BUSITEMA UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

GSM BASED PIPED WATER THEFT DETECTION SYSTEM

BY

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DECLARATION

I, Khabusi Simon Peter, Registration Number BU/UG/2012/67 do hereby declare this Project entitled "GSM based piped water theft detection system" as my original work except where explicit citations has been made and that it has never been submitted to any Institution of higher learning for academic award.

Signed: **...**   Date: **...**

KHABUSI SIMON PETER

APPROVAL

This is to certify that the project report entitled **"*GSM based piped water theft detection system*"** has been done under my supervision and is hereby being submitted for examination with my recommendation.

Signed**…………………………………….**

Date**……………………………..**

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DEDICATION

To my family members for their financial support and prayers, and to my supervisor, Mr. Alunyu Andrew Egwar who guided me tirelessly.

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I extend my sincere gratitude to the Almighty God who out of his love and mercy enabled me accomplish this project. He paved a way where there was no way!

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Finally, I thank my family members who supported me financially, morally and spiritually throughout the period of system development that today, the GSM based piped water theft detection system is now in existence.

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LIST OF ACRONYMS

NWSC: National Water and Sewerage Corporation

WALOPU: Water Loss Prevention Unit

NRW: Non-Revenue Water

GSM: Global Systems for Mobile Communication

TDMA: Time Division Multiple Access

FDMA: Frequency Division Multiple Access

SMS: Short Message Service

LCD: Liquid Crystal Display

PCB: Printed Circuit Board

uPVC: Unplasticized Polyvinyl Chloride

μC: Microcontroller

HDPE: High density polyethylene

ABSRACT

National Water and sewerage corporation (NWSC), a body mandated by the government of Uganda to supply clean water to her citizens face great challenges arising from water theft. Water theft has led to increased Non-Revenue Water (NRW). Despite attempts to curb the problem, water theft has remained an issue in the operation of NWSC. Currently, the Corporation requires a dedicated system to handle this big challenge. Therefore, the GSM based piped water theft detection system that has been designed will help NWSC to handle this challenge. It operates in such a way that if any water theft is detected along the water distribution lines, an alert message is sent to the administrator so that an immediate action can be undertaken. The principle behind this operation follows the fact that Water Supply Corporations distribute water at a uniform flow rate defined according to the pressure zone of a given location i.e. different areas have different distribution pressures hence different flow rates but areas within the same pressure zone have same flow rates. This system is able to detect a considerable fluctuation in the flow rate and sends an alert message. The different forms of theft such as meter by-pass, meter reversals, meter tampering, and illegal tapping have been dealt with. For the theft that does not affect flow rate, the water supplied to the given service line will be metered such that no matter what a customer does to the physical meter, the actual amount of water consumed will be recorded. To attain this functionality, flow rate sensors have been interfaced with microcontrollers, the central processing unit of the entire system. The GSM Module has also been interfaced and is in charge of sending the alert message to the administrator's phone. The administrator therefore can follow up to the area where suspected theft is taking place and investigations can start.

CONTENTS

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This chapter gives a brief introduction of the study of the GSM based piped water theft detection system i.e.; background, problem statement, objectives, justification/ significance and the scope of the study.

1.1 Background of Study

In urban areas, there is tremendous need of water and water distribution network plays an important role in delivering water to individual families, offices, construction sites, etc. For the efficient delivery of water is dependent on water flow rate, pressure of water and purity of water but sometimes it is found that some individuals run motors to suck more water from pipelines to drain point to serve their excessive need of water [1]. This in turn disturbs steady flow of water which is meant to flow at a constant flow rate in town areas [2][3][4] and due to that, other consumers in that particular area get affected because of this misuse of water. This is just one of the ways in which people steal water. Other ways include; meter bypass, Meter tampering, Meter reversals and vandalism [5].

A lecture given on February 20, 2015 at Brookings Mountain West Lecture Series, Vanda Felbab-Brown explains that Water theft and smuggling are perpetrated by both the wealthy and those who are chronically deprived of water, as she provides examples from California, southern Europe, Nigeria, Kenya, the Middle East, and South Asia [6]. In many parts of the world, elaborate smuggling of water with complex network chains and water mafias has emerged. Smuggling modes vary and among others include the development of illegal pipelines, and illegal truck deliveries.

Felbab-Brown further explains that, "For many reasons, the illegal use and delivery of water are difficult to address [6]. Large-scale agriculture and industry often exercise great influence over regulators and law enforcement. In slum areas, mostly unconnected to legal pipelines, the suppression of illegal water distribution can sever access to water and hence threaten the physical survival of the most marginalized and poor. Across the world, citizens tend to be vehemently opposed to increased water pricing, yet without effective regulation, appropriate pricing, and suppression of water crimes, the sustainability, long-term viability, and inclusive and equitable use of water cannot easily be achieved [6]."

National Water and Sewerage Cooperation, (NWSC), a Public Utility Company, completely owned by the Government of Uganda, established in 1972, with the mandate to operate and provide water and sewerage services in the areas entrusted to it, on a sound commercial and financially viable basis face a great challenge of water theft [5]. The Managing Director of NWSC, Dr. Silver Mugisha stated that one of the biggest challenges facing most water utilities in developing countries is the high level of Non-Revenue Water (NRW) that includes both physical and commercial losses (mainly caused by illegal water use and water theft) [7].

A statement by Vivien Newumbe the public relations officer Kampala Water in New Vision on 15th September, 2015, says "the National Water and Sewerage Corporation (NWSC) is facing a challenge of water theft and increased vandalism of its water installations" [8]. She further explained that Majority of people especially those staying in higher altitude areas are greatly affected. Bursting a water pipe or tapping water illegally creates low pressure zones (the pressure and volume reduce). This leads to intermittent water supply affecting the enjoyment of services by most times paying customers. Illegal water connections are also a source of unsafe water. "When one bursts a water pipe there is the risk of contamination as in most cases water is drawn from the ground using cups or containers," she said. In the same article, Agnes Kyotalengerire reports that the problem of un-authorized water use cannot be under-estimated and its negative impact on the operations of the corporation as a whole and Kampala water in general is obvious. February 2012 data alone revealed that 20% of water produced is unaccounted for which greatly affects the operations since this water is in reality lost or stolen revenue.

In this regard, Phiona Wall, the public relations officer NWSC observed that the company incurs losses of about 30 to 35 % in uncollected revenue annually.

Despite attempts made by water supply and distribution companies to curb water theft through use of various measures to detect water theft like identifying meter readings that are lower than previous readings, low consumption based on knowledge of average water consumption, refusal of access into a property for NWSC employees to inspect water meter or water service; pro-active community-based illegal use reduction program through the WALOPU (Water Loss Prevention Unit) where the corporation partnered with the

Police and community to fight illegal water use and reduce NRW, the situation has remained alarming [5].

1.2 Problem Statement

National water and Sewerage Corporation has constantly recorded cases of water theft such as illegal connections and reconnections, meter bypass, meter tampering, meter reversals and vandalism. In spite of attempts such as use of police and penalties by National Water to solve these problems, the problem of water theft has remained a big challenge in the operation of NWSC due to lack of a dedicated system to solve this problem. Therefore, the GSM based piped water theft detection system has been implemented to detect water theft and alert the authorities via an SMS.

1.3 Objectives

1.3.1 Main Objective

To Design and Implement a piped water theft detection system that detects water theft and alerts the authorities via an SMS.

1.3.2 Specific Objectives

  i.   To review existing literature and identify the requirements for the design of the GSM based piped water theft detection system.
 ii.   To design the metering, Flow rate monitoring and SMS sending modules and integrate them to detect piped water theft.
iii.   To implement the designed system.
 iv.   To test and validate the system.

1.3 Justification and Significance

Water theft does not only affect the operation of NWSC in Uganda but also affects the quality and quantity of water supplied to individual families, offices, institutions and construction sites. Often times, illegal connections causes contamination of water hence increasing the risk of contracting water borne diseases by the consumers. The amount of water also supplied will reduce due to diversions of water to unauthorized destinations and the ultimate reduction of water flow rate hence far destinations may not be reached. This is just one of the challenges imposed by one of the ways of water stealing. However, others such as meter bypass, meter tampering, meter reversals and vandalism greatly affects revenue collected from water. In addition to consumer challenges that may arise from

water theft, the operation of NWSC is compromised due to loss of revenue. The government at the end is also affected as this water theft directly affects revenue. Proper handling of these problems will help in solving the different challenges that may result as mentioned above.

By the fact that water is a basic need of life, its quality and availability is very necessary in the lives of all Ugandans. Hence proper regulation and monitoring of the water distribution networks with the help of a dedicated system is very paramount.

1.4 Scope

1.4.1 Technical Scope

Using the identified requirements of this project, the system functionality was programmed in Arduino 1.6.3. The system was implemented on a bread board then soldered on a Ferro-board with all the physical components proposed. The system is limited to detecting theft along the water distribution lines and alerting the authorities via an SMS.

1.4.2 Geographical Scope

The system has been designed to be used along the branched water distribution networks in Uganda by NWSC. If further developed, it will be deployed at the individual families, offices, institutions and construction sites.

1.4.3 Time Scope

The review of literature and existing systems, system design, implementation, and testing and validation took five months from November 2015 to April 2016.

1.5 Limitations and Assumptions

1.5.1 Limitations

i. This system is limited to piped water theft prevention.
ii. The system does not differentiate between water theft and other losses that may occur during water distribution such as leakages and pipe busts.

1.5.2 Assumption

i. That water reservoirs are supplied with enough water to maintain the required pressure in the given pressure zone.

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