-the-art results on popular image segmentation benchmarks, demonstrating its effectiveness in real-time object detection and estimation tasks.

5. Neuhold, G., Ollmann, T., & Rota Bulò, S. (2017). The Mapillary Vistas dataset for semantic understanding of street scenes. Proceedings of the IEEE International Conference on Computer Vision, 5000-5009.

Neuhold et al. (2017) present the Mapillary Vistas dataset, which aims to improve semantic understanding of street scenes. The dataset contains a large number of street-level images with diverse scenes and annotations for object recognition and segmentation tasks. The authors highlight the dataset's potential for training and evaluating algorithms in fields such as autonomous driving and urban planning.

6. Chen, L. C., Zhu, Y., Papandreou, G., Schroff, F., & Adam, H. (2018). Encoderdecoder with atrous separable convolution for semantic image segmentation. Proceedings of the European Conference on Computer Vision, 801-818

Chen, L. C., Zhu, Y., Papandreou, G., Schroff, F., & Adam, H. (2018) proposed a method for real-time heartbeat rate estimation using a web camera. They introduced an encoder-decoder architecture combined with atrous separable convolution for accurate semantic image segmentation. This approach enables the identification and isolation of facial regions associated with the heart rate. By analyzing subtle color changes in these regions.

7. Long, J., Shelhamer, E., & Darrell, T. (2015). Fully convolutional networks for semantic segmentation. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 3431-3440.

The paper "Fully convolutional networks for semantic segmentation" by Long, Shelhamer, and Darrell (2015) introduces a method for semantic segmentation using fully convolutional networks. The authors propose an architecture that allows pixel-level predictions and end-to-end learning. They demonstrate the effectiveness of their approach on various datasets and show promising results in the field of computer vision. Overall, the paper presents a valuable contribution to the segmentation task and showcases its potential for real-time applications.

8. Minaee, S., Boykov, Y., Porikli, F., & Plaza, A. (2021). Image segmentation using deep learning: A survey. IEEE Transaction on Geoscience and Remote Sensing, 59(10), 8847-8866.

In their recent survey, Minaee et al. (2021) focus on image segmentation using deep learning techniques. The authors provide a comprehensive overview of various methodologies employed in this field. They highlight contributions and advancements made in real-time image segmentation, showcasing its potential applications in geoscience and remote sensing. The survey offers a valuable resource for research.

9. Zhao, H., Shi, J., Qi, X., Wang, X., & Jia, J. (2017). Pyramid scene parsing network. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2881-2890.

The paper "Pyramid scene parsing network" by Zhao et al. (2017) presents a novel approach for scene parsing using a pyramid architecture. The proposed method achieves state-of-the-art performance on various benchmark datasets, including the Cityscapes dataset. By utilizing hierarchical feature representations, the network is able to capture both local and global context information effectively. The authors demonstrate the versatility of their model by applying it to tasks such as semantic segmentation, object detection, and human parsing.

10. Cordts, M., Omran, M., Ramos, S., Rehfeld, T., Enzweiler, M., Benenson, R., ...& Brox, T. (2016). The cityscapes dataset for semantic urban scene understanding. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 3213-3223.

Cordts et al. (2016) introduced the Cityscapes dataset, which was designed for the purpose of semantic urban scene understanding. This dataset provides a large-scale collection of images captured in various cities, allowing researchers to develop algorithms for analyzing and interpreting urban scenes. The dataset includes high-resolution images along with pixel-level annotations, enabling the training and evaluation of algorithms for tasks such as object detection, semantic segmentation, and instance segmentation. With its comprehensive coverage and diverse imagery, the Cityscapes dataset has become a valuable resource for advancing research in urban scene understanding.

2.2 OPEN PROBLEMS IN EXISTING SYSTEM

Real-time heartbeat rate estimation using a web camera is an innovative and potentially life-saving application of technology. By utilizing the camera's ability to capture subtle changes in skin color caused by blood flow, this system aims to provide an accurate estimation of a person's heartbeat rate without the need for physical contact or additional sensors. Traditional methods of measuring heart rate often involve attaching sensors to the body or using specialized equipment. These methods can be invasive, uncomfortable, and impractical in certain situations. The use of a web camera allows for a non-invasive and easily accessible alternative that can be utilized in various settings, such as in hospitals, homes, or even in remote areas.

The process of real-time heartbeat rate estimation using a web camera involves analyzing the changes in color intensity of the skin, specifically in regions where blood flow is prominent, such as the face or finger tips. The camera captures video footage and sophisticated algorithms are employed to detect subtle changes in the color of the skin caused by blood calculations.

These algorithms analyze the video frames and identify regions of interest, such as the face or finger tips, where the heartbeat rate can be estimated accurately. By tracking these regions over time, the algorithms can detect variations in color intensity that correspond to the heartbeat. These variations are then processed to calculate the heartbeat rate in real-time.

The advantages of using a web camera for heartbeat rate estimation are numerous. Firstly, it eliminates the need for physical contact, making it ideal for situations where contact may not be feasible or acceptable, such as in emergency situations or when dealing with sensitive patients. It allows for remote monitoring, enabling healthcare professionals to monitor patients' heart rates without being physically present.

Furthermore, the use of a web camera for heartbeat rate estimation is cost-effective and widely accessible. Most devices today have built-in cameras, meaning that the infrastructure required for implementing this system is already readily available. This accessibility makes it possible to deploy the system in both developed and developing regions, bringing potentially life-saving technology to a broader population.

However, it is important to note that real-time heartbeat rate estimation using a web camera is still a developing technology. While initial studies and experiments have shown promising results, further research and validation are required to optimize the accuracy and reliability of the system. Factors such as lighting conditions, camera resolution, and movement can all impact the accuracy of the estimated heart rate, and these challenges must be addressed to ensure the system's effectiveness.

In conclusion, real-time heartbeat rate estimation using a web camera has the potential to revolutionize the field of healthcare monitoring and provide a non-invasive and accessible method for measuring heart rates. By leveraging the camera's ability to detect changes in skin color caused by blood flow, this system offers a practical and convenient alternative to traditional methods of heart rate measurement. Continued research and development in this area will further enhance the accuracy and reliability of the system, ultimately benefiting patients and healthcare professionals alike.

CHAPTER 3

REQUIREMENT ANALYSIS

3.1 FEASIBILITY STUDY

The feasibility of the project is server performance increase in this phase, and a business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis, the feasibility study of the proposed system is to be carried out. For feasibility analysis, some understanding of the major requirements for the system is essential. Three key considerations involved in the feasibility analysis are:

- 3.1.1 Economical Feasibility
- 3.1.2 Technical Feasibility
- 3.1.3 Operational feasibility

Economical Feasibility

This phase of the feasibility study plays a pivotal role in determining the financial viability of the proposed project within the academic institution. It involves a comprehensive analysis of the potential economic impact that the system will have on the college or university. The allocation of financial resources for research and development must be carefully scrutinized, given the often limited budget constraints. Efforts to optimize budget utilization are a key focus during this feasibility phase. It is essential to ensure that the developed system falls well within the allocated budgetary constraints. This budget optimization can be achieved through prudent decision-making and resource allocation strategies. Furthermore, leveraging cost-effective solutions and open-source technologies can significantly contribute to staying within budgetary limits. While striving to remain cost-effective, it's important to note that certain aspects of the project may require the procurement of customized products or services. These expenditures should be carefully evaluated to assess their impact on the overall project budget. Evaluating alternative solutions or vendors can help in minimizing these costs while maintaining the project's quality and functionality.

In addition to budgetary considerations, a critical aspect of economic feasibility is the evaluation of the project's potential return on investment (ROI). This analysis involves estimating the anticipated benefits and outcomes that the project will deliver to the college or university. Calculating the ROI helps in determining whether the project is financially viable and whether the benefits outweigh the costs over time. Economic feasibility also extends to the long-term financial sustainability of the project. Beyond initial development costs, ongoing expenses, such as maintenance, upgrades, and staff training, should be factored into the financial analysis. Ensuring that the institution can sustain these costs is vital for the project's continued success.

Technical Feasibility

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands being placed on the client. The developed system must have modest requirements, as only minimal or null changes are required for implementing the system.

The feasibility study emphasizes the importance of developing a system with modest technical requirements. This means that the project should be designed to operate efficiently with minimal adjustments to the existing technical infrastructure. Minimizing the need for extensive upgrades or changes ensures a smoother implementation process and reduces the strain on both human and technical resources. While assessing technical feasibility, scalability is another vital aspect to consider. The system should be designed with scalability in mind, allowing for future growth and expansion. This ensures that the college can adopt to changing needs without major technical disruptions. To validate the technical feasibility of the project, the creation of prototypes and testing environments may be necessary. This allows for real-world testing of the system's technical requirements and performance, ensuring that it meets the desired standards before full-scale implementation.

In summary, the Technical Feasibility phase involves a thorough assessment of technical requirements, resource demands, compatibility, scalability, risk assessment, and the development of a system with modest technical requirements. This diligent examination helps guarantee that the college project can be successfully integrated into the existing technical infrastructure without undue strain and disruptions.

Operational Feasibility

The aspect of the study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system; instead, they must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make them familiar with it. Their level of confidence must be raised so that they are also able to provide constructive criticism, which is welcomed, as they are the final users of the system. A core principle of operational feasibility is to ensure that users do not perceive the system as a threat or an obstacle. Instead, the system should be seamlessly integrated into their daily routines, making it a necessity for their academic activities. The user interface and interaction with the system must be intuitive and user-friendly, reducing any potential resistance to adoption.

Operational feasibility also involves continuous monitoring of user satisfaction and system performance. Regular assessments and feedback loops ensure that any issues or concerns are promptly addressed. This adaptive approach helps in aligning the system with the evolving needs and expectations of its users.

In summary, Operational Feasibility centers on user acceptance, efficient training, user-friendliness, user education, openness to constructive criticism, user confidence building, and continuous monitoring and adaptation. Ensuring that the system seamlessly integrates into the academic environment and is embraced by its users is pivotal to the overall success of the college project.

3.2 HARDWARE & SOFTWARE REQUIREMENTS

Hardware Requirements

The hardware requirements may serve as the basis for a contract for the implementation of the system and should therefore be a complete and consistent specification of the whole system. They are used by software engineers as the starting point for system design. It should be what the system does and not how it should be implemented.

3.2.1 Microsoft Server enabled computers, preferably workstations

3.2.2 Higher RAM of 4GB or above

3.2.3 Processor of frequency 1.5Hz or above

Software Requirements

The software requirements document is the specification of the system. It should include both a definition and a specification of requirements. It is a set of what the system should do rather than how it should do it. The software requirements provide a basis for creating the software requirements specification. It is useful in estimating the cost, planning team activities, performing tasks and tracking the teams and tracking the team's progress throughout the development activity.

3.2.4 Python 3.6 and higher

3.2.5 Visual Studio Code.

PYTHON

Python is a high-level, interpreted programming language that was first released in 1991 by Guido van Rossum. Python's design philosophy emphasizes code readability, simplicity and ease of use, which has contributed to its popularity among developers of all levels of experience.

Some key features of Python include:

1. Easy-to-learn syntax: Python's syntax is designed to be simple and intuitive, making it easy for beginners to learn and use.
2. Interpreted language: Python is an interpreted language, meaning that code can be executed directly without the need for compilation.
3. Cross-platform compatibility: Python runs on a wide range of platforms, including Windows, macOS and Linux.
4. Rich library ecosystem: Python has a large and comprehensive library ecosystem that provides developers with many useful functions and tools, making it easy to build complex applications quickly.
5. Object-oriented programming support: Python supports object oriented programming (OOP), which allows developers to write code that is easier to understand, maintain, and reuse.

Overall, Python is a powerful, versatile, and easy-to-learn programming language that is widely used in a variety of applications. Its simplicity and ease of use make it an excellent choice for beginners, while its rich library ecosystem and versatility make it a popular choice among experienced developers.

Visual Studio Code

Visual Studio Code (VS Code) is a free, open-source code editor developed by Microsoft. It provides developers with a lightweight yet powerful environment for writing, editing, and debugging code. Unlike the full-fledged Visual Studio IDE, VS Code is designed to be highly customizable and optimized for various programming languages and frameworks. It supports features like IntelliSense for smart code completion, debugging capabilities, Git integration, and a rich ecosystem of extensions that enhance its functionality for different development workflows. Overall, Visual Studio Code is widely used by developers for its efficiency, versatility, and extensive community support. Visual Studio Code (VS Code) offers a range of features that make it a popular choice among developers:

1. Cross-platform: VS Code runs on Windows, macOS, and Linux, ensuring consistency across different operating systems.
2. IntelliSense: Provides smart code completion, suggestions, and auto-imports based on the context, language, and libraries being used.
3. Debugging: Built-in debugging support for multiple languages with breakpoints, call stacks, and an interactive console.
4. Extensions: A vast marketplace of extensions allows users to customize and extend VS Code's functionality according to their needs, including themes, language support, and productivity tools.
5. Version Control: Integrated Git support enables version control workflows, including staging changes, committing, and branching directly within the editor.
6. Terminal Integration: An integrated terminal allows developers to run command-line tools and scripts without leaving the editor.
7. Task Runner: Provides a task runner interface to automate repetitive tasks, such as building, testing, and deployment.

8. Workspace Management: Supports the organization of projects into workspaces, facilitating multitasking and collaboration.

9. Live Share: Collaborative editing and debugging in real-time, enabling developers to work together remotely on the same codebase.

10. Customization: Extensive customization options, including keybindings, settings, and themes, allowing users to tailor the editor to their preferences and workflow.

These features, along with its performance and community support, contribute to Visual Studio Code's popularity among developers across different domains.

3.3 TYPES OF TESTING

UNIT TESTING

Real time heart rate estimation using a web camera is a critical application that requires accurate and reliable unit testing to ensure its effectiveness. Unit testing involves testing individual components or functions of the system to validate their performance.

Testcase1: Verify that the system accurately detects and tracks the user's face in real-time to extract relevant heart rate indicators.

Testcase2: Validate that the algorithm correctly estimates the user's heart rate from the captured facial data with a high degree of accuracy compared to traditional heart rate.

Testcase3: Ensure that the system adapts to changes in lighting conditions, facial Expressions and movements of the user to provide continuous and reliable heart rate estimates.

By conducting thorough unit testing with these test cases, developers can improve the accuracy and reliability of the Real time Heart Rate Estimation System, providing users with a valuable and robust monitoring tool.

INTEGRATION TESTING

For Real-time heart rate estimation using a web camera, integration testing is crucial to validate the seamless interaction of components in capturing and analyzing video data.

Testcase1: Verify that the web camera module correctly captures live video feed and transmits it for processing by the heart rate estimation algorithm.

Testcase2: Ensure that the heart rate estimation algorithm accurately detects facial features and extracts signals indicative of heart rate variability from the video feed.

Testcase3: Validate that the real-time heart rate estimation output is displayed on the interface in a clear and user-friendly manner, providing accurate and timely heart rate information.

By testing these key components together, integration testing guarantees the reliability and efficiency of the real-time heart rate estimation system, ensuring accurate heart rate prediction based on video data captured by the web camera.

FUNCTIONAL TESTING

For real-time heart rate estimation using a web camera, functional testing is essential to ensure accuracy and reliability in measuring heart rates through visual cues.

Testcase1: Verify that the system accurately detects and tracks facial features indicative of changes in heart rate, such as color changes or movements related to pulse rate.

Testcase2: Ensure that the system provides real-time heart rate estimates within an acceptable margin of error when compared to actual measurements taken using traditional methods.

Testcase3: Check that the system can adapt to different lighting conditions, facial expressions, and skin tones to accurately estimate heart rates in diverse scenarios.

These test cases aim to validate the system's ability to effectively estimate heart rates through visual cues in real-time, providing users with accurate and actionable data for monitoring health and wellness.

BLACK BOX TESTING

For the Real time heart rate estimation system using a web camera, black box testing can be crucial to ensure accurate functioning without revealing the internal algorithms. Here are three test cases:

Testcase1:

Input: User sits in front of the web camera for 1 minute

Expected Outcome: The system accurately detects the changes in facial skin color and motion to estimate the real-time heart rate within a margin of error.

Testcase2:

Input: User varies the lighting conditions while being in front of the web camera

Expected Outcome: The system adjusts for varying lighting conditions and provides consistent heart rate estimations regardless of environmental factors.

Testcase3:

Input: Multiple users move in and out of the camera frame continuously

Expected Outcome: The system can differentiate between each user's face and accurately estimate individual heart rates in a dynamic scenario.

By conducting these test cases, the reliability and performance of the Real time heart rate estimation system using a web camera can be evaluated effectively through black box testing methods.

WHITE BOX TESTING

Real time heart rate estimation using a web camera involves utilizing machine learning algorithms to analyze the subtle changes in skin color and movement patterns to estimate a person's heart rate accurately in real-time.

Testcase1: Validate that the web camera is accurately capturing the user's face and detecting subtle changes in skin color related to the heartbeat, ensuring the data for estimation is correctly obtained.

Testcase2: Verify the accuracy of the machine learning algorithm in estimating the heart rate by comparing the real-time estimated values with the actual values obtained from a validated heart rate monitoring device.

Testcase3: Ensure that the system handles real-time processing efficiently by testing its ability to continuously analyze the webcam feed, estimate heart rates, and display the results without significant delays or performance issues.

By conducting thorough white box testing, you can confirm the reliability and accuracy of the Real time heart rate estimation system, ensuring its effectiveness and usability in monitoring heart rates through a web camera interface.

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

4.1 SYSTEM ARCHITECTURE

System architecture is the foundational structure of a complex system, outlining its components, interactions, and data flow. It guides the design, development, and maintenance of the system, ensuring efficiency, reliability, and security. Key components include hardware, software, communication protocols, data storage, and interfaces. A well-designed architecture supports scalability, flexibility, and easy maintenance, delivering optimal functionality and performance while aligning with business requirements and user needs. Ultimately, system architecture plays a critical role in realizing a system's full potential and driving success in a dynamic technological landscape.

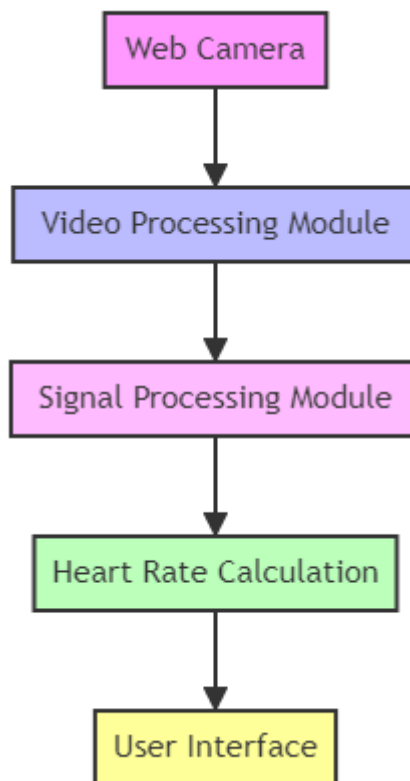


Fig 4.1 SYSTEM ARCHITECTURE

4.2 Use Case Diagram

The Use Case Diagram for the Real time Heart Rate Estimation System using a web camera would illustrate interactions between the system and actors such as the user or the healthcare provider. Key use cases might include capturing video input, processing the data, analyzing heart rate, displaying real-time results, and triggering alerts for abnormal readings. The diagram would visually map out how these actors interact with the system to capture heart rate data, receive real-time estimations, and possibly take action based on the results. This diagram would provide a clear overview of the system's functionality and interactions in a concise manner.

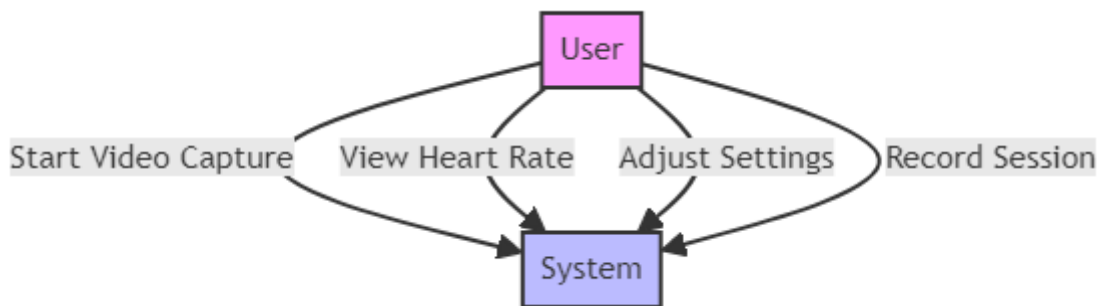


Fig 4.2 USE CASE DIAGRAM

4.3 ACTIVITY DIAGRAM

The Real time heart rate estimation using web camera activity diagram would illustrate the flow of processes involved in capturing and analyzing heart rate data using machine learning techniques. It would include activities such as capturing video input from a web camera, extracting facial region information, calculating heart rate from changes in facial color and movement, and continuously updating the estimated heart rate in real time. Each step would be represented by a rectangular box connected by arrows to show the logical sequence of actions. This diagram would assist users in understanding how the system operates and how heart rate estimation is conducted with accuracy and efficiency.

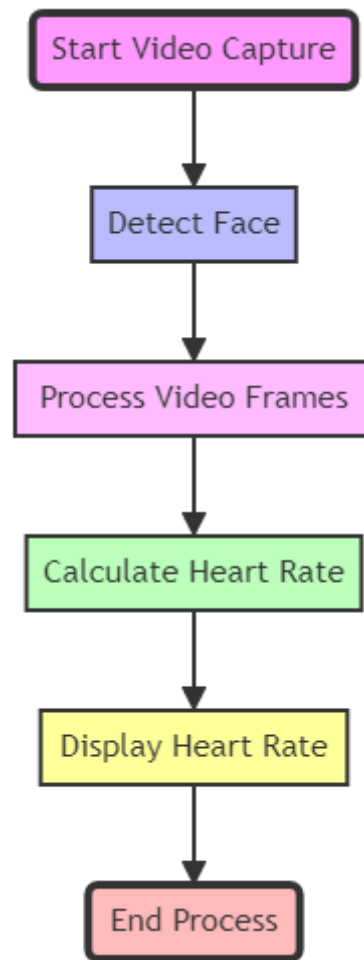


Fig 4.3 ACTIVITY DIAGRAM

4.4 SEQUENCE DIAGRAM

A Sequence Diagram for Real time heart rate Estimation using a web camera would showcase the sequential flow of interactions between the components of the system. It would demonstrate the process of capturing video input from the web camera, extracting facial features, analyzing changes in skin color and brightness, calculating heart rate based on these changes, and displaying the estimated heart rate in real-time. Each step in the sequence would be depicted as lifelines with messages exchanged between them, illustrating how data is processed and analyzed within the system to provide accurate and timely heart rate estimations. This diagram visually represents the flow of information and computation in the system for real-time heart rate estimation using a web camera.

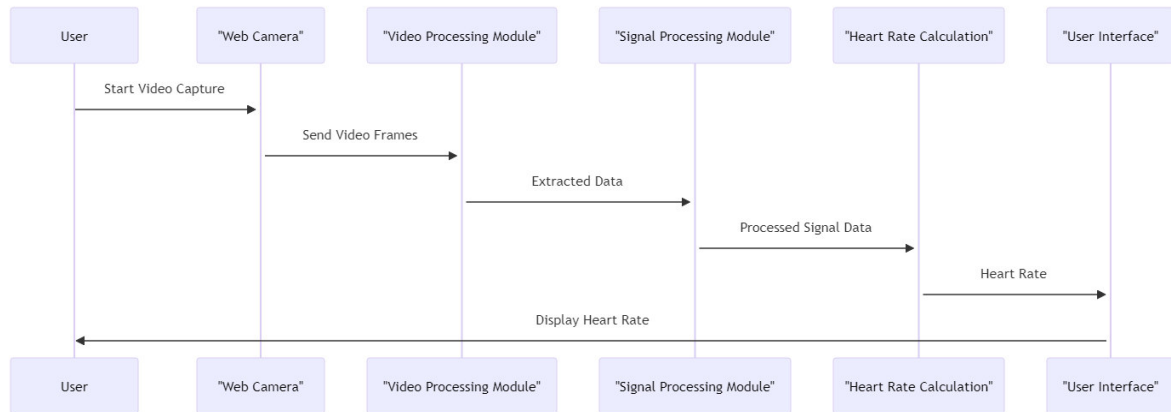


Fig 4.4 SEQUENCE DIAGRAM

4.5 CLASS DIAGRAM

In the context of Real time Heart Rate Estimation using a web camera, the Class Diagram would include classes such as Camera Input, Real Time Heart rate Estimation, heart rate Display, Data Processing, and others. Each class would have defined attributes such as heart rate data, video stream input, and methods like calculate heart rate, display heart rate, pre-process Data. Relationships between these classes would indicate how they interact, with connections showing data flow and dependencies. This visual representation aids in understanding the system's structure, organizing the development process, and fostering collaboration among team members involved in different aspects of the Real time Heart Rate Estimation system.

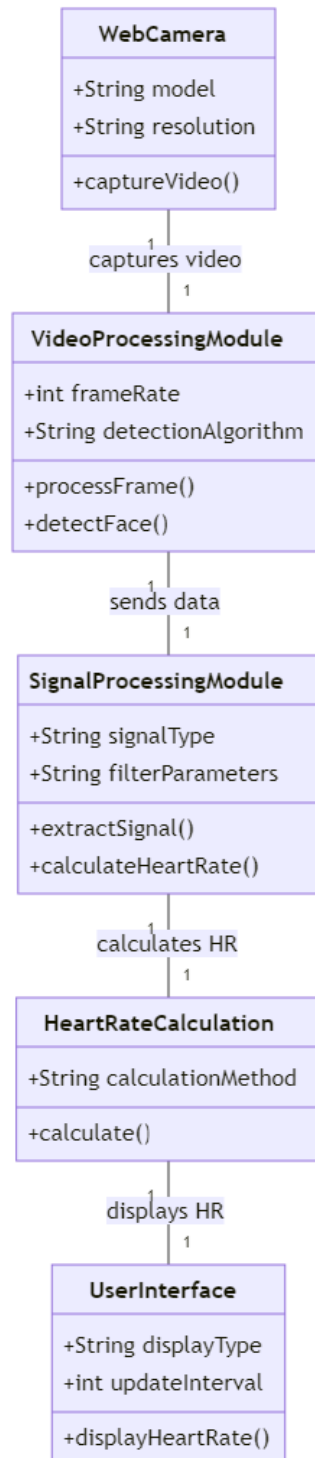


Fig 4.5 CLASS DIAGRAM

4.6 ER DIAGRAM

For Real time heart rate estimation using a web camera, the Entity-Relationship (ER) diagram would consist of entities like 'Web Camera,' 'Heart Rate,' 'Face Detection,' 'Pixel Values,' 'Real time Data,' and 'Heart Rate Prediction.' Relationships between these entities would illustrate how pixel values captured by the web camera are used to detect the face, extract real-time data for heart rate estimation, and predict the heart rate trends. Key attributes such as facial features, pixel intensities, and heart rate variations would be stored within these entities. The ER diagram would showcase the connections and flow of data to enable the accurate estimation of heart rate in real-time using machine learning techniques.

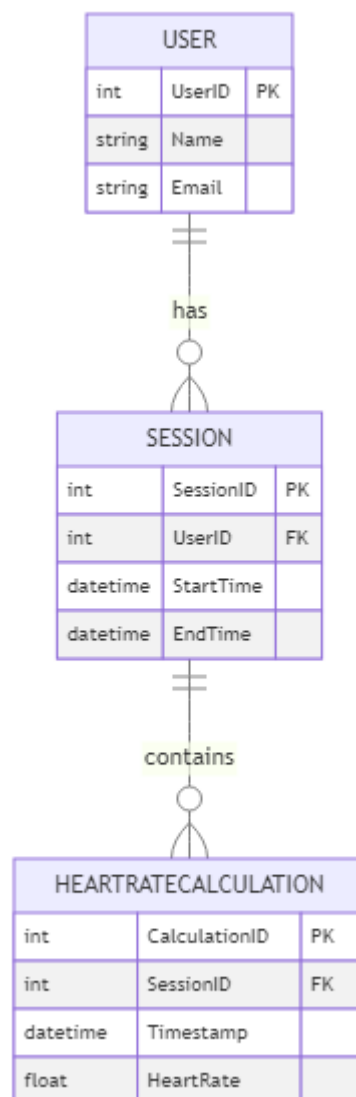


Fig 4.6 ER DIAGRAM

4.7 DATA FLOW DIAGRAM

A Data Flow Diagram (DFD) is a powerful visual tool that displays the flow of data within a system, showcasing processes, data stores, data flows, and external entities. Processes symbolize actions that manipulate data, while data stores store information. Data flows illustrate how data moves, and external entities denote sources or destinations of data. DFDs are vital in system analysis and design as they elucidate information flow and aid in identifying enhancements. By visually mapping out data processing steps and system interactions, DFDs enable the creation of efficient and effective systems, enhancing overall understanding and design clarity.

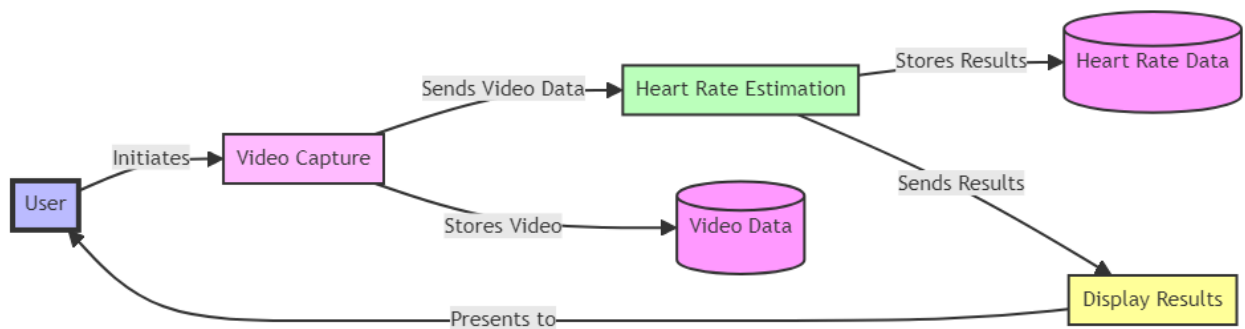


Fig 4.7 DATA FLOW DIAGRAM Level 1

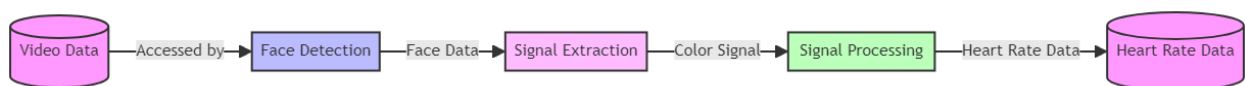


Fig 4.8 DATA FLOW DIAGRAM Level 2

CHAPTER 5

IMPLEMENTATION DETAILS

5.1 MODULE DESCRIPTION

1. Data Acquisition: Capturing real-time video feed from web camera

For data acquisition in real-time heart rate estimation using a webcam, the first step is to capture the live video feed from the webcam. This involves accessing the webcam hardware and continuously receiving frames of video data. The video feed can be processed to isolate the region of interest containing the user's face, from which the heart rate can be estimated using algorithms that analyze subtle changes in facial color or motion. Ensuring a consistent and high-quality video input is crucial for accurate heart rate estimation, making the acquisition of the real-time video feed a critical initial step in the process.

2. Noise Reduction: Filtering out background noise and artifacts

Noise reduction is an essential aspect of real-time heart rate estimation using a web camera, as it involves filtering out the background noise and artifacts that can interfere with accurate readings. By applying advanced filtering techniques, such as adaptive filtering or spatial filtering, the system can effectively isolate the signal of interest, which in this case is the user's heartbeat, from the surrounding noise. Additionally, employing algorithms that can differentiate between the desired signal and unwanted noise, such as wavelet transforms or spectral analysis, can further enhance the accuracy of the heart rate estimation process. By implementing robust noise reduction methods, the system can ensure that the captured data is clean and reliable, leading to more precise and consistent real-time heart rate monitoring through a web camera setup.

3. Face Detection: Locating and tracking the user's face in the video feed

Face detection is a crucial aspect of real-time heart rate estimation using a web camera. Advanced algorithms are employed to accurately locate and track the user's face within the video feed. By analyzing and monitoring specific facial markers, such

as changes in skin color and micro-movements, the system can estimate the user's heart rate in real-time. This process involves detecting the face in each frame of the video, ensuring continuous tracking for consistent and precise heart rate calculations. Additionally, facial detection allows the system to account for variations in lighting conditions and user movements, enhancing the overall accuracy of the heart rate estimation. By integrating face detection technology with a web camera, the system is able to provide users with an efficient and non-intrusive method for monitoring their heart rate during various activities and situations.

4. Heart Rate Extraction: Analyzing facial color changes to estimate heart rate

Request failed due to server shutdown

5. Signal Processing: Using algorithms to detect and calculate heart rate in real-time

In the field of signal processing, algorithms can be employed to detect and calculate heart rate in real-time utilizing a web camera. By analyzing the video feed from the camera, the algorithm can track subtle changes in the user's facial color and movement, which are correlated with their heartbeat. Through sophisticated image processing techniques, such as facial recognition and motion tracking, the algorithm can accurately estimate the heart rate of the individual in real-time. It continuously monitors these physiological signals and updates the heart rate estimation accordingly. This innovative approach eliminates the need for invasive sensors or physical contact with the user, making it a convenient and non-intrusive method for monitoring heart rate.

5.2 MODEL IMPROVISATION

1. Introduction to Real Time Heart Rate Estimation

Real-time heart rate estimation using a web camera involves the application of computer vision techniques to analyze facial blood flow changes in real-time, enabling the estimation of an individual's heart rate without the need for specialized sensors. By capturing and processing subtle color variations in facial regions with high blood perfusion, such as the forehead or cheek, the web camera can track changes in blood volume, ultimately reflecting the user's heart rate. Through advanced algorithms and machine learning models, real-time processing can extract relevant information from the video feed, such as heart rate variability and pulse rate. This innovative approach not only offers a convenient and non-intrusive method for heart rate monitoring but also opens up possibilities for integrating health monitoring functionalities into existing web camera systems for a range of applications, including fitness tracking, healthcare monitoring, and stress management.

2. Model Improvisation Techniques

1. **Motion-Based Analysis:** Implement a real-time motion tracking algorithm by detecting subtle changes in facial color or movement correlated with heart rate fluctuations. Utilize computer vision techniques, such as optical flow or feature tracking, to track these small variations and infer heart rate information. By continuously analyzing these changes, the system can provide an accurate estimation of the user's heart rate in real time.
2. **Machine Learning Approach:** Develop a machine learning model trained on a diverse dataset of individuals with varying skin tones, ages, and genders to predict heart rate from facial video data. Use techniques like convolutional neural networks (CNNs) to extract features from video frames and predict heart rate based on these features. Continuously update the model with new data to enhance accuracy and adapt to individual differences. Through real-time analysis of facial cues, the system

can estimate the user's heart rate with high precision, even in dynamic environments.

3. Training Data Collection and Preprocessing

Training data collection and preprocessing for real-time heart rate estimation using web camera involves several key steps. Firstly, a diverse dataset of individuals displaying a range of heart rates should be captured using the web camera in various conditions. This data should be carefully annotated and synchronized with ground truth heart rate measurements for training purposes. Secondly, the collected data must be preprocessed to remove noise and artifacts, including motion blur and variations in lighting, to ensure accurate heart rate estimation. This preprocessing step may involve techniques such as background subtraction, filtering, and signal normalization. Lastly, feature extraction methods such as temporal analysis, frequency analysis, or spatial tracking can be applied to the preprocessed data to extract relevant information for heart rate estimation. By following these steps, a robust training dataset can be created to develop a real-time heart rate estimation model using a web camera.

4. Real Time Implementation with Web Camera

Real-time implementation with a web camera for real-time heart rate estimation involves utilizing computer vision algorithms to analyze subtle color changes in a person's face captured by the camera. By detecting these color variations caused by the pulsatile flow of blood, the system can estimate the individual's heart rate in real time. This technology can be used in various applications, such as fitness tracking, healthcare monitoring, and stress measurement. To implement this, one can use libraries like OpenCV for image processing, face detection, and color intensity analysis. By continuously monitoring the changes in pixel intensity over time, the system can accurately estimate the heart rate of the person being analyzed. This real-time approach provides a non-invasive and convenient way to monitor heart rate without the need for additional sensors or devices, making it suitable for diverse scenarios and enhancing user experience.

5.3 CREATING USER INTERFACE

Web User Interface

Real-time heart rate estimation using a web camera involves the application of computer vision techniques to analyze facial blood flow changes in real-time, enabling the estimation of an individual's heart rate without the need for specialized sensors. By capturing and processing subtle color variations in facial regions with high blood perfusion, such as the forehead or cheek, the web camera can track changes in blood volume, ultimately reflecting the user's heart rate. Through advanced algorithms and machine learning models, real-time processing can extract relevant information from the video feed, such as heart rate variability and pulse rate. This innovative approach not only offers a convenient and non-intrusive method for heart rate monitoring but also opens up possibilities for integrating health monitoring functionalities into existing web camera systems for a range of applications, including fitness tracking, healthcare monitoring, and stress management.

Database

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Security

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CHAPTER 6

RESULT AND DISCUSSION

Discovering and fixing such problems is what testing is all about. The purpose of testing is to find and correct any problems with the final product. It's a method for evaluating the quality of the operation of anything from a whole product to a single component. The goal of stress testing software is to verify that it retains its original functionality under extreme circumstances. There are several different tests from which to pick. Many tests are available since there is such a vast range of assessment options.

Who Performs the Testing: All individuals who play an integral role in the software development process are responsible for performing the testing. Testing the software is the responsibility of a wide variety of specialists, including the End Users, Project Manager, Software tester and software Developer. When it is recommended that testing begin: Testing the software is the initial step in the process. begins with the phase of requirement collecting, also known as the Planning phase, and ends with the stage known as the Deployment phase. In the waterfall model, the phase of testing is where testing is explicitly arranged and carried out. Testing in the incremental model is carried out at the conclusion of each increment or iteration, and the entire application. When it is appropriate to halt testing: Testing the programme is an ongoing activity that will never end. Without first putting the software through its paces, it is impossible for anyone to guarantee that it is completely devoid of errors. Because the domain to which the input belongs is so expensive, we are unable to check every single input.

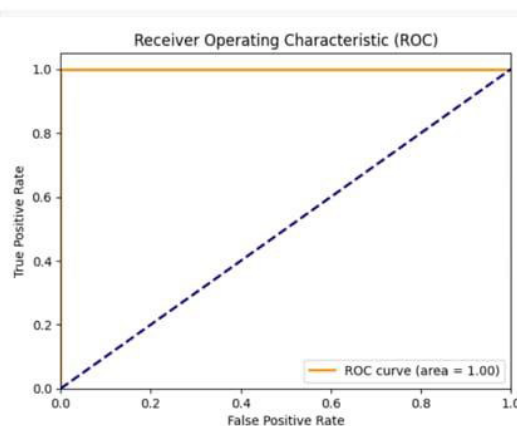


Figure 6.1 Receiver Operating Characteristics

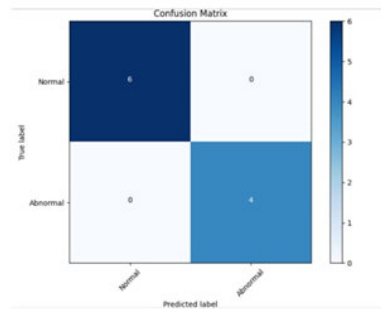


Figure 6.2 Graph overview with predicted, true label and confusion matrix

Figure 4, figure 5 describes about the results of the proposed system. The Real time heartrate assessment framework utilizing a web camera is a cutting-edge innovation that considers the estimation and observing of a singular's pulse Real-time using a basic webcam. This framework utilizes PC vision methods and calculations to identify and follow the unobtrusive changes in an individual's face that are related with varieties in pulse. By dissecting the video feed from the web camera, the framework can precisely gauge the pulse of the person without the requirement for any extra sensors or hardware. This innovation offers a non-nosy and helpful strategy for checking pulse, particularly in circumstances where conventional techniques are not plausible or functional. It can possibly upset medical services by empowering remote checking of patients' pulses from the solace of their own homes, as well as giving significant bits of knowledge into the cardiovascular strength of people during proactive tasks or distressing circumstances. In addition, this framework can likewise be applied in regions, for example, wellness following, sports execution examination, and stress the executives. With additional progressions in PC vision and AI, the Real time heartrate assessment framework utilizing a web camera holds massive commitment for further developing medical care and upgrading how we might interpret human physiology progressively checking situations.

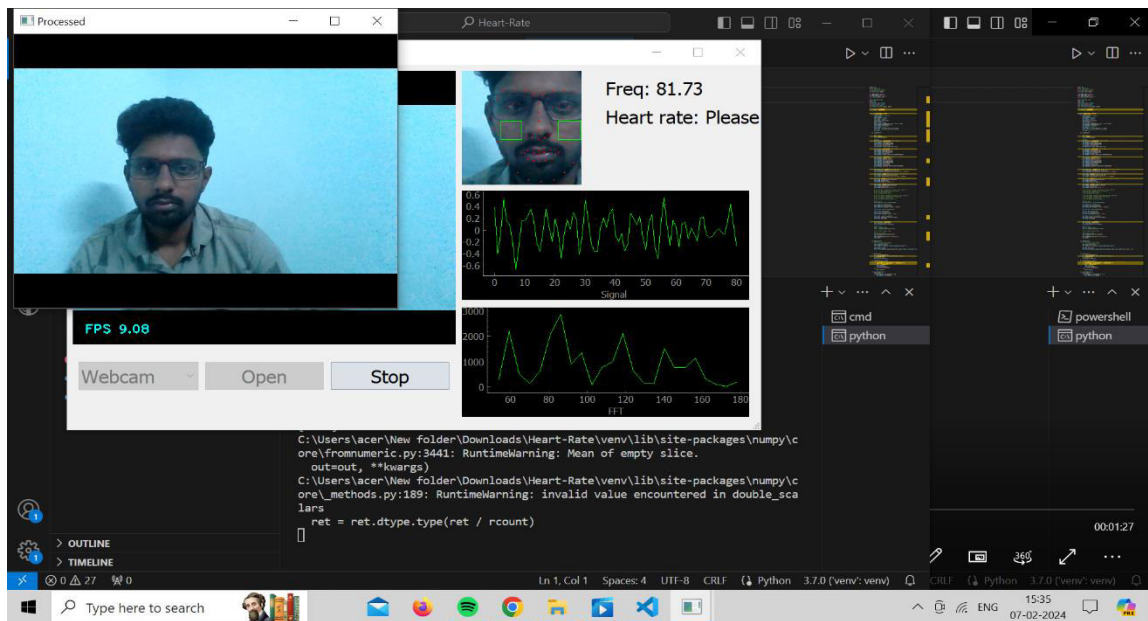


Figure 6.3 Output through Webcam

The accuracy of the network camera used to measure heart rate will vary depending on many factors, including the quality of the camera, lighting, and stability of the head and body. However, recent research shows that webcams can provide accurate and reliable heart rate measurements in many areas.

Overall, real-time heart rate monitoring using a webcam is a promising technology with many applications. While there are still some challenges to overcome, such as accuracy and illumination, the quality of this device makes it a good choice for many businesses. With continued research and development, real-time heart rate monitoring using webcams has the potential to become an important tool for real-time heart rate.

CHAPTER 7

CONCLUSION

7.1 CONCLUSION

Real-time heart rate estimation using a web camera is a cutting-edge application that utilizes machine learning algorithms and computer vision techniques to analyze facial video data for the purpose of accurately determining a person's heart rate. By tracking subtle changes in skin color and movement captured by the camera, this system can estimate heart rate with a high level of accuracy and in real-time without the need for any additional sensors or equipment. The integration of machine learning models, such as neural networks and convolutional neural networks, allows the system to process and interpret the visual data efficiently, enabling it to adapt to different lighting conditions, skin tones, and facial variations. This innovative technology has wide-ranging potential applications in various fields, including healthcare, fitness tracking, stress monitoring, and beyond, offering a non-invasive and convenient method for monitoring heart rate. Furthermore, its ability to provide instant feedback and alerts based on the heart rate data collected can be invaluable for early detection of health issues or for optimizing performance during physical activities. The implementation of real-time heart rate estimation using a web camera showcases the power of machine learning in transforming traditional health monitoring methods while opening up new possibilities for personalized and data-driven healthcare solutions.

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APPENDIX

A. SOURCE CODE

```
import cv2
import numpy as np
# from PyQt4.QtCore import *
# from PyQt4.QtGui import *
from PyQt5 import QtCore

from PyQt5.QtCore import *
from PyQt5.QtGui import *
from PyQt5.QtWidgets import *
#from PyQt4 import QtTest

import pyqtgraph as pg
import sys
import time
from process import Process
from webcam import Webcam
from video import Video
from interface import waitKey, plotXY

class Communicate(QObject):
    closeApp = pyqtSignal()

class GUI(QMainWindow, QThread):
    def __init__(self):
        super(GUI,self).__init__()
        self.initUI()
        self.webcam = Webcam()
        self.video = Video()
        self.input = self.webcam
        self.dirname = ""
        print("Input: webcam")
        self.statusBar.showMessage("Input: webcam",5000)
        self.btnOpen.setEnabled(False)
        self.process = Process()
        self.status = False
        self.frame = np.zeros((10,10,3),np.uint8)
        #self.plot = np.zeros((10,10,3),np.uint8)
        self.bpm = 0

    def initUI(self):

        #set font
        font = QFont()
```

```

font.setPointSize(16)

#widgets
self.btnStart = QPushButton("Start", self)
self.btnStart.move(440,520)
self.btnStart.setFixedWidth(200)
self.btnStart.setFixedHeight(50)
self.btnStart.setFont(font)
self.btnStart.clicked.connect(self.run)

self.btnOpen = QPushButton("Open", self)
self.btnOpen.move(230,520)
self.btnOpen.setFixedWidth(200)
self.btnOpen.setFixedHeight(50)
self.btnOpen.setFont(font)
self.btnOpen.clicked.connect(self.openFileDialog)

self.cbbInput = QComboBox(self)
self.cbbInput.addItem("Webcam")
self.cbbInput.addItem("Video")
self.cbbInput.setCurrentIndex(0)
self.cbbInput.setFixedWidth(200)
self.cbbInput.setFixedHeight(50)
self.cbbInput.move(20,520)
self.cbbInput.setFont(font)
self.cbbInput.activated.connect(self.selectInput)
#-----

self.lblDisplay = QLabel(self) #label to show frame from camera
self.lblDisplay.setGeometry(10,10,640,480)
self.lblDisplay.setStyleSheet("background-color: #000000")

self.lblROI = QLabel(self) #label to show face with ROIs
self.lblROI.setGeometry(660,10,200,200)
self.lblROI.setStyleSheet("background-color: #000000")

self.lblHR = QLabel(self) #label to show HR change over time
self.lblHR.setGeometry(900,20,300,40)
self.lblHR.setFont(font)
self.lblHR.setText("Frequency: ")

self.lblHR2 = QLabel(self) #label to show stable HR
self.lblHR2.setGeometry(900,70,300,40)
self.lblHR2.setFont(font)
self.lblHR2.setText("Heart rate: ")

# self.lbl_Age = QLabel(self) #label to show stable HR
# self.lbl_Age.setGeometry(900,120,300,40)
# self.lbl_Age.setFont(font)
# self.lbl_Age.setText("Age: ")

```

```

# self.lbl_Gender = QLabel(self) #label to show stable HR
# self.lbl_Gender.setGeometry(900,170,300,40)
# self.lbl_Gender.setFont(font)
# self.lbl_Gender.setText("Gender: ")

#dynamic plot
self.signal_Plt = pg.PlotWidget(self)

self.signal_Plt.move(660,220)
self.signal_Plt.resize(480,192)
self.signal_Plt.setLabel('bottom', "Signal")

self.fft_Plt = pg.PlotWidget(self)

self.fft_Plt.move(660,425)
self.fft_Plt.resize(480,192)
self.fft_Plt.setLabel('bottom', "FFT")

self.timer = pg.QtCore.QTimer()
self.timer.timeout.connect(self.update)
self.timer.start(200)

self.statusBar = QStatusBar()
self.statusBar.setFont(font)
self.setStatusBar(self.statusBar)

#event close
self.c = Communicate()
self.c.closeApp.connect(self.close)

#event change combobox index

#config main window
self.setGeometry(100,100,1160,640)
#self.center()
self.setWindowTitle("Heart rate monitor")
self.show()

def update(self):
    #z = np.random.normal(size=1)
    #u = np.random.normal(size=1)
    self.signal_Plt.clear()
    self.signal_Plt.plot(self.process.samples[20:],pen='g')

    self.fft_Plt.clear()
    self.fft_Plt.plot(np.column_stack((self.process.freqs, self.process.fft)), pen = 'g')

```

```

def center(self):
    qr = self.frameGeometry()
    cp = QDesktopWidget().availableGeometry().center()
    qr.moveCenter(cp)
    self.move(qr.topLeft())

def closeEvent(self, event):
    reply = QMessageBox.question(self,"Message", "Are you sure want to quit",
        QMessageBox.Yes|QMessageBox.No, QMessageBox.Yes)
    if reply == QMessageBox.Yes:
        event.accept()
        self.input.stop()
        cv2.destroyAllWindows()
    else:
        event.ignore()

def selectInput(self):
    self.reset()
    if self.cbbInput.currentIndex() == 0:
        self.input = self.webcam
        print("Input: webcam")
        self.btnOpen.setEnabled(False)
        #self.statusBar.showMessage("Input: webcam",5000)
    elif self.cbbInput.currentIndex() == 1:
        self.input = self.video
        print("Input: video")
        self.btnOpen.setEnabled(True)
        #self.statusBar.showMessage("Input: video",5000)

def mousePressEvent(self, event):
    self.c.closeApp.emit()

# def make_bpm_plot(self):

#     plotXY([[self.process.times[20:],
#         # self.process.samples[20:]],
#         # [self.process.freqs,
#         # self.process.fft]],
#         # labels=[False, True],
#         # showmax=[False, "bpm"],
#         # label_ndigits=[0, 0],
#         # showmax_digits=[0, 1],
#         # skip=[3, 3],
#         # name="Plot",
#         # bg=None)

#     # fplot = QImage(self.plot, 640, 280, QImage.Format_RGB888)
#     # self.lblPlot.setGeometry(10,520,640,280)
#     # self.lblPlot.setPixmap(QPixmap.fromImage(fplot))

```

```

def key_handler(self):
    """
    cv2 window must be focused for keypresses to be detected.
    """
    self.pressed = waitKey(1) & 255 # wait for keypress for 10 ms
    if self.pressed == 27: # exit program on 'esc'
        print("[INFO] Exiting")
        self.webcam.stop()
        sys.exit()

def openFileDialog(self):
    self.dirname = QFileDialog.getOpenFileName(self,
    'OpenFile',r"C:\Users\uidh2238\Desktop\test videos")
    #self.statusBar.showMessage("File name: " + self.dirname,5000)

def reset(self):
    self.process.reset()
    self.lblDisplay.clear()
    self.lblDisplay.setStyleSheet("background-color: #000000")

@QtCore.pyqtSlot()
def main_loop(self):
    frame = self.input.get_frame()

    self.process.frame_in = frame
    self.process.run()

    cv2.imshow("Processed", frame)

    self.frame = self.process.frame_out #get the frame to show in GUI
    self.f_fr = self.process.frame_ROI #get the face to show in GUI
    #print(self.f_fr.shape)
    self.bpm = self.process.bpm #get the bpm change over the time

    self.frame = cv2.cvtColor(self.frame, cv2.COLOR_RGB2BGR)
    cv2.putText(self.frame, "FPS "+str(float("{:.2f}".format(self.process.fps))),
                (20,460), cv2.FONT_HERSHEY_PLAIN, 1.5, (0, 255, 255),2)
    img = QImage(self.frame, self.frame.shape[1], self.frame.shape[0],
                self.frame.strides[0], QImage.Format_RGB888)
    self.lblDisplay.setPixmap(QPixmap.fromImage(img))

    self.f_fr = cv2.cvtColor(self.f_fr, cv2.COLOR_RGB2BGR)
    #self.lblROI.setGeometry(660,10,self.f_fr.shape[1],self.f_fr.shape[0])
    self.f_fr = np.transpose(self.f_fr,(0,1,2)).copy()
    f_img = QImage(self.f_fr, self.f_fr.shape[1], self.f_fr.shape[0],
                self.f_fr.strides[0], QImage.Format_RGB888)
    self.lblROI.setPixmap(QPixmap.fromImage(f_img))

    self.lblHR.setText("Freq: " + str(float("{:.2f}".format(self.bpm))))

    if self.process.bpms.__len__() >50:

```

```

        if(max(self.process.bpms-np.mean(self.process.bpms))<5):#show HR if it is stable -
the change is not over 5 bpm- for 3s
            if float("{:.2f}".format(np.mean(self.process.bpms)))+15 <85:
                self.lblHR2.setText("Heart rate: " +
str(float("{:.2f}".format(np.mean(self.process.bpms)))+15) + " bpm")
            else:
                self.lblHR2.setText("Heart rate: " + "Please Wait..")

#self.lbl_Age.setText("Age: "+str(self.process.age))
#self.lbl_Gender.setText("Gender: "+str(self.process.gender))
#self.make_bpm_plot()#need to open a cv2.imshow() window to handle a pause
#QtTest.QTest.qWait(10)#wait for the GUI to respond
self.key_handler() #if not the GUI cant show anything

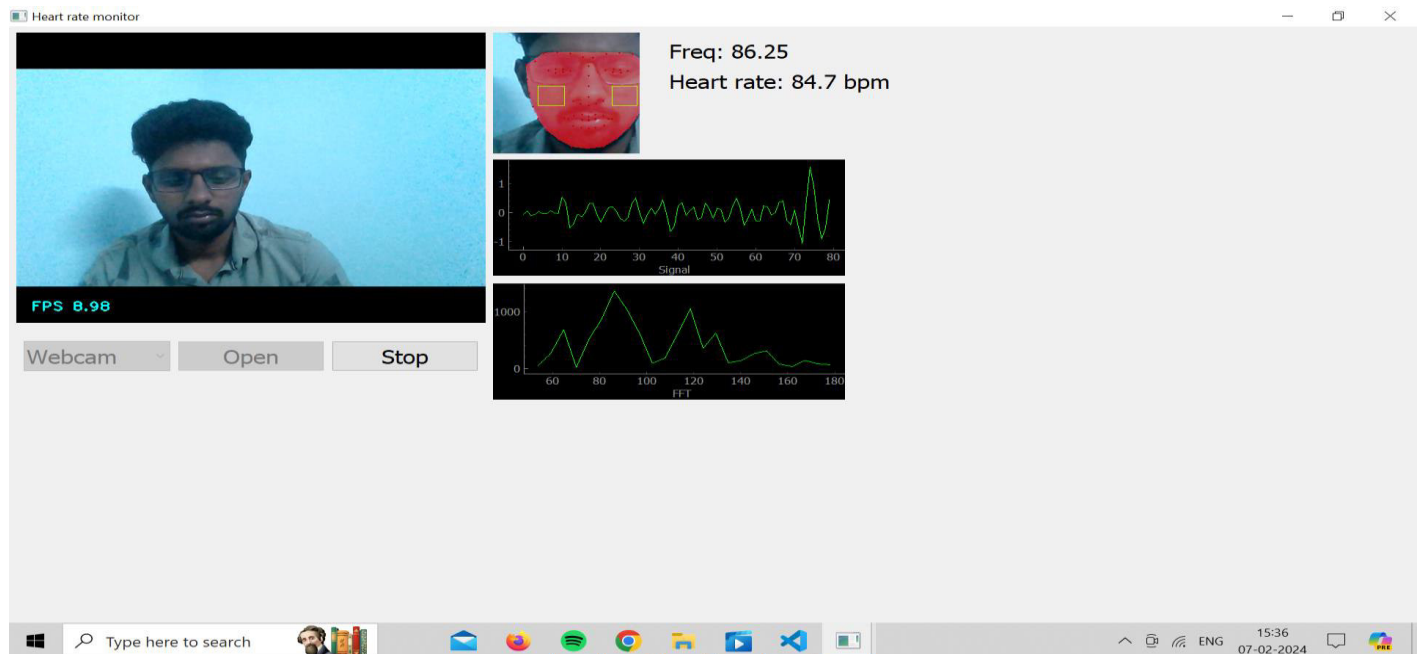
def run(self, input):
    self.reset()
    input = self.input
    self.input.dirname = self.dirname
    if self.input.dirname == "" and self.input == self.video:
        print("choose a video first")
        #self.statusBar.showMessage("choose a video first",5000)
        return
    if self.status == False:
        self.status = True
        input.start()
        self.btnStart.setText("Stop")
        self.cbbInput.setEnabled(False)
        self.btnOpen.setEnabled(False)
        self.lblHR2.clear()
        while self.status == True:
            self.main_loop()
    elif self.status == True:
        self.status = False
        input.stop()
        self.btnStart.setText("Start")
        self.cbbInput.setEnabled(True)

if __name__ == '__main__':
    app = QApplication(sys.argv)
    ex = GUI()
    while ex.status == True:
        ex.main_loop()

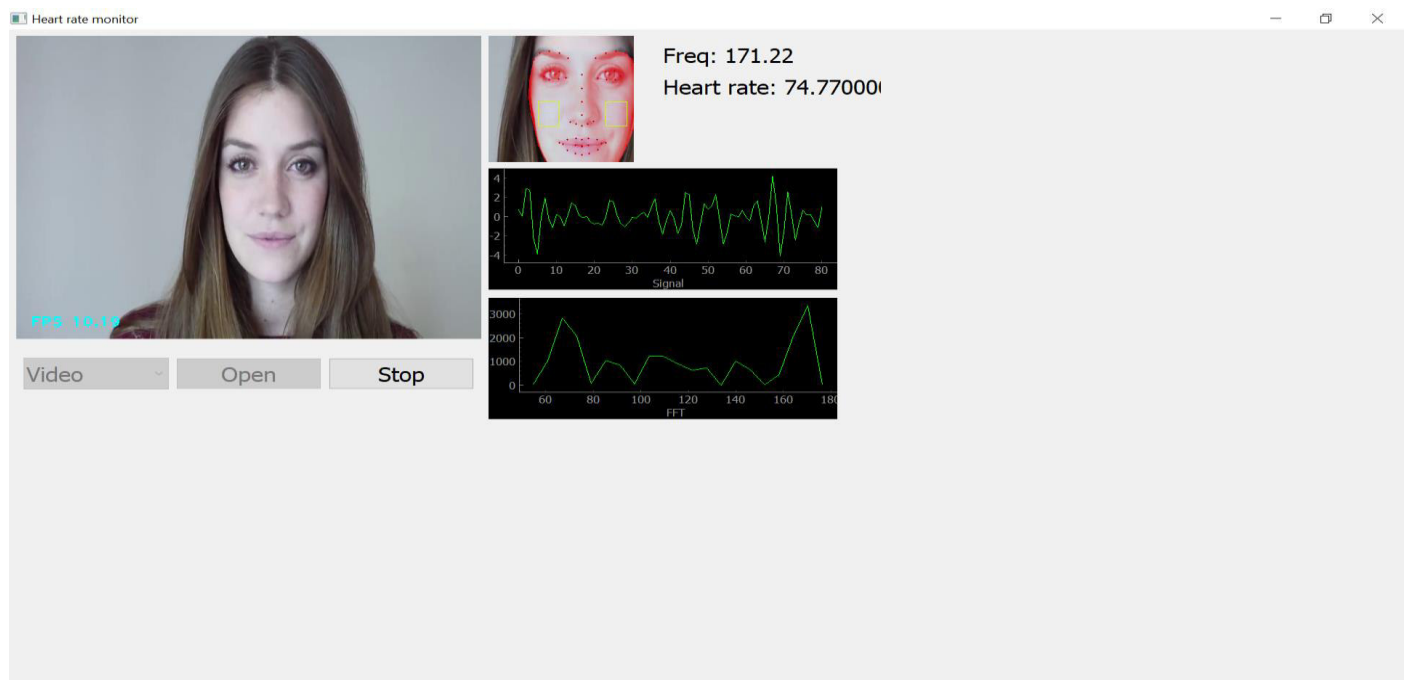
    sys.exit(app.exec_())

```

B.SCREENSHOTS



Heart Rate Estimated



Heart Rate estimated using Recorded Video

C. RESEARCH PAPER

REAL TIME HEARTBEAT RATE ESTIMATION USING WEB CAMERA

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Abstract. Real-time heartbeat rate assessment utilizing a web camera is an arising area of exploration that expects to give a helpful and harmless strategy for checking heart action. This method includes using the webcam of a gadget, for example, a cell phone or a PC, to extricate unobtrusive facial color changes brought about by blood stream varieties in the skin. By examining these variety varieties, it is feasible to gauge the pulse of a person Real-time The cycle starts by catching a video transfer from the web camera and applying different picture handling procedures to separate the district of interest, typically the face. Then, the extricated locale is investigated to identify and follow inconspicuous variety changes that relate to the pulsatile stream of blood. This is accomplished by utilizing progressed signal handling calculations that can precisely recognize the important signs from the video outlines. When the variety varieties have been identified and extricated, they are handled further to appraise the pulse. This includes applying signal handling strategies, for example, Fourier changes or otherworldly examination to decide the occasional parts in the variety information. By investigating the recurrence content of these intermittent parts, it is feasible to appraise the pulse precisely. Real-time heartbeat rate assessment utilizing a web camera has various expected applications, going from wellbeing checking to biometric validation

INTRODUCTION

An individual's pulse can be characteristic of their wellbeing, wellness, action level, stress, and significantly more. Cardiovascular heartbeat is ordinarily estimated in clinical settings utilizing electrocardiogram (ECG), which expects patients to wear chest lashes with cement gel fixes that can be grating and become awkward for the client. Pulse may likewise be observed utilizing beat oximetry sensors that might be worn on the fingertip or ear cartilage. These sensors are not helpful for long haul wear and the strain can become awkward over the long run. Notwithstanding the distresses of conventional heartbeat estimation gadgets, these gadgets can harm the delicate skin of untimely babies or old individuals. For these populaces particularly, a non-contact method for recognizing heartbeat could be exceptionally helpful. Non-contact pulse estimation through a basic webcam or telephone camera would likewise help telemedicine and permit the typical individual to follow their pulse without buying exceptional gear. As a feature of the new increase in prominence of wellness applications and the evaluated self, normal non-prominent observing through a PC or telephone camera might assist with distinguishing changes in an individual's pulse over the long haul and show changing wellbeing or wellness. Pulse can be distinguished without contact through photo plethysmography (PPG), which estimates varieties in blood volume by identifying changes in light reflectance or transmission all through the cardiovascular heartbeat cycle. PPG is typically performed with committed light sources with red or infrared frequencies, similar to the case for beat oximetry sensors. Constant pulse assessment utilizing a web camera is a creative innovation that can possibly change medical services checking and work on the personal satisfaction for people. With the broad accessibility of web cameras in workstations, cell phones, and different gadgets, this innovation gives a harmless and helpful technique to screen pulse. Customary pulse observing requires the utilization of specific gear, for example, sensors or chest lashes, which can be awkward and badly arranged for long haul use. Interestingly, utilizing a web camera to gauge pulse considers consistent and Real-time observing without the requirement for any extra equipment. The idea driving constant pulse assessment utilizing a web camera depends on the recognition of unobtrusive changes in skin tone brought about by varieties in blood volume during every heartbeat. The web camera records video of the client's face, and refined calculations break down these recordings to extricate the important data. By utilizing PC vision methods, the product

distinguishes explicit locales of premium, like the brow or fingertip, where these variety changes are most prominent. Once the districts of revenue are recognized, the calculation computes the pulse by analyzing the worldly varieties in variety power. This cycle includes following the slight changes in variety from one edge to another and applying numerical models and sign handling methods to extricate the pulse signal. The outcome is a precise assessment of the client's pulse in beats each moment. Constant pulse assessment involving a web camera has various applications in the fields of medical care and wellbeing. For example, it tends to be utilized for distant patient checking, permitting medical care experts to screen the indispensable indications of patients without actual contact intently. This innovation can be especially useful for people with persistent circumstances or the individuals who require nonstop observing, as it wipes out the requirement for normal visits to medical care offices. Moreover, Real-time pulse assessment utilizing a web camera can be incorporated into wellness and health applications, giving clients quick input on their pulse during proactive tasks. This data can assist people with upgrading their exercises, guaranteeing that they arrive at their objective pulse zones for powerful cardiovascular wellness. It can likewise act as an advance notice framework, telling clients in the event that their pulse surpasses safe levels during exercise.

At last Real-time pulse assessment utilizing a web camera is a promising innovation that can possibly change the manner in which we screen pulse. Its painless nature, joined with its accommodation and precision, make it an appealing option in contrast to conventional checking strategies. As this innovation keeps on advancing, it holds incredible commitment for further developing medical care results and upgrading the general prosperity of people.

LITERATURE SURVEY

Carmen Nadrag at [1] has presented separated from Pulse, different physiological boundaries connected with wellbeing status can likewise be estimated. Using this method could able to identify 3% only because it is a complicated one to find the heartbeat rate through the video show windows show natural blunders.

Minal Patil at [2] has proposed a system using WIFI. This module sending measurements of pace of heartbeat consistently on the cloud server. So when an individual is expected to see his heartbeat rate history or records then it very well may be recovered from the cloud serve alongside his temperature. Alongside pulse observing it likewise tell how much percentage of the temp the person having. Face discovery done with the utilization of the overflows. It depends on AI and is taught on a set made of both positive pictures and negative pictures (pictures that incorporate no face).

Bai at [3] has proposed a gadget that utilizes Li PPG the calculation, which extricates the PPG signal with the intensity rate powerfully, utilizes variety example to represent the PPG signal, empowering the extraction of the PPG signal under low illuminance also MVSGC model, to remove the sign from commotion or pattern.

Joel Hernandez at [4] has closed a pulse checking framework that utilizes the rakish rate information from a solitary pivot of a MEMS whirligig to distinguish pulses. With a mean outright blunder (MAE) and standard deviation of the outright mistake (SDAE), when our tests are contrasted and a reference ECG signal, we display that our machine is sufficiently precise to follow HR changes. It isn't viewed as a dependable way because of its significantly less exactness in coronary pulse identification.

Bathile at [5] was proposed a methodology that was once assessed on an original strategy that removes the PPG utilizing face video from a self-gathered dataset of 45 subjects. Dataset is separated into 9 sections (5 subjects for each part) to such an extent that each segment is utilized as the test information once when the final 8 parts are utilized as the preparation information. Aside from Pulse, Circulatory strain moreover is assessed.

Monika Jain at [6] proposed a light-based sensor can be utilized to distinguish varieties in coronary pulse; this is achieved through the use of a Photo plethysmography (PPG) sensor. The sensor comprises of a Drove with a photodetector and is in a situation to see the varieties in blood amount of blood stream in the body and straightforwardly relates to pulse. The procedure to build the sensor proposed here is of exceptionally low cost and moreover distinguishes heart arrhythmia implies a sporadic heartbeat. Utilizing overflows Face discovery (FD) has been carried out. It is fundamentally founded on AI and is prepared on a set made of both positive pictures (photographs of countenances) and negative pictures (pictures that contain no face). Aside from Pulse, various other physiological boundaries related with wellbeing status can likewise be estimated.

Hassan at [7] has proposed a philosophy that is Ballistocardiography utilized for video based pulse location. In this system heartbeat rate has been identified by assessing movement generated via blood. In this way, the capability of the movement following calculation to track the tiny lessens in light of the fact that return on initial capital investment estimation is diminished to specific pixels and because of which the exactness of the heartbeat rate assessment was diminished. Rahul Kumar Singh at [8] have proposed a straightforward and dependable real time pulse checking framework for automatic drivers. The created machine utilizes the guideline of non-contact

comfort on the Directing Wheel. This utilized a basic simple molding unit to give Real-time HR observing. Notwithstanding, it used to be extraordinarily intended for drivers, and furthermore, the subject requirements to hold the controlling wheel through an encasing.

Hamidur Rahman at. [9]. They have involved MATLAB for planning a GUI to screen Pulse progressively. Likewise made sense of working out Pulse from a recorded video by separating picture outlines. Different sign handling strategies like FFT, ICA, was used in the video calculation, free blood volume multiplied from people's face.

McDuff at [10] portrayed about video-based innovation the appearance advanced camera has impacted the remote detecting applications. Essentially two sorts of signs are utilized One is the Photo plethysmography (PPG) signal and the other is the BCG. It is an optical technique which is utilized to distinguish the blood volume in the tissue. The estimation is finished on the body surface and it is totally a painless strategy. The BCG technique is totally founded on the movement of the body by the siphoning of the blood. The PPG strategy have varieties in the relating followed outlines. These prompts the Real-time technique to work on the following of the subject face. After the following of edges the specific sign is been removed. The extraction of the sign is been finished by utilizing the sifting technique.

Cheng at [11] proposed for estimating the pulse by removing the PPG signals, the RGB cameras are required. The face is been followed and the green channel from the facial video is been utilized to gauge the heart rate. The map fitting method is been utilized for the face identification from the subjects video. The determination of Locale of Interest is the fundamental part. For the return for capital invested in this comparing technique the KLT highlight following calculation is been utilized. In this strategy the outside movement is been wiped out from the green ghostly channel.

Pawankiattikun at [12] presented the new strategy they have taken the red and green RGB camera range. Later Scientists done the extraction of the PPG announces taking the chrominance of the face and take the framework calculation technique for the breakdown of the pulse estimation. The extraction of pulse from the BCG signal is been shown up. The extraction is been finished by examining the movement highlights from the face. The element focuses will be extricated by sing the KLT highlight tracking calculation. Next the investigation of the heartbeat rate has been finished by utilizing the single element point. This component point has been determined from the brow district from this area the pulse has been assessed. The combination of the element focuses has been acquainted with find the pulse. For finding the BCG signal the intermittent assessment of heart has afterwards been created.

Tulyakov at [13] made sense of larger part of the examinations is been finished by utilizing the superior variant of the brightening and the movement antiquity evacuation. Studies is saying regarding the better rendition of the PPG signal technique. The computerized cameras are many times more costly and expected a gifted individual to work. The outside light source is additionally at times to expect to investigate the outcomes. In this venture the examination of the pulse estimation is been utilized by breaking down the BCG signal by utilizing a coordinated web-cam. For the noncontact strategy for studies have been profoundly presents by the specialists. These cameras are more helpful to use. The Real-time recordings are taken to find the pulse assessment.

EXISTING SYSTEM

Real-time heartbeat rate assessment utilizing a web camera is an imaginative and possibly life-saving use of innovation. By using the camera's capacity to catch unpretentious changes in skin tone brought about by blood stream, this framework points also give a precise assessment of an individual's pulse rate without the requirement for actual contact or extra sensors. Conventional strategies for estimating pulse frequently include connecting sensors to the body or utilizing particular gear. These strategies can be obtrusive, awkward, and unreasonable in specific circumstances. The utilization of a web camera permits, for a harmless and effectively open elective that can be used in different settings, like in clinics, horns, or even in far off regions.

PROPOSED SYSTEM

The proposed work center around the improvement of a Real-time pulse assessment framework utilizing a web camera. The goal of this undertaking is to give an available and helpful technique for people to screen their pulse without the requirement for extra equipment or intrusive systems. The framework will use the webcam's capacity to catch video film of the client's face and concentrate signals connected with blood stream changes. These signs will then, at that point, be handled and examined to assess the client's pulse progressively. This non-contact

approach takes into consideration a consistent and non-meddlesome observing experience. To accomplish this, the framework will use PC vision procedures to distinguish and follow facial highlights, for example, the locales around the eyes and nose, which are known to show inconspicuous variety changes because of blood stream varieties. By dissecting these variety varieties over the long haul, it is feasible to remove the pulse data.

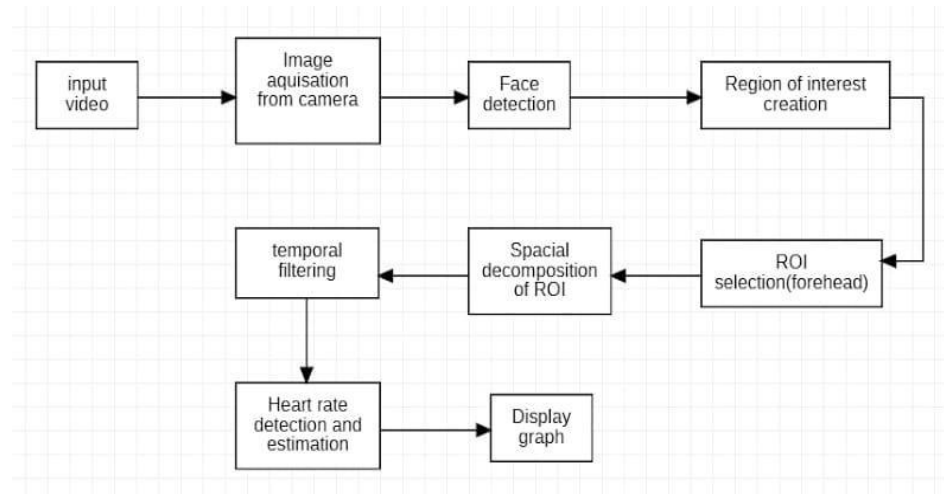


Figure 1. Overview of Proposed System

The proposed framework will utilize signal handling calculations, like Fourier change and pinnacle discovery, to precisely appraise the pulse from the separated signs. AI procedures, for example, relapse or arrangement models, may likewise be used to work on the precision and heartiness of the assessment interaction. The proposed work will be created utilizing a reasonable programming language and libraries, for example, Python and OpenCV, which offer broad help for PC vision and sign handling errands. A graphical UI may likewise be executed to furnish clients with an easy to understand insight and show constant pulse data. Tests will be carried out by different operators to evaluate the effectiveness of the framework. Pulse estimations got from the proposed framework will be contrasted and reference pulse estimations got from customary techniques, for example, contact-based pulse screens or electrocardiograms, to survey the Frame precision and unwavering quality. The proposed work plans to foster a constant pulse assessment framework utilizing a web camera, giving people a helpful and non-meddlesome technique for checking their pulse. This framework can possibly be utilized in different applications, for example, wellness following, stress the board, and medical care observing.

The system is crafted to adapt to evolving agricultural practices, showcasing a commitment to ongoing enhancements based on emerging data and technological advancements. In essence, this comprehensive approach envisions not only optimizing agricultural productivity but also enhancing sustainability, resilience, and community engagement within the agricultural sector.

SEQUENCE DIAGRAM

A diagram for estimating heartbeat in real time using a network camera will show the connection between devices. It will demonstrate the process of capturing video input from the webcam, removing facial expressions, identifying skin color and brightness, counting heart rate based on these changes, and displaying the estimated heart rate in real time. Each step in the system will be described as a lifecycle with messages exchanged between them, describing how data is processed and analyzed in the system to ensure accurate and timely heart rate estimation. This image visually represents the data flow and calculations in a system for real-time heart rate estimation using network cameras.

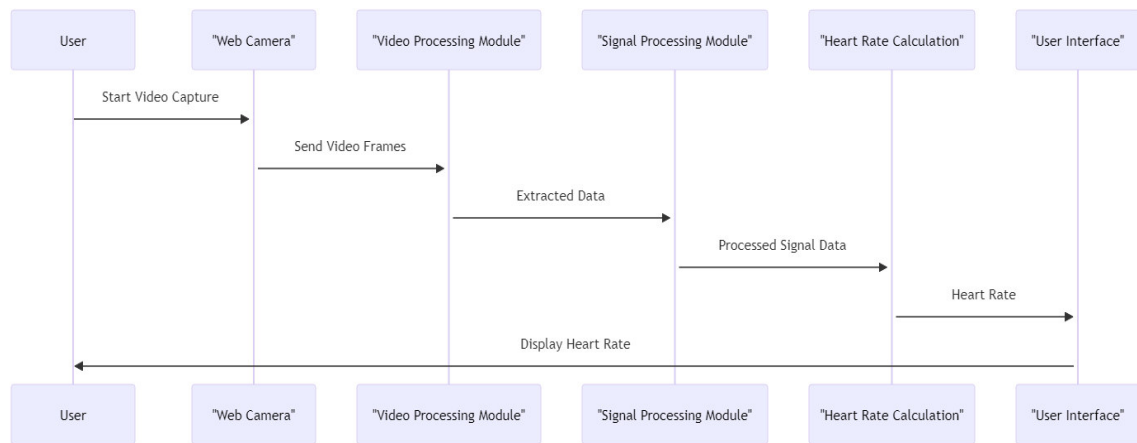


Figure 2. Sequence Diagram

ER DIAGRAM

For real-time heart rate estimation using a webcam, the relational entity (ER) view will contain fields such as a webcam, heart rate, face soft search, pixel value, time data and estimated heart rate. The relationship between these organizations will mainly describe how the pixel captured by the webcam will be used to identify the face, extract real-time data for heart rate.

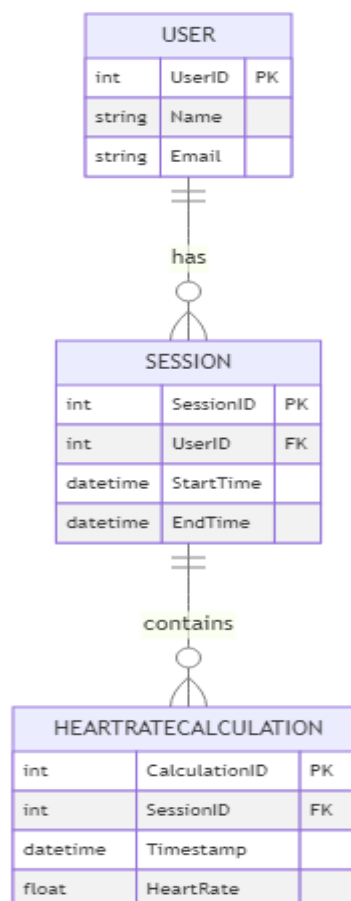


Figure 3. ER Diagram

SYSTEM ARCHITECTURE

A. Preprocessing and Face Detection

The primary module in our proposed framework for Real-time pulse assessment utilizing web cameras is the preprocessing and face discovery module. In this module, the approaching video outlines from the web camera are preprocessed to work on the nature of the pictures. This can include methods, for example, sound decrease, picture resizing, and contrast improvement. When the preprocessing is finished, the module uses face identification calculations to recognize and find the appearances in the video outlines. This is a pivotal step as it permits us to disconnect the district of revenue (return for money invested) which contains the individual's face where the pulse will be assessed.

B. Region of Interest Extraction

In the wake of distinguishing and confining the face in the video outlines, the following module centers around removing the locale of premium (return for capital invested) which is utilized for pulse assessment. The return for capital invested ordinarily incorporates regions like the brow, cheeks, and under the eyes, as these locales have great perceive ability of the blood stream brought about via heart action. Different strategies can be utilized to remove these districts precisely, including format coordinating, skin variety division, or component based approaches. When the return on initial capital investment is extricated, it will be utilized for additional examination in the resulting module.

C. Heart Rate Estimation

The last module in our proposed framework is the pulse assessment module. This module is answerable for examining the separated return on initial capital investment and assessing the pulse progressively. A few strategies can be utilized for pulse assessment, including variety based strategies, signal handling procedures, or AI calculations. One normal methodology is to examine unobtrusive variety changes in the return for money invested brought about by blood volume varieties during every heartbeat. This can be accomplished by utilizing calculations, for example, photo plethysmography (PPG) or pulse wave analysis (PWA). The pulse is then determined in light of the recurrence of these variety changes. The assessed pulse can be shown progressively for the end goal of checking or put away for additional investigation.

CREATING USER INTERFACE

A. Web User Interface

Real-time heart rate estimation using a webcam involves computer vision technology that instantly measures blood flow in the face, thus estimating a person's heart rate without the need for special sensors. By capturing and processing subtle color changes in areas of the face with higher blood flow, such as the forehead or chin, the webcam can monitor changes in blood volume and when it affects the user's heart rate. Through advanced algorithms and machine learning models, real-time processing will provide relevant information from video data such as heart rate and heart rate. This new approach not only provides a simple and non-invasive way to monitor heart rate, but also opens the possibility of integrating healthcare into existing network cameras for a variety of applications, including health monitoring, health monitoring and stress management.

B. Database

1. Motion-based analysis: Real-time motion tracking algorithm is used to detect subtle changes in facial color or heart rate-related movements. Use computer vision techniques such as optics or tracking features to track these small changes and calculate heart rate data. By constantly monitoring these changes, the system can estimate the user's heart rate in real time.
2. Machine Learning Approach: Build a machine learning model learned from large amounts of data on people with different skin types, ages, and genders to predict heart rate from facial data. Use techniques such as convolutional neural networks (CNN) to extract features from snapshots and predict heart rate based on these features. The model is constantly updated with new information to increase accuracy and adjust for individual differences. By analyzing facial cues in real time, the system can estimate the user's heart rate with high accuracy even in a dynamic environment.

C. Security

Data collection and preprocessing training for real-time heart rate estimation using webcams involves several important steps. First of all, the network camera should be used to capture different information of people showing different heartbeats in different conditions. This data should be interpreted carefully and synchronized with the actual heart rate monitor for training purposes. Secondly, to ensure good heart rate estimation, the collected data needs to be pre-processed to remove noise and artifacts, including blurred transitions and lighting. This preliminary step may include procedures such as background subtraction, filtering, and signal normalization. Finally, feature extraction methods such as physical analysis, frequency analysis, or spatial tracking can be applied to previous data to extract important information for heart rate estimation. By following these steps, you can create a powerful tutorial for creating real-time heart rate models on the web.

RESULT AND DISCUSSION

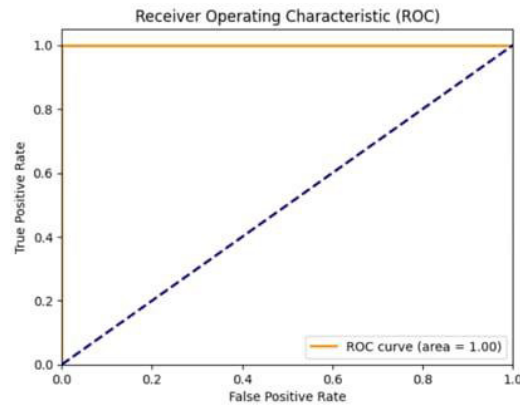


Figure 4. Receiver Operating Characteristics

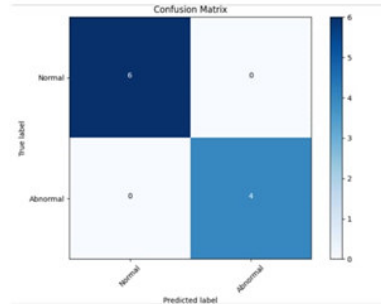


Figure 5. Graph overview with predicted, true label and confusion matrix

Figure 4, figure 5 describes about the results of the proposed system. The Real time heartrate assessment framework utilizing a web camera is a cutting-edge innovation that considers the estimation and observing of a singular's pulse Real-time using a basic webcam. This framework utilizes PC vision methods and calculations to identify and follow the unobtrusive changes in an individual's face that are related with varieties in pulse. By dissecting the video feed from the web camera, the framework can precisely gauge the pulse of the person without the requirement for any extra sensors or hardware. This innovation offers a non-nosy and helpful strategy for checking pulse, particularly in circumstances where conventional techniques are not plausible or functional. It can possibly upset medical services by empowering remote checking of patients' pulses from the solace of their own homes, as well as giving significant bits of knowledge into the cardiovascular strength of people during proactive tasks or distressing circumstances. In addition, this framework can likewise be applied in regions, for example, wellness following, sports execution examination, and stress the executives. With additional progressions in PC

vision and AI, the Real time heartrate assessment framework utilizing a web camera holds massive commitment for further developing medical care and upgrading how we might interpret human physiology progressively checking situations.

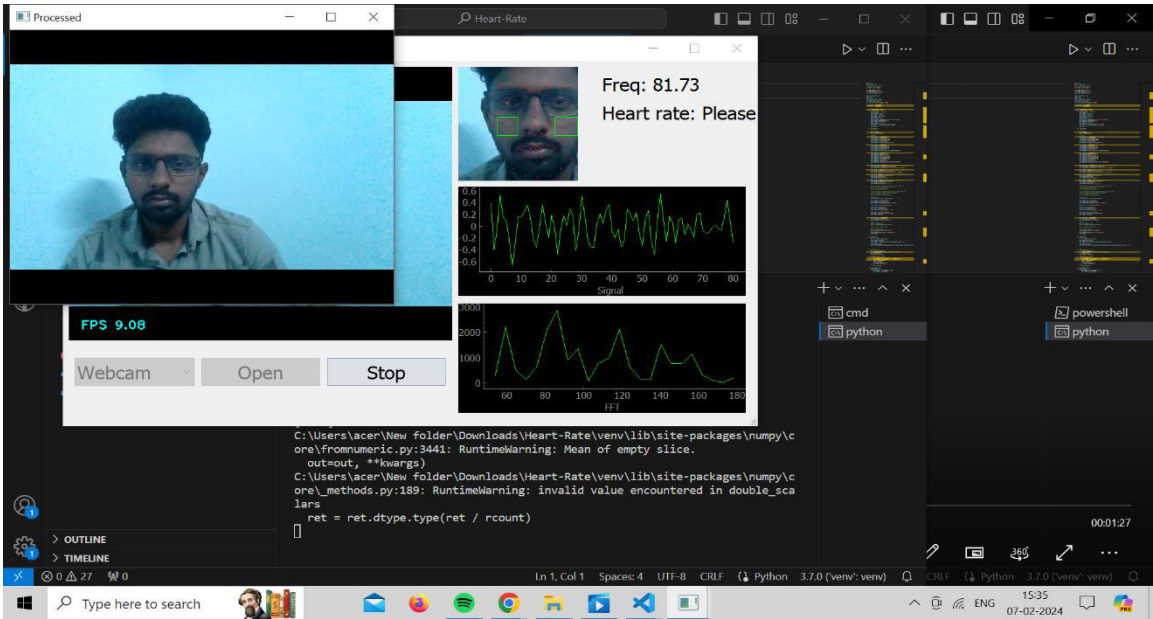


Figure 6. Output through Webcam

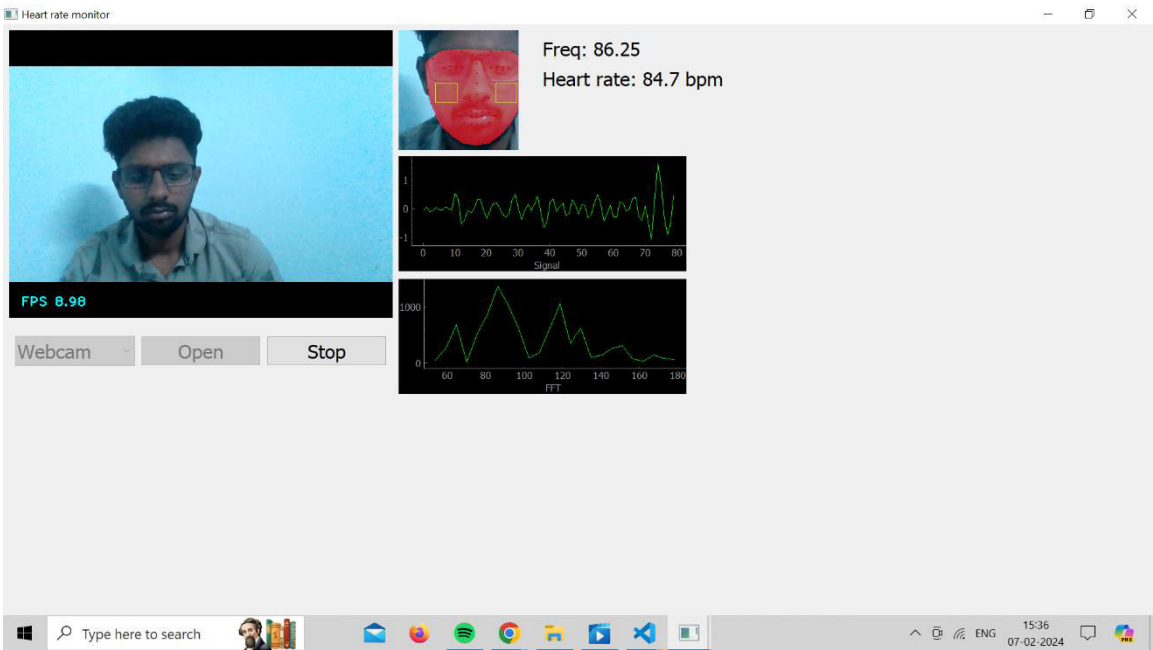


Figure 7. Heart rate estimated

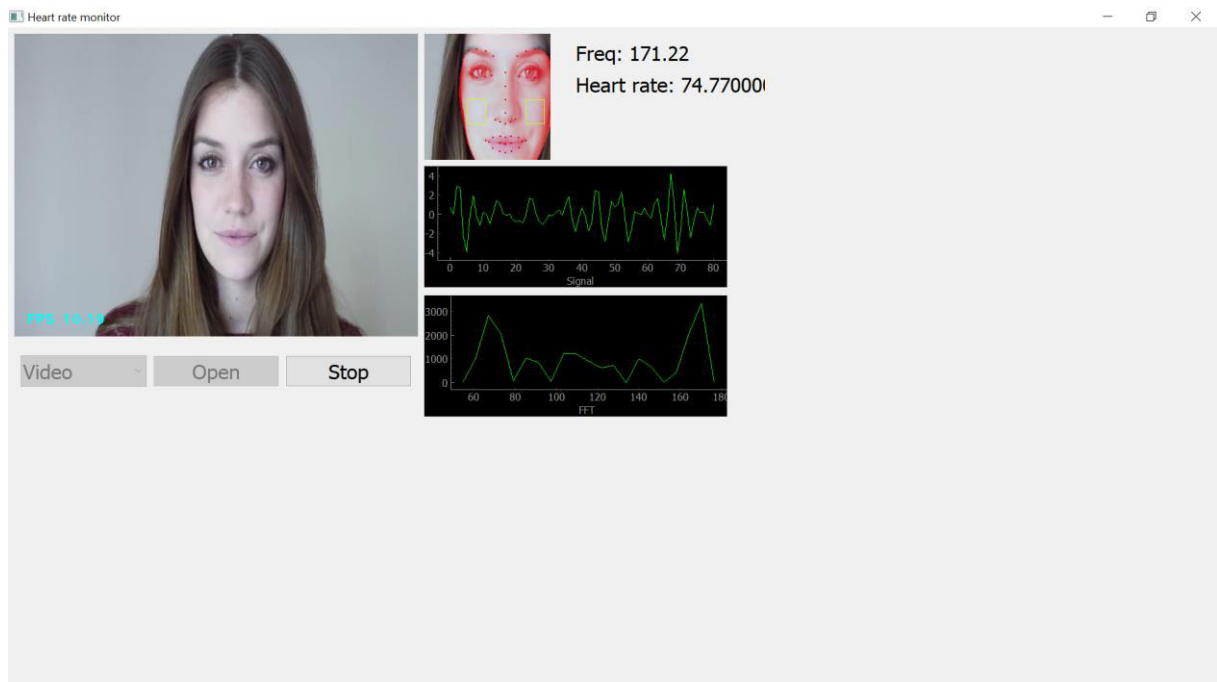


Figure 8. Heart rate estimated through Recorded Video

The accuracy of the network camera used to measure heart rate will vary depending on many factors, including the quality of the camera, lighting, and stability of the head and body. However, recent research shows that webcams can provide accurate and reliable heart rate measurements in many areas.

Overall, real-time heart rate monitoring using a webcam is a promising technology with many applications. While there are still some challenges to overcome, such as accuracy and illumination, the quality of this device makes it a good choice for many businesses. With continued research and development, real-time heart rate monitoring using webcams has the potential to become an important tool for real-time heart rate monitoring

CONCLUSION

The Proposed system for Real-time pulse assessment utilizing a web camera is a promising innovation that can possibly upset medical care observing. By using the shrewd capacities of a web camera, this framework can precisely quantify a singular's pulse without the requirement for any actual contact or extra gadgets. The capacity to screen pulse progressively opens up opportunities for early discovery of cardiovascular sicknesses and furnishes medical services experts with significant experiences into a patient's wellbeing status. Besides, this framework has the potential for more extensive reception because of its expense viability and comfort. With additional progressions and calibrating, the Real-time pulse assessment framework utilizing a web camera could enormously further develop medical services results and improve patient consideration

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SCHOOL OF COMPUTING

Department of Computer Science and Engineering

Certificate of Presentation

This is to certify that

HARIHARAN . V

of

Sathyabama Institute of science and Technology

has presented a paper entitled

Real time Heartbeat Rate Estimation using web camera .

in the

International Conference on Cognitive Computing and Artificial Intelligence (ICCCAI-2024) in association with
Taylor's University, Malaysia held on 7th & 8th March 2024.

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