iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** II **Month of publication:** February 2025

DOI: https://doi.org/10.22214/ijraset.2025.67126

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue II Feb 2025- Available at www.ijraset.com

Automated Patient Care Analysis to Prioritize Critical Cases Through Sensor-Based Monitoring

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Abstract: This paper proposes a novel Digital Priority Allocation System (DPAS) for hospitals, leveraging sensor technology and real-time data management to optimize patient care prioritization. Aiming to address challenges like delayed checkups and inadequate attention, the DPAS utilizes sensor-based data collection and automated analysis to prioritize critical cases. The system integrates hardware components like sensor modules and microcontrollers with software frameworks like Python and Google Firebase. Testing methodologies ensure DPAS effectiveness in simulating patient vitals and optimizing resource allocation. This paper highlights the societal and industrial benefits of DPAS in revolutionizing healthcare decision-making and enhancing patient care. It provides a blueprint for implementing the system, paving the way for efficient and patient-centric healthcare solutions.

Keyword: Automation,Sensor, Patient Care Optimization, Microcontroller, IOT

I. INTRODUCTION

Efficient resource allocation and timely care delivery are crucial in healthcare, especially in settings facing high demand and complex challenges. In India, for instance, shortcomings in timely checkups and adequate patient attention highlight a critical need for intervention. Research suggests delays in vital sign assessments can negatively impact patient safety, particularly for critically ill patients. Each hour of delay can increase adverse events by 10%. This not only jeopardizes patient well-being but also strains healthcare resources. The DPAS emerges as a timely solution to address these concerns. It integrates sensor-based data collection and real-time database management to revolutionize resource allocation dynamics within hospitals. By prioritizing patient care tasks based on criticality, the system aims to mitigate risks associated with delayed care and inadequate attention.

II. LITERATURE REVIEW

Several existing healthcare systems utilize similar Internet-of-Things (IoT) approaches. However, limitations exist. For instance, a project presented at the 2020 International Conference on Electrical and Electronics Engineering (ICE3) proposed an IoT-based healthcare system using sensors like the pulse rate and MAX30102 for vital sign measurement. This approach faces challenges in data security and privacy due to internet transmission, connectivity issues in remote areas, calibration and maintenance difficulties leading to inaccurate readings, limited access to healthcare professionals hindering timely intervention, and potential usability barriers for certain demographics.

III. PROBLEM FORMULATION

A. Sensor Selection

The MAX30102 sensor module stands out due to its dual-wavelength measurement capability. Emitting both red and infrared light, it enhances the accuracy of heart rate and SpO2 measurements by detecting variations in light absorption caused by changes in blood volume. Additionally, the high sensitivity and low noise levels contribute to superior performance in detecting subtle changes.

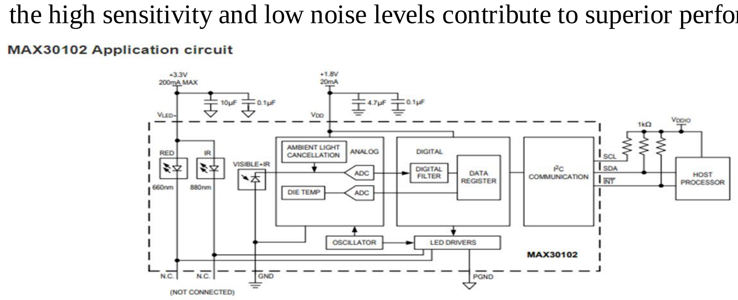

Fig 1:Application Circuit of MAX3012 [7]

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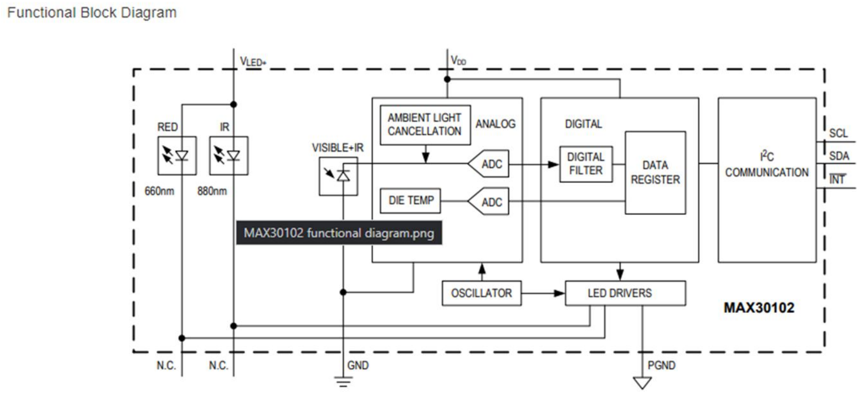

Fig 2: Block Diagram of MAX 30102[7]

B. *Working Principle*

The MAX30102 operates based on photoplethysmography (PPG). This technique involves emitting light into the skin and measuring the amount of light absorbed by oxygenated and deoxygenated hemoglobin. Examining the second derivative wave of the PPG signal can aid in early identification of potential cardiovascular conditions.

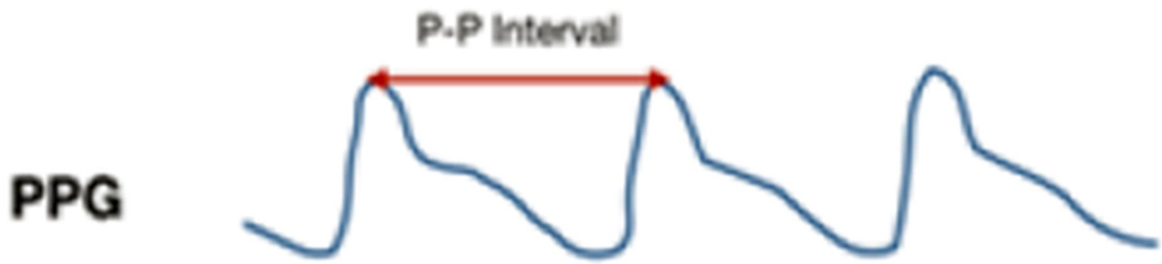

Fig 3: PPG Intervals

IV. RESULTS

A. *Data Collection and Analysis*

Sensor data from each patient bed is uploaded to a Firebase Realtime Database. A Python program collects these vitals and compares them against ideal ranges based on age and gender. This comparison determines the priority level for each patient. The system then generates a prioritized list, ranking patients from highest (most critical) to lowest priority (healthy).

B. *Priority Allocation Methodology*

The Digital Priority Allocation System (DPAS) implements a sophisticated, data-driven approach to prioritizing patient care. The system continuously records vital parameters including pulse rate, blood oxygen levels, and body temperature through MAX30102 sensors positioned at each patient bed. This real-time data is automatically uploaded to a Google Firebase database at regular intervals, creating a dynamic snapshot of each patient's physiological status.

The DPAS employs a specialized algorithm that examines the consistency of the most recent ten data uploads for each patient. This temporal analysis is critical for detecting both acute deviations and concerning trends before they become life-threatening. When the system identifies significant fluctuations in any monitored parameter—such as sudden tachycardia, oxygen desaturation, or fever spikes—it immediately triggers an alert, assigns a priority level to the patient, and generates an automated report that is transmitted directly to the attending nurse's interface. The priority allocation mechanism categorizes patients into distinct tiers based on the severity and persistence of their abnormal readings. Patients exhibiting multiple parameter deviations or sustained critical values receive the highest priority designation. The final prioritized list is dynamically updated after each data analysis cycle, ensuring that medical staff attention is continuously directed toward the most vulnerable patients. This intelligent triage system reduces response time to deteriorating conditions, minimizes the risk of oversight during high-volume periods, and optimizes the allocation of limited healthcare resources—ultimately reducing adverse events and improving patient outcomes across the facility.

V. CONCLUSION

The reviewed research reveals advancements in healthcare monitoring and delivery solutions. However, challenges remain concerning technical issues, usability, and privacy. The future of healthcare technology is promising, with a focus on incorporating monitoring systems into wearable devices for comprehensive and continuous patient care. The DPAS offers a valuable solution to address resource allocation challenges in hospital settings, prioritizing care for critical patients and enhancing overall patient well-being.

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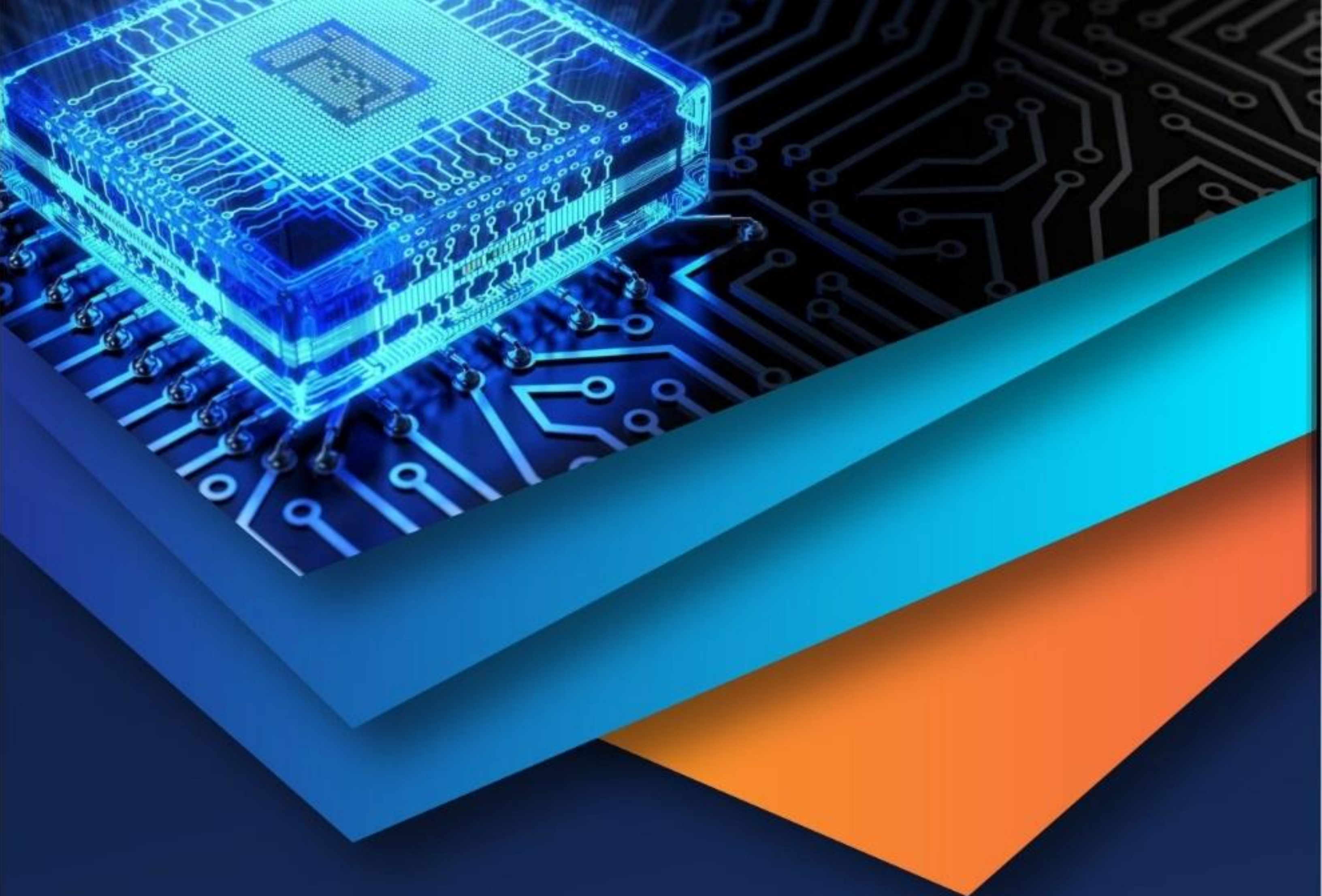

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