
FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTER ENGINEERING AND INFORMATICS

Final Year Project Report

**IOT-BASED CARDIAC ARREST PATIENT MONITORING AND ALERT
SYSTEM**

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**This Final Year Project Report submitted to the Department of
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Declaration

We, **Namutali Aspon** and **Namukooli Angel Agnes**, do hereby declare that this project report was done by us and has never been published or submitted to any Academic Institution of Higher Learning for an academic award.

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Approval

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Dedication

We dedicate this report to the following:

1. Namukoli Agness Angel's Parents and Siblings: Parents Baligeya Kaalo Patrick and Balinabyo Maria, brothers Kaalo Richard and Kaalo Tom
2. Namutali Aspon's Parents and Siblings: Parents Wetende Stephen and Mutyembu Robbinah, brothers Wakubona Peter, Massette Vincent and Sisters Kibone Mercy and Sikhoya Constance
3. Supervisor Dr. Alunyu Andrew Egwar

Abstract

Cardiac arrest remains a leading cause of mortality both globally and in Uganda, where limited healthcare resources, delayed emergency response, and insufficient monitoring contribute to high fatality rates. This project proposes the design and implementation of an **IoT-based cardiac arrest patient monitoring and alert system** aimed at improving real-time detection and response to cardiac emergencies in hospitals. Cardiac arrest, characterized by the abrupt cessation of heart function, requires immediate medical intervention to prevent irreversible organ damage or death. In many Ugandan hospitals, particularly government-run facilities, timely medical response is often hindered by staff shortages, communication delays, and the absence of continuous monitoring systems.

This system integrates biomedical sensors, ECG (AD8232), blood pressure, pulse rate and oxygen saturation sensors (MAX30100/MAX30102) with an ESP32 microcontroller and a SIM800C GSM module for wireless communication. It enables real-time monitoring of patients' vital signs and automatically sends SMS alerts to medical personnel when abnormalities are detected, including when a patient's condition deteriorates suddenly or an emergency button is pressed. The solution is designed to be non-invasive, compact, and cost-effective, making it suitable for deployment in resource-constrained healthcare settings.

The project follows a systematic methodology: identifying user and technical requirements, designing hardware and software components, integrating the system, and validating its effectiveness through testing. Focused primarily on hospitalized cardiac arrest patients, the system aims to reduce emergency response time and improve patient outcomes. This research has the potential to bridge critical gaps in emergency cardiac care in Uganda and contribute to broader efforts to modernize patient monitoring and enhance public health infrastructure.

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Table of abbreviations

Abbreviation	Abbreviation in full
HTTP	Hypertext Transfer Protocol
HTML	Hypertext Markup Language
CSS	Cascading style sheet
JS	JavaScript
SMS	Short Message service
ECG	Electrocardiogram
PCB	Printed Circuit Board
XAMPP	Cross-platform, Apache, MariaDB, PHP and Perl
SQL	Structured Query Language
VSC	Visual Studio Code
DOM	Document Object Model
NPM	Node package management
SIM	Subscriber Identity Module
UI	User Interface
IoT	Internet of Things

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REFERENCES

- [1] T. Gao et al., "Wireless medical sensor networks in emergency response: Implementation and pilot results," in Proc. IEEE Conf. Technologies for Homeland Security, 2008, pp. 335-340.
- [2] A. Pantelopoulos and N. Bourbakis, "A survey on wearable sensor-based systems for health monitoring and prognosis," IEEE Trans. Syst. Man Cybern. Part C (Applications and Reviews), vol. 40, no. 1, pp. 1-12, 2010.
- [3] M. Zehender, T. Meinertz, J. Keul, and H. Just, "ECG variants and cardiac arrhythmias in athletes: Clinical relevance and prognostic importance," Am. Heart J., vol. 119, no. 6, pp. 1378-1391, 1990.
- [4] K. Yeh, T. Lin, Y. Hsieh, C. Chang, Y. Yang, and S. Lu, "A cuffless wearable system for real-time cutaneous pressure monitoring with cloud computing assistance," in Proc. IEEE Int. Symp. VLSI Design Automation and Test (VLSI-DAT), 2018, pp. 1-4.
- [5] T. Ng and W. Liao, "Sensitivity analysis and energy harvesting for a self-powered piezoelectric sensor," J. Intell. Mater. Syst. Struct., vol. 16, no. 10, pp. 785-797, 2005.
- [6] C. C. Liu, S. H. and J. C. Yang, "The wearable device for acute mountain sickness by using SpO2 measurement," J-Stage, 2018. [Online]. Available: <https://doi.org/10.11239/jsmbe.Annual56.49>.
- [7] World Health Organization (WHO), Global health estimates: Causes of death 2016, Geneva, Switzerland: WHO, 2019.
- [8] M. Kaggwa, J. Muwema, and D. Namatovu, "Incidence of cardiac arrest at Mulago Hospital," Ugandan Medical Journal, vol. 65, no. 3, pp. 175-180, 2019.
- [9] K. Yeh, T. Lin, Y. Hsieh, C. Chang, Y. Yang, and S. Lu, "A cuffless wearable system for real-time cutaneous pressure monitoring with cloud computing assistance," in Proc. IEEE Int. Symp. VLSI Design Automation and Test (VLSI-DAT), 2018, pp. 1-4.
- [10] Ministry of Health, Annual health sector performance report, Kampala, Uganda: Ministry of Health, 2020.
- [11] "1971: Microprocessor integrates CPU function onto a single chip," The Silicon Engine. Computer History Museum, 2019. [Online]. Available: <https://computerhistory.org>.
- [12] "GSM BRANDS Trademark of GSM Sales LLC - Registration Number 5523328 - Serial Number 87703883," Justia Trademarks, 2023. [Online]. Available: <https://trademarks.justia.com>.

[13] "GSM Audio Codec: Vocoder: AMR, CELP etc.," Electronics Notes, 2023. [Online]. Available: <https://www.electronics-notes.com>.

[14] "GSM Global system for Mobile Communications," 4G Americas, 2014. [Online]. Available: <https://www.4gamericas.org>.

[15] S. Bennett, A History of Control Engineering 1930–1955, London, U.K.: Peter Peregrinus Ltd. on behalf of the Institution of Electrical Engineers, 1993.

[16] J. E. Bromwich, "A panic button for the phone," The New York Times, Nov. 20, 2015. [Online]. Available: <https://www.nytimes.com>.

[17] Certified Alarm Technician Level 1 Manual, NTS, Oct. 10, 2007.

[18] "What is a web application?", StackPath, 2022. [Online]. Available: <https://stackpath.com>.

[19] Y. Sattar and L. Chhabra, "Electrocardiogram," Treasure Island (FL): StatPearls Publishing, 2022.

[20] R. E. Kerber, L. B. Becker, J. D. Bourland, J. O. Cummins, A. P. Hallstrom, M. B. Michos, G. Nichol, J. P. Ornato, W. H. Thies, R. D. White, B. D. Zuckerman, "Automatic external defibrillators for public access defibrillation," Circulation, vol. 95, pp. 1677-1682, 1997.

[21] "CPR Adult Courses," American Red Cross, 2007. [Online]. Available: <https://www.redcross.org>.

[22] W. H. Colby, The Ascent of Medical Technology, New York, NY: AMACOM Books, 2007.

[23] "Holter Monitor," American Heart Association, 2018. [Online]. Available: <https://www.heart.org>.