



FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL ENGINEERING
FINAL YEAR PROJECT REPORT
DESIGN OF SMART RAIN WATER HARVESTING CONTROL AND
TREATMENT SYSTEM FOR SAFE DRINKING WATER

BY

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A final year project report submitted to the faculty of engineering of Busitema university in partial fulfillment of the requirement for the award of a diploma in electrical and electronics engineering.

MAY 2025

DECLARATION

I Mukasa Nasuru, honestly declare that the work described in this report is, except for citation and quotations, entirely my own work and has not been submitted as an exercise for a diploma at this or any other institute or higher learning

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27/06/2025.

APPROVAL

This is to approve that this report is submitted by Mukasa Nasuru to the department of electrical engineering, Busitema university, in partial fulfillment of the requirement for the award of a diploma in electrical and electronics engineering under supervision of

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ACKNOWLEDEMENT

I would like to express my special thanks of gratitude to my guides and mentors Eng. George Kilama and Ms. Patience Tusiimire for the support and guidance in completing my project, I'm also grateful to the university staff for their consistent support and assistance and finally, I appreciate all the support by all my friends and family who constantly supported me and kept my hopes high even in the difficult times that I could go through. I'm doing this project not just because of marks but also for knowledge and skill set.

Above all the Almighty Allah, you are the master of everything, may you continue blessing me and all these people that helped me towards this journey writing this report

DEDICATION

I dedicate my project work to my family and many friends. A special feeling of gratitude to my loving parents and my supervisors Ms. Patience Tusiimire and engineer Kilama George

ABSTRACT

Water scarcity and contamination pose significant challenges to sustainable development, necessitating innovative solutions for efficient water management. This project focuses on the design of a smart rainwater harvesting, control, and treatment system, incorporating real-time monitoring and thermal treatment. A review of existing technologies highlights the effectiveness of sensor-based automation, thermal sterilization, and filtration in improving water quality. The system is developed using water level and quality sensors, an Arduino Mega microcontroller, heating elements, and a filtration unit, with data displayed on an LCD and logged for analysis. The methodology involves testing the system's response to varying water quality parameters, with temperature thresholds optimized for microbial elimination. Results demonstrate a significant improvement in water purity post-treatment, with efficiency exceeding 80% in most trials. The economic analysis confirms the system's feasibility, with a projected payback period of less than four years. This solution presents a scalable and cost-effective approach to enhancing water security in urban and rural environments.

LIST OF ACRONYMS

CPU: Central Processing Unit

RAM: Random Access Memory

ROM: Read Only Memory

Km: Kilometer

?: Percent

RWH: Rainwater harvesting

UV: Ultra violet

IoT: Internet of things

MSNs: Mobile sensor networks

IDE: Integrated Development Environment

UART: Universal Asynchronous Receiver Transmitter

I/O: Input out

KB: Kilobyte

MHz: Megahertz

DC: Direct current

AC: Alternating current

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Arduino Digital I/O: <https://www.arduino.cc/en/Tutorial/Foundations/DigitalPins>

<https://images.app.goo.gl/PVERoEHYHVXJEtkf7>

<https://images.app.goo.gl/myjebAR98vYUtPFP6>

<https://github.com/milesburton/Arduino-Temperature-Control-Library>

<https://www.electronicwings.com/nodemcu/relay-module-interfacing-with-nodemcu>

Chen, Z., et al. (2020). Applications of IoT in water quality monitoring systems: A review. *Environmental Science & Technology*.

Smith, J., & Brown, R. (2018). *Smart Water Systems: Technologies and Applications*. Springer.

Kumar, P., Singh, M., & Jain, S. (2019). IoT-Based Water Quality Monitoring System for Smart Cities. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 9(1), pp. 234-239.

Wang, X., & Li, Y. (2017). ZigBee Wireless Sensor Networks for Water Quality Monitoring and Management. *IEEE Transactions on Consumer Electronics*, 63(4), pp. 567-573.

Bahadur, N. et al. (2015). [Referenced in context for pollution impact].

CDC (2021). Effectiveness of heat treatment in eliminating microbial contaminants.

WHO (2020). Safe water treatment and disease prevention guidance.

UNICEF & WHO (2021). Report on global access to safe drinking water.

Ministry of Water & Environment, Uganda (2022). National statistics on water access.

United Nations Environment Programme (UNEP)
Rainwater Harvesting and Utilization – An Environmentally Sound Approach for Sustainable Urban Water Management.
<https://www.unep.org>

International Water Management Institute (IWMI)
Jayasinghe, G., & Gunawardena, E.R.N. (2010). *Rainwater Harvesting for Domestic Use in Sri Lanka: Potential, Issues, and Sustainable Strategies.*
<https://www.iwmi.cgiar.org>

<https://www.daraz.com.np/products/water-flow-float-switch-water-level-control-switch-water-over-flow-switch-i105977034.html>

<https://www.elsys.se/shop/product/external-temperature-probe-2m/?v=f003c44deab6>