Smart Medical Mirror

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ABSTRACT — The abstract of the paper introduces the concept of a smart medical mirror system designed to address the challenge of irregular medical check-ups by providing users with a convenient and effortless means of monitoring their basic vital signs. The system aims to detect health issues early by enabling continuous monitoring of parameters such as heart rate, SPO2, body temperature, and BMI. By leveraging the ubiquity of mirrors in homes, the proposed system integrates sensors and processing units within a mirror structure to deliver real-time health information to users during their daily routines. The paper outlines the hardware and software design of the system, detailing sensor selection, processing unit configuration, and mechanical assembly. Validation of the system's accuracy and usability is conducted through testing on multiple users, demonstrating coherence with FDA-approved medical systems. The abstract emphasizes the potential of the smart medical mirror to encourage regular health monitoring and suggests future enhancements to expand its functionality.

In modern society, the challenge of neglecting regular medical check-ups due to time constraints or lack of motivation persists. To address this issue, a novel solution is proposed: a smart medical mirror system that seamlessly integrates into daily routines, offering effortless measurement of vital signs such as heart rate, SPO2, body temperature, and BMI. This paper details the development and testing of the system, which utilizes a combination of sensors, processing units, and mechanical design to achieve its functionality. Results from user testing demonstrate the system's accuracy, usability, and potential to encourage regular health monitoring. The findings suggest that such innovative technologies hold promise in promoting proactive healthcare practices.

Keywords: Sensor Integration, Arduino Programming, Raspberry Pi Programming, Home Healthcare

1. INTRODUCTION

In contemporary society, despite the advancement of medical science, many individuals neglect regular medical check-ups due to various reasons, including time constraints and lack of motivation. However, early detection of medical issues through continuous monitoring can significantly impact the prevention and treatment of diseases. This paper addresses this challenge by introducing a novel solution: a smart medical mirror system designed to seamlessly integrate into daily routines and provide effortless monitoring of vital signs.

The concept of the proposed system stems from the recognition that individuals often prioritize their external appearance over internal health concerns. By leveraging the ubiquitous presence of mirrors in homes and the habitual act of checking one's appearance, this system aims to transform the mundane task of mirror usage into an opportunity for proactive health monitoring.

The system's functionality extends beyond a traditional mirror, as it incorporates sensors capable of measuring vital signs such as heart rate, SPO2, body temperature, and BMI. By utilizing familiar everyday objects in innovative ways, the system offers users the convenience of performing basic medical check-ups within the comfort of their homes, without disrupting their daily routines.

This paper presents the development and validation of the smart medical mirror system, detailing its hardware and software components, assembly process, and testing results. Through user testing, the paper evaluates the system's accuracy, usability, and potential impact on encouraging regular health monitoring practices.

In summary, this paper proposes a promising solution to address the prevalent issue of medical check-up negligence, leveraging the familiarity of household mirrors to promote proactive healthcare practices and enhance individual well-being.

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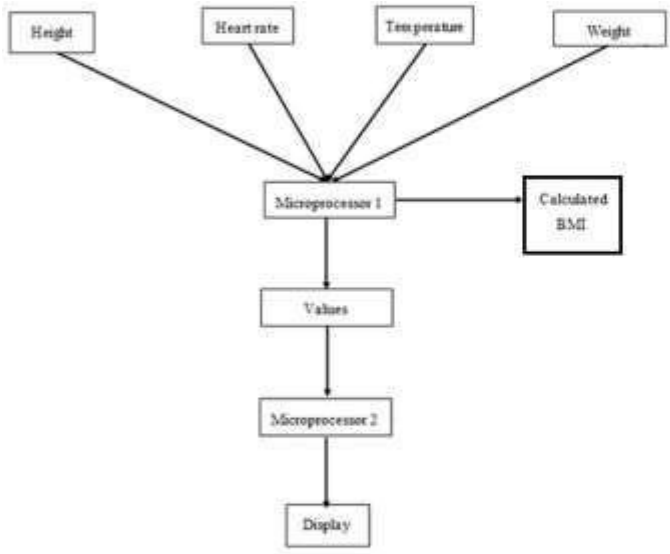


Fig. 1. Block diagram of the system

HARDWARE DESIGN

The hardware design section provides detailed insights into the components, sensors, and mechanical aspects of the smart medical mirror system. Here's a refined summary of this section:

Sensors:
The selection of sensors is crucial for accurate measurement of vital signs. The paper outlines the criteria for choosing sensors, including size, cost, accuracy, and operational voltage. Various sensors are employed, including:
- Ultrasonic sensor (HCSR04) for height measurement
- Weight sensor (HX-711) for weight measurement
- Temperature sensor (DS18B20) for room and body temperature measurement
- MAX30105 sensor for heart rate and SPO2 measurement

Processing Units:
Two main processing units are utilized: Arduino and Raspberry Pi. The Arduino board is responsible for initial data processing, analog-to-digital conversion, and interfacing with sensors. The Raspberry Pi handles further data processing, calculations, and display on the mirror screen. The

rationale for using each processing unit is explained, highlighting their respective functionalities and advantages.

Mechanical Design:

The mechanical design of the smart medical mirror system ensures optimal integration of components for functionality and user experience. Key aspects of the mechanical design include:

- Placement of sensors: Sensors are strategically positioned to facilitate accurate measurement while ensuring user convenience.
- Assembly: The mirror, display screen, microcontroller boards, power supply, and electronic circuits are assembled within a wooden frame, ensuring proper alignment and minimal interference.
- Wiring: Ample space is provided for wiring between components, and cuts are made for wires to pass through, maintaining a neat and organized setup.
- Sensor placement: Considerations such as sensor tilt angle and placement height are addressed to optimize sensor performance and user interaction.

The hardware design section provides a comprehensive overview of the physical components and layout of the smart medical mirror system, emphasizing functionality, usability, and integration for effective health monitoring.

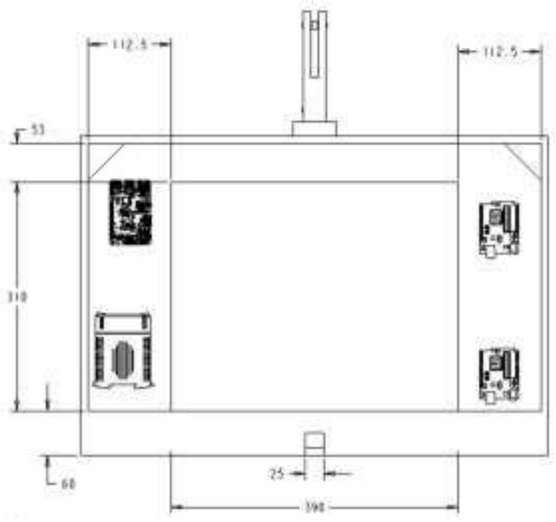


Fig. 2 Inner View Dimensions

Fig. 5. Inner Assembly of the System

SOFTWARE DESIGN

The software design section outlines the programming logic and functionality of the smart medical mirror system, encompassing both Arduino and Raspberry Pi platforms. Here's a refined summary of this section:

Arduino Programming

The Arduino programming segment focuses on sensor data acquisition, initial processing, and communication with the Raspberry Pi. Key aspects of the Arduino programming include:

Sensor interfacing:

Code is written to interface with each sensor, retrieving raw data for processing.

Analog-to-digital conversion:

Analog sensor readings are converted to digital values for further processing.

Data transmission:

Processed sensor data is transmitted to the Raspberry Pi via serial communication (USART interface).

Flowchart:

A flowchart illustrates the logical flow of the Arduino program, outlining the sequence of sensor data acquisition and transmission steps.

Raspberry Pi Programming:

The Raspberry Pi programming segment handles data interpretation, calculations, and display on the mirror screen. Key aspects of the Raspberry Pi programming include:

Data processing:

Received sensor data is processed to calculate vital sign parameters such as BMI, heart rate, SPO2, and body temperature.

Display control:

Code controls the display output on the mirror screen, formatting and presenting vital sign data in a user-friendly manner.

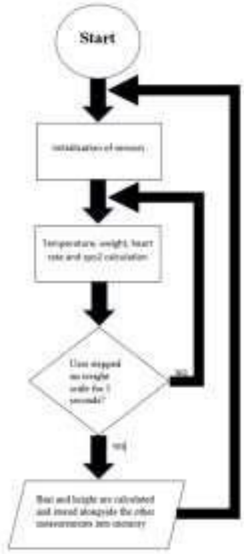
Time and date display:

The Raspberry Pi also manages time and date settings, ensuring accurate display alongside vital sign data.

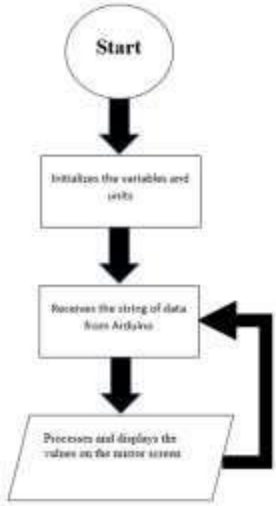
Flowchart:

A flowchart illustrates the logical flow of the Raspberry Pi program, detailing the sequence of data processing and display steps.

The software design section provides insight into the programming logic and functionality of both Arduino and Raspberry Pi platforms within the smart medical mirror system. It highlights the role of each platform in sensor data acquisition, processing, and presentation, ensuring seamless integration and user-friendly operation of the system.



Flowchart of Arduino Program



Flowchart of Raspberry Pi Program

System Implementation and Validation

Assembly Process:

The assembly process involves integrating the hardware components and setting up the software functionalities of the smart medical mirror system. Key steps in the assembly process include:

- Mounting the mirror glass and display screen within a wooden frame.
- Fixing the microcontroller boards, power supply, and electronic circuits behind the mirror screen.
- Ensuring proper wiring between components and creating cuts for wire passage.
- Securing sensors in optimal positions for accurate measurement.

Testing Procedures:

The testing phase involves validating the functionality, accuracy, and usability of the smart medical mirror system. Testing procedures include:

- Sensor calibration: Calibrating sensors to ensure accurate measurement of vital signs.
- Data comparison: Comparing the system's measurement outputs with those of FDA-approved medical systems to validate accuracy.
- User testing: Engaging multiple users with diverse profiles to evaluate system usability and user experience.
- Feedback collection: Gathering user feedback on ease of use, convenience, and overall satisfaction with the system.

Validation Results:

Results from the validation phase demonstrate the effectiveness and reliability of the smart medical mirror system. Key findings include:

- Coherence between system outputs and FDA-approved medical systems, validating accuracy.
- Positive user feedback on ease of use and convenience, indicating high user acceptance.
- Minor issues encountered, such as sensor placement optimization, addressed during testing and resolved for improved performance.

Overall, the implementation and validation phase confirm the successful development and functionality of the smart medical mirror system. The system's accuracy, usability, and potential to encourage regular health monitoring are validated through rigorous testing procedures and user feedback, highlighting its effectiveness as a proactive healthcare solution.

Placement of Height Sensor

Placement of Weight Scale

Data Displayed on the Mirror

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