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FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER ENGINEERING

FINAL YEAR PROJECT REPORT

TITLED: A REMOTE-CONTROLED MORTUARY ROBOT

BY:

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A project Report submitted to the Department of Computer Engineering in Partial Fulfillment of the Requirement for the Award of a Bachelor's Degree in Computer Engineering of Busitema University

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ABSTRACT

In Uganda and worldwide, currently the cleaning and the embalming process of the dead bodies is done majorly using human labor known as mortuary attendants who are prone to the high risks of infections inside the mortuaries. And yet mortuaries are important integral in hospital which helps for storage of un identified bodies, examination in the post mortem room or removal for autopsy.

Use of Personal Protective Equipment (PPE) is one the method the mortuary attendants use to protect themselves from infections while performing their tasks in the mortuary. However, this method is constrained by certain factors like improper use of the PPE, too much heat due to the time taken putting on the PPE while performing the tasks in the mortuaries and also some hospitals in Uganda luck the PPE for the mortuary attendants. And this is one of the reasons why most mortuary attendants are at a risk of infections in the mortuaries.

In this system, the remote is used to control the robot movement inside the mortuary and also control the manipulation of the arms in performing the cleaning, the carrying and the embalming process.

Key words: Remote, Robot, Mortuary, Mortuary Attendants, Arms, Arduino, embalming, corpse.

DECLARATION

I **OCHUDANG THOMAS AMAKE**, an undergraduate student of a Bachelor of Computer Engineering solemnly declare that this research is my original work that has been done and prepared by myself. It has not been previously or concurrently submitted for the award of any academic degree, diploma or certificate of Busitema University or any other university. The materials borrowed from other sources and included herein have been properly cited and acknowledged. All information in this document has been obtained and presented in accordance with academic rules and ethical standards of the Busitema University Senate.

SIGN: …….

DATE: ……

APPROVAL

This is to approve that this Final Year Project Report has been fully and consistently worked on and submitted to the Department of Computer Engineering under the supervision of the undersigned supervisor.

SIGN: …….

DATE: ……

Mr. LUSIBA BADIRU

Department of Computer Engineering

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DEDICATION

I dedicate this project report to my dear cousin sister Mary Francis, my beloved mother Akumu Jenifer for the love and support they have provided to me throughout this project period. I also dedicate it to my project supervisor Mr. Lusiba Badru for his tremendous effort and guidance in relation to my project report, the courage, moral and support he offered to me during my research period may the almighty bless him.

ACKNOWLEDGEMENT

Above all, I thank God the almighty for the gift of life, wisdom and guidance for without Him, nothing would have happened and I wouldn't be able to accomplish my project stage.

I cannot express enough thanks to my supervisor for his continued support and encouragement: Mr. Lusiba Badru. I offer my sincere appreciation for the learning skills provided by my supervisor. Also, I acknowledge all the other lecturers who have always given me time for consultation regardless of whether they are my supervisors or not, thank you for the helping attitude. My completion of this project could not have been accomplished without the support of my classmates; Tinkamanyire Amon, Kyazze Walid and all the other colleagues, thank you for allowing me time away from you to research and write. You deserve a trip to Germany. Lastly, I thank my family members My little sisters Joan and Mary, my Mother Mis Jenifer and finally my little brother Joseph for their support and prayers. The countless times you provided me support will not be forgotten.

LIST OF ACRONYMS

PPE Personal Protective Equipment

RIP Rest in Peace.

ppm parts per million

HBV hepatitis B virus

HCV hepatitis C virus

HIV Human immunodeficiency virus

UV Ultra violet

EVD Ebola Virus Disease

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CHAPTER ONE

1.Introduction

1.1Background of study

Mortuary /Morgue is a place where dead bodies are kept in the refrigerated body store before burial/cremation and examined in the post mortem room or removal for autopsy [1]. When death occurs, corpses need to be kept for several days because of delays occasioned by formalities from different authorities, therefore Mortuary is an important integral part of every hospital as it leads with the preservation of the dead body so that the forensic clinicians and pathologists may investigate the cause of the death and make scientific investigations, carry out post-mortems among others.

Information on the status of mortuary services in Uganda is largely missing, Mortuaries have for long been used as places to preserve and prevent deterioration of human corpses. They are useful sources for tracking records and information on dead persons as well as an institution for research. Despite the increased urge to improve service delivery around the world, mortuary facilities have not received as much attention. Globally, hospitals face a challenge of maintaining mortuary facilities to act as any other services point. Unfortunately, mortuary services are a neglected business especially in developing countries like Uganda where the situation is made worse. Mortuaries are usually found unhygienic with rodents and foul odor and hospitals continue to struggle to maintain mortuary facilities and services [2].

Mortuaries are usually not of acceptable standard with old infrastructure like post-mortem tables and often treated as dumping grounds for dead bodies leading to poor corpses' storage. This usually creates a problem to the society. Mortuary services involves managing the receipt, storage and release of deceased people and their property safely, securely, efficiently, effectively and appropriately as the core business of mortuary services teams. This involves several procedures like cleaning, embalming among others, most of which exposes the workers to health hazards. Majority of workers in the morgue, like in other sectors, face hazards and risks often resulting in occupational-related injuries and deaths [1][2].

A person responsible for handling and washing bodies is known as a mortuary attendant. A mortuary attendant's job includes receiving, preserving, cleaning and releasing bodies which they perform these tasks manually currently in Ugandan mortuaries and worldwide. Mortuary workers are often overlooked in studies on health and safety among health workers. This is probably because they are few in number. However, this does not eliminate the fact that their health is at risk due to the hazards they face as they perform their duties.

All dead bodies are potentially infectious and "standard precautions" should be implemented for every case. Several reports have documented diseases contracted by mortuary workers during the washing, dressing and embalming processes [3]. Cultural practices like risky burial rites, washing and touching of dead bodies were shown to be responsible for about 60% of Ebola Virus Disease cases in Guinea. Similar practices were also reported as the main source for the transmission of EVD in Gabon, Uganda and Sierra Leone. In Sierra Leone, for instance, 365 Ebola deaths were

linked to the single funeral ceremony of a famous traditional healer [4]. Although most organisms in the dead body are to infect healthy persons, some infectious agents may be transmitted when persons are in contact with blood, body fluids or tissues of dead body of person with infectious diseases.

Funerary bathing is performed in traditional funerals in some countries in West Africa. The ritual washing of the dead is believed to be one of the factors which resulted in the rapid spread of Ebola virus in Guinea, Liberia and Sierra Leone . Mortuaries are a potential source of Ebola infection, posing occupational risks due to the hazards involved in handling dead bodies that might be on the verge of decay or contamination [4][3].

In mortuary currently mortuary attendants use personal protective equipment (PPE) which includes; chemical goggles or a face shield to minimize the risk of drugs splashing into the face or eyes, overalls, rubber boots, a chemical resistant apron, nitrile**,** neoprene or PVC glove**s,** respiratory protection specific to the type of vapor or gas (a dust mask does not protect against inhaling hazardous vapors). Exposure to chemical hazards in the mortuary may lead to health effects like respiratory irritation, eye irritation, skin irritation, dermatitis, respiratory sensitization (possibly leading to occupational asthma), cancer and other latex allergies [5].

The effectiveness of PPE is dependent on it being used correctly. If the wrong PPE is used i.e. latex gloves may not provide adequate protection against exposure to some hazardous chemicals, such as formaldehyde and/or glutaraldehyde, or it is not fitted correctly, it is unlikely to provide adequate protection. You also need to make sure that staffs are trained to use PPE and that it is maintained correctly and frequently and also most mortuaries in Ugandan hospital luck these PPE, therefore the mortuary attendants end up performing their tasks without the PPE [2]. Despite these measures being put in place, mortuary attendants still face other various hazards apart from infection including but not limited to chemical hazards, physical strain, work related psychological stress and hazardous environments that may result in hearing problems eye strain, electric shock or burns and fractures or dislocations [6].

The following are the methods of embalming commonly used;

1.1.1 Natural means of preservation

Natural means of preservation include freezing, desiccation/exsiccation either by dry cold or by dry heat, and the nature of the soil.[1]

1.1.2 Artificial means of preservation

Artificial means of preservation comprise the application of simple heat or cold, powders, such as a sawdust bed mixed with zinc sulphate, evisceration combined with immersion, drying, local incision and immersion, arterial injections, cavity injections. Furthermore, simple immersion in alcohol, brine, etc., and sole arterial injection, which can be combined with cavity treatment and/or immersion, were used[2]

1.2 Problem statement

Health and safety of employees is a major concern of all health services managers. Most interventions on health and safety in the health sector have been majorly targeting the clinical staff, little attention being given to other staff cadres including the mortuary attendants. Mortuaries can be very dangerous places when proper health and safety measures are not taken to protect the employees and visitors

Considering the duties mortuary attendants perform, how they perform them and for how long they work, their health and well-being is at risk of infection as a result of Exposure to infected bodies with for example cholera, tuberculosis [7], Ebola, Covid19 virus, Lassa fever**,** body fluids, pricks from sharp objects like middles and also exposure to the hazardous drugs like formaldehyde, paraformaldehyde, glutaraldehyde, methanol, phenol [5] used in the embalming process. Therefore, there is need for a Remote-Controlled Mortuary Robot to perform the core tasks of a mortuary attendants in the mortuary to curtail infection risks.

1.3 Objectives

1.3.1 Main objective

To design and implement a Remote-Controlled Mortuary Robot to carry out embalming process, the carrying and cleaning the dead body.

1.3.2 Specific Objectives

1. To study the operation of mortuary attendants in order to gather requirements for the new developed system.
2. To design and develop a robot arm and locomotion unit.
3. To integrate the arm unit modules, the locomotion unit module and the user interface unit of the robot.
4. To test and validate the developed system.

1.4 Significance of the study.

With the state and the condition, the mortuary attendants under go when carrying out their work in the mortuary especially public mortuaries in Ugandan hospitals and the entire world, their life and wellbeing is at risk and their entire family. Therefore, at this point of view there is need of a Remote-Controlled Mortuary Robot which will enhance Morticians work in the mortuary and relieve them from the risks they face in the mortuaries during their work. The system is easy to use and it is remote controlled by the morticians to carry out his/her task inside the mortuary.

1.5 Scope

1.5.1 Geographical scope

The system is developed for public mortuaries in government hospitals in Uganda and some private hospitals within the locality having functional mortuaries.

1.5.2 Technical scope

The technical scope is focused on the design and implementation of a Remote-Controlled Mortuary Robot to carry out embalming process by only injecting the embalming chemicals.

CHAPTER TWO

2.Literature Review

2.1 introduction

This chapter is mainly be looking at the concepts and definitions and techniques used and review of related work which has already been put to paper in related fields of research and the developed systems.

2.1.0 Definition of the system mortuary.

A mortuary is a hospital service point used for security and safety of human corpses awaiting identification or removal for autopsy, burial or any other post-death rituals.

It should have designs of facilities for viewing bodies, a waiting room/reception room, and a Centre for visiting relatives. It should have separate arrangements for keeping decomposed and infectious bodies, for performing autopsies, space for handing over the dead bodies to the relatives/undertakers and a viewing gallery for the students/investigating officers/nominees.

Bodies received into the hospital mortuary either from within or without the hospital should be registered and recorded in a mortuary register and tagged. Personal belongings of the deceased should be, safely kept in a lockable storage Various method of preservation of the dead bodies exist to permit burial without unseemly haste and infection prevention. These include; embalming, the use of chemicals such as formaldehyde, arsenic fluid, glutaraldehyde, phenol, formalin (40% aqueous formaldehyde), water conditioner, cell conditioner, dyes, humectants, anti-oedemic chemicals and additional disinfectants [2].

2.1.1 Autopsy or post-mortem

An autopsy or post-mortem examination is a step-by-step examination of the outside of the body and the internal organs by a doctor called a pathologist to provide detailed information on cause of the death, confirming or correcting clinical diagnosis and for providing opportunities for medical education on pre and postgraduate level [2].

2.1.2 Mortuary attendant

A person responsible for handling, receiving, preserving, cleaning and releasing bodies in the mortuary.

2.2 when a patient die.

The death must be certified by the Doctor who has been treating the patient. This involves ensuring that there has been cessation of heartbeat, breathing and that there is a lack of pupillary response to light. In reality, this tends not to happen for several minutes after the death has happened. This declaration must be made in the patient's clinical notes, in the ED, the medical staff tend to append the clinical notes with RIP (Rest in Peace).

In every case of death from an infectious disease, it shall be the duty of the occupier of the building in which the death has occurred immediately to notify the local authority of the death; and on receipt of the notification the local authority shall at once transmit the information received to the

nearest medical officer of health and make the best arrangements practicable, pending the removal of the body and the carrying out of thorough disinfection, for preventing the spread of the disease. It shall be an offence against this Act for the occupier of any premises to keep any dead body in any room in which food is kept or prepared or eaten or to keep any dead body for more than twenty-four hours in any room in which any person lives, sleeps or works, or to keep the body of any person who is known to have died of infectious disease in any place other than a mortuary or other place set apart for the keeping of dead bodies, without first obtaining the sanction of the local authority or a medical officer of health.

Where any person dies of an infectious disease, it shall be an offence against this Act to remove the body except to a mortuary or for the purpose of immediate burial and it shall be the duty of any person who removes the body to take it directly to the mortuary or to the place of interment for burial. Nothing in this section shall be deemed to prevent the removal by due authority of any dead body from a hospital to a mortuary.

2.3 Care of the Body After Death

Family members or close friends may choose to be involved in washing and dressing the body after death has occurred. Caring for a body is not easy and can stir up strong emotions. See Moments After a Death, Many people turn to health care providers and funeral directors for help. They find comfort and assurance in entrusting the body to those who provide professional services. The deceased may have left instructions for their after-death care to be handled by the health care team and chosen funeral home. Other people practice religions or belong to communities that view care of the body as a family responsibility. Their faith community, elders or neighbors provide guidance and support for hands-on care of the body. For some, this is a way of honoring the person a final act of kindness to him or her [8].

2.3.1 Washing, dressing and positioning the body

Washing the body of a dead person, sometimes as part of a religious ritual, is a customary funerary practice in several cultures. It was delegated to professionals in ancient Egypt, ancient Rome, by well-off Victorians, and continues so in modern America, but was traditionally performed by "family, friends, and neighbors."[8]

Washing and dressing the body is an act of intimacy and sign of respect. Those who were most involved in the person's physical care may feel the most comfortable in doing this. Continued respect for the person's modesty is essential.

Regardless of whether the person died at home or in hospital, hospice or nursing home, washing and positioning the body is best done where death occurs before stiffening of the body (rigor mortis) sets in. Rigor mortis happens within two to seven hours after death. Regardless of the location of care, you may need four to six people to help in gently moving and turning the body.

At home, you can wash the body in a regular bed. However, a hospital bed or narrow table will make the task easier. Since the body may release fluids or waste after death, place absorbent pads or towels under it. It is important to take precautions to protect yourself from contact with the

person's blood and body fluids. While you are moving, repositioning and washing the body, wear disposable gloves and wash your hands thoroughly after care.

Washing the person's body after death is much like giving the person a bath during his or her illness [8].

Wash the person's face, gently closing the eyes before beginning, using the soft pad of your fingertip. If you close them and hold them closed for a few minutes following death, they may stay closed on their own. If they do not, close again and place a soft smooth cloth over them. Then place a small soft weight to keep the eyes in position. To make a weight, fill a small plastic bag with dry uncooked rice, lentils, small beans or seeds.

After you have washed the face, close the mouth before the body starts to stiffen. If the mouth will not stay shut, place a rolled-up towel or washcloth under the chin. If this does not provide enough support to keep the mouth closed, use a light-weight, smooth fabric scarf. Place the middle of the scarf at the top of the head, wrapping each end around the side of the face, under the chin and up to the top of the head where it can be gently tied. These supports are come unnecessary in a few hours and can be removed.

Wash the hair unless it has been washed recently. For a man, you might shave his face if that would be his normal practice.

- Clean the teeth and mouth. Do not remove dentures because you may have difficulty replacing them as the body stiffens.
- Clean the body using a facecloth with water and a small amount of soap. Begin with the arms and legs and then move to the front and back of the trunk. You may need someone to help you roll the person to each side to wash the back. If you wish, you can add fragrant oil or flower petals to your rinse water. Dry the part of the body you are working on before moving to another. Some families or cultures may also choose to apply a special lotion, oil or fragrance to the person's skin.
- Dress or cover the body according to personal wishes or cultural practices. A shirt or a dress can be cut up the middle of the back from the bottom to just below but not through the neckline or collar. Place the arms into the sleeves first and then slipping the neck opening over the head, tucking the sides under the body on each side.
- Position the arms alongside his or her body and be sure the legs are straight. If the person is in a hospital bed with the head raised, lower the head of the bed to the flat position

Funerary bathing is performed in traditional funerals in some countries in West Africa. The ritual washing of the dead is believed to be one of the factors which resulted in the rapid spread of Ebola virus in Guinea, Liberia and Sierra Leone[4].

2.3.2 Embalming

Embalming is a process of preserving bodies by injecting preservatives into the dead body to slow down the process of decay in the mortuary [5].

2.3.2.1 Natural means of preservation

Natural means of preservation include freezing, desiccation/exsiccation either by dry cold or by dry heat, and the nature of the soil. [2]

2.3.2.2 Artificial means of preservation

Artificial means of preservation comprise the application of simple heat or cold, powders, such as a sawdust bed mixed with zinc sulphate, evisceration combined with immersion, drying, local incision and immersion, arterial injections, cavity injections. Furthermore, simple immersion in alcohol, brine, etc., and sole arterial injection, which can be combined with cavity treatment and/or immersion, were used.[2]

Embalming products are primarily solutions and mixtures containing the following:

- formaldehyde
- paraformaldehyde
- glutaraldehyde
- methanol
- phenol
- Isopropanol
- Glycerin
- Methylated spirit
- Camphorated spirits of wine
- Isopropy of alcohol

The image below shows the setup of mortuary in Leone, how corpse are packed in the storage chambers and how mortuary attendants dress to protect them selves inside the mortuary .

Figure 1: shows Inside a mortuary

James H. Bedino conducted a research on formaldehyde exposure hazards and health effects on embalmers. Major health effects identified include carcinogenicity, allergic contact dermatitis sensitizer and inhalation sensitizer, and producer of asthma and asthmatic-like symptomology in humans. Formaldehyde was also identified as having a negative influence on pregnancy, including birth defects, fetal abnormalities, spontaneous abortions, short term miscarriages, and reduced fertility and difficulties.

The WHO estimates that three million percutaneous exposures occur yearly among 35 million health care workers globally; over 90% occurring in developing countries. Health care workers in Africa suffer two to four needle-stick injuries per year on average, with Nigeria, Tanzania and

South Africa reporting 2.1 injuries per health care worker on average. Worldwide occupational exposure accounts for 2.5% of HIV cases and 40% of Hepatitis B and C cases among health care workers. As a result of occupational exposure, an estimated 66,000 Hepatitis B, 16,000 Hepatitis C and up to 1,000 HIV infections occur among health care workers. These infections are preventable through infection control measures which significantly reduce the risk of HIV and Hepatitis transmission among health workers and the biggest percentage is among mortuary attendants globally, to the best of my knowledge.

Formaldehyde exposure was studied in six funeral homes in Detroit area. Air samples were collected under a variety of conditions, the average formaldehyde concentration in the embalming room was 0.74 ppm (parts per million) (0.25 to 1.39 ppm, with a peak of 5.26 ppm). Eye and upper respiratory tract irritation in some employees were reported [9]. frequent absences were due to cuts and lacerations.

In a research to estimate the risk of exposure and infection with blood borne pathogens, a sero-epidemiologic survey was conducted among mortuary attendants in Maryland. Of the 130 participants, seroprevalence for HIV, HBV, and HCV infection was 0.8%, 4.6%, and 0%, respectively. Nearly 19% of participants reported at least one blood borne exposure in the past 6 months. The one HIV infection and all but two of the HBV infections were correlated with well-established non-occupational risk behaviors. Disposable gloves were worn by 96%, and eating, drinking, or smoking during embalming was infrequent. Sixty-one percent of the participants reported having received one or more doses of hepatitis B vaccine at some time in the past. Of those who reported having received all three doses of vaccine, 67% had adequate titers to hepatitis B surface antibody, the marker of protection related to vaccination [10].

To minimize the risks of transmission of known and also unsuspected infectious diseases, dead bodies should be handled in such a way to minimize the risks of transmission of known and also unsuspected infectious diseases, dead bodies should be handled in such a way that workers exposure to blood, body fluids and tissues is reduced. A rational approach should include staff training and education, safe working environment, appropriate safe work practices, the use of recommended safety devices and vaccination against hepatitis B. To minimize the risks of transmission of known and also unsuspected infectious diseases, dead bodies should be handled in such a way that workers' exposure to blood, body fluids and tissues is reduced. A rational approach should include staff training and education, safe working environment, appropriate safe work practices, the use of recommended safety devices and vaccination against hepatitis B.

There is a need to maintain the confidentiality of a patient's medical history even after his/her death. At the same time, there is obligation to inform personnel who may be at risk of infection through contact with dead bodies so that appropriate measures may be taken to guard against infection. The discrete use of labels such as "Danger of infection" on the dead body is considered appropriate.

The objectives of drawing up this set of guidelines are:

- To enable the deceased's family to obtain funeral services
- To protect the involved personnel, e.g., workers and relatives.

Hospitals, public mortuaries, funeral workers and staff on board conveyances are urged to adopt them in light of local circumstances and requirements. The adopted precautions should be widely disseminated to all staff involved. For handling of Dead Bodies of suspected/confirmed Ebola Virus Disease (EVD) [11].

Dead body care.

- All dead bodies must be identified and correctly labeled with identity labels and category tags
- Dead body which is found soiled with blood or body fluids should be placed in a disposable plastic bag instead of linen.
- Dead bodies should be stored in cold chambers maintained at approximately 4°C.
- Since each and every dead body brought to autopsy is a potential source of infection, at all times, pathologists and other support staff should observe standard precautions in the performance of any autopsy.

2.3.2.1 Health effects of embalming products

Exposure to embalming products such as glutaraldehyde and formaldehyde can pose serious health risks to workers and can worsen existing health problems. Formalin solutions contain formaldehyde, which is a highly hazardous substance. Paraformaldehyde, a powdered formaldehyde product, is also sometimes used in embalming processes. Formaldehyde is highly toxic by inhalation, skin contact and by swallowing. Solutions containing formaldehyde give off formaldehyde gas, which is easy to breathe in, so effective ventilation at your funeral home is essential [5].

2.4 Related work

2.2.1 Manual Process

Human being known as mortuary attendant carries out the task in the mortuary manually using his/her hands with the aid of Personal Protective Equipment (PPE). This is the poorest method to apply in the mortuary because the mortuary attendants are exposed to very many health risks due to exposure to hazardous products and many others [6].

2.2.2 UV Disinfection Robot

UV disinfection robot helps to keep patients and staff safe from harmful germs. The robot delivers one automated, measured dose of UVC light to consistently disinfect an entire room during one cycle. It operates from one placement within the room, ensuring significant pathogen reduction in direct and shadowed areas [12], [13].

2.2.3 Nursing-care Assistant Robot – Riba

RIBA is a human like nursing-care assistant robot developed in our research center [14], which has two high DOF and high-power arms. RIBA is the first robot that can lift up and set down about 63[kg] real human and transfer him/her from a bed or wheelchair to other place stably and safely using two arms [15].

2.2.4 surgery robot assistant

Robotic surgery, or robot-assisted surgery, allows doctors to perform many types of complex procedures with more precision, flexibility and control than is possible with conventional techniques. Robotic surgery is usually associated with minimally invasive surgery — procedures performed through tiny incisions. It is also sometimes used in certain traditional open surgical procedures [16].

2.4.2 Developed system

The developed Remote-Controlled Mortuary Robot is able to clean the bodies and carry out the embalming process and basically this is simple immersion in alcohol method [2] by the help of the robot Arm controlled by a remote under mortuary attendant's instructions. The system consists of locomotion unit to enhance the movement of the robot, arm unit to enhance the cleaning and the preservation process and then user interface unit to enhance users to send commands to the robot.

2.2.3 Table 1 comparison table for existing systems

Existing system	Advantages	Drawbacks
1.Manual process	● It's cheap in application.	● Its prone to very many health risks due to exposure to hazardous products and bodies. ● Its tiresome in the application process.
2.UV Disinfection Robot	● It can also clean entire rooms better than humans. ● The robot can carefully navigate around the room	● The system is only limited to disinfection which is not 100% efficient-from protecting the mortuary attendants inside the mortuary.

3.Nursing-care Assistant Robot – Riba	● It simplifies the work of nurses in the hospitals. ● It puts patients at ease and to gives a friendly, non-threatening, appearance.	● The system is limited to lifting the patients from a bed to a wheelchair only and it cannot perform the tasks of a mortuary attendants.
5.Surgery robot assistant	● Fewer complications, such as surgical site infection ● Less pain and blood loss ● Quicker recovery ● Smaller, less noticeable scars	● Robotic-surgery involves risk, some of which may be similar to those of conventional open surgery and it cannot perform mortuary tasks

CHAPTER THREE

3.0 METHODOLOGY

3.1 Introduction

This chapter explains the functional modules, procedures and methods that were used in data collection, analysis, designing the system, testing methods or procedures and the techniques that is used to meet the earlier mentioned objectives.

3.2 Requirements Gathering

A number of research techniques was used to help in collecting system requirements needed to achieve the objectives of the project, and these include the following;

3.2.1 Literature review

Documents including scientific books, online journals, research related reports were so instrumental in project implementation. On-line search from the World Wide Web was a critical source of majority of the documents to be used for both technical and non-technical reference.

3.1.3 Consultations:

This was done to get advice from experts as well as people with knowledge about or related to the field in which my developed project was carried out. These included Technical personnel from hospital.

3.1.3 Observation

This method involved an attentive watching of the operation carried out by the mortuary attendants in mortuary in Busia referral hospital Kenya.

3.3 Requirements analysis

This was aimed at extracting requirements from all the collected data for the purpose of designing an effective "Remote Controlled Mortuary robot". The data collected was analyzed qualitatively basing on the objectives of the study, cross checked for consistency basing on the concepts of the literature review and interpreted to provide requirements for designing a system that is more reliable and easier to use. After collecting and interpreting all the relevant information, a documentation report with all the findings and challenges met was formed intended to help other people who might be interested in enhancing the performance of the system developed. These included both functional and non-functional requirements.

3.4 System Design

The system design composes generally a hardware system and a software system. The hardware system is responsible for:

- Providing an interface where the user sends commands to the system and this is by using a remote to control the system.
- Providing a locomotive mechanism for moving the system inside the mortuary.
- Providing a robotic arm for carrying out the washing and the embalming process

Meanwhile, the software system was used for programming the different hardware components, enabling them to communicate and perform the required tasks. Below is a list of hardware components and software tools I used.

3.4.1 Arduino ATmega328P microcontroller*:*

Arduino is brain of overall system. Arduino is single-board microcontroller intended to make building interactive objects or environments more accessible. Introduced in 2005, the Arduino's designers sought to provide an inexpensive and easy way for hobbyists, students, and professionals to create devices that interact with their environment using and actuators.

*3.4.*2 12V DC Battery*:*

This Rechargeable battery is a 12V Li-ion or lead acid Battery and it is specially designated for powering the system devices which use 12V DC power.

3.4.3 Dc Motor and Motor Drivers

A motor driver receives signals from the microprocessor and transmits the relative signal to the Dc motors. It has two voltage pins, one of which is used to draw current for its working and the other is used to apply voltage to the motors.

3.4.4 Servomotor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. This will help in rotating the arm in the designated direction.

3.4.5 IR Remote/sender and Receiver

IR Transmitter and receiver are used to control any device wirelessly, means remotely. TV remote and TV are the best example of IR transmitter and receiver. TV generally consist TSOP1738 as the IR receiver, which senses modulated IR pulses and convert them into electrical signal.

Software Tools

3.4.6 Arduino platform

This provides a platform for programming the microcontroller.

3.4.8 System block diagram

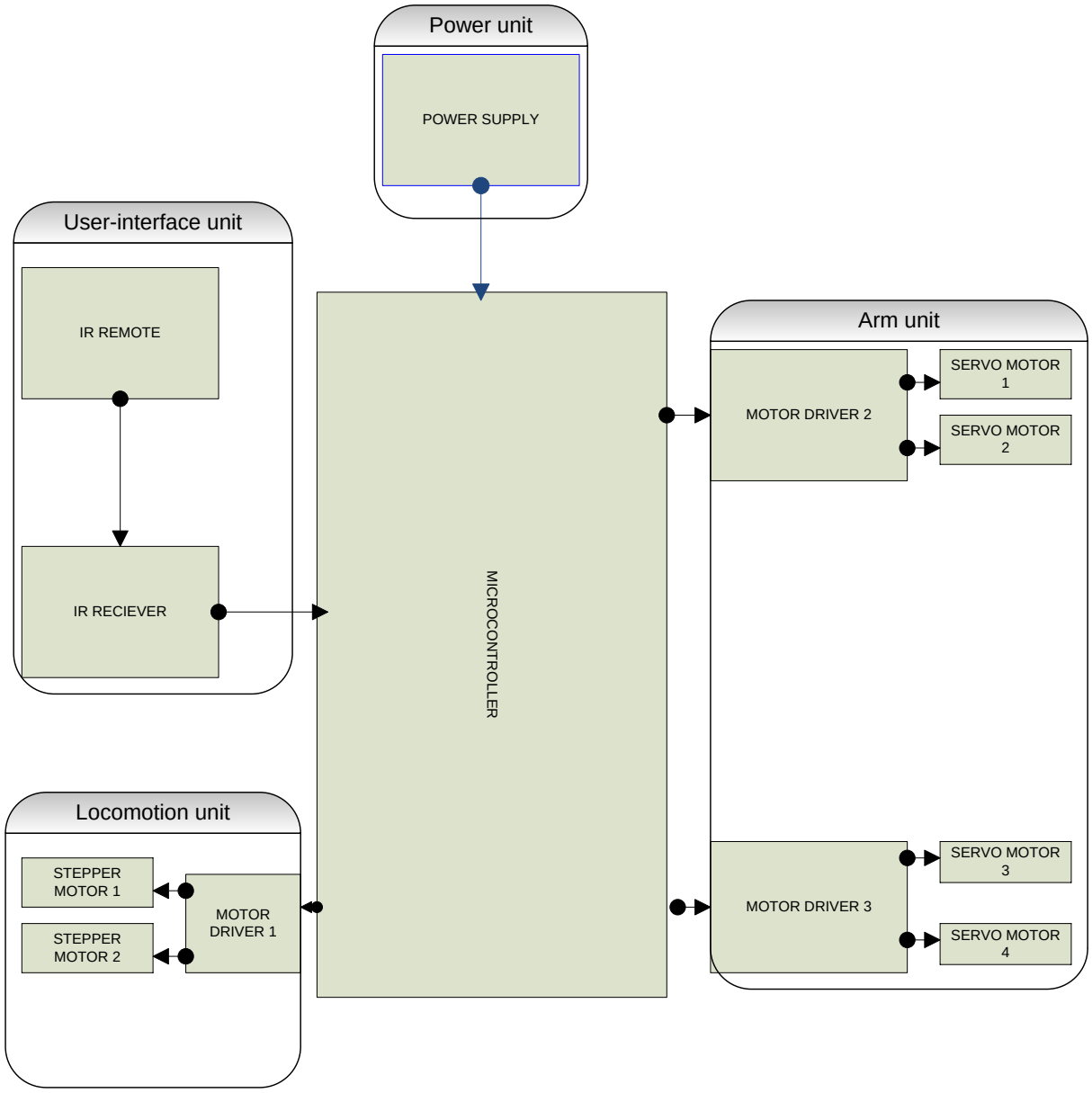

Figure 2: system design layout

3.4.9 Conceptual system design

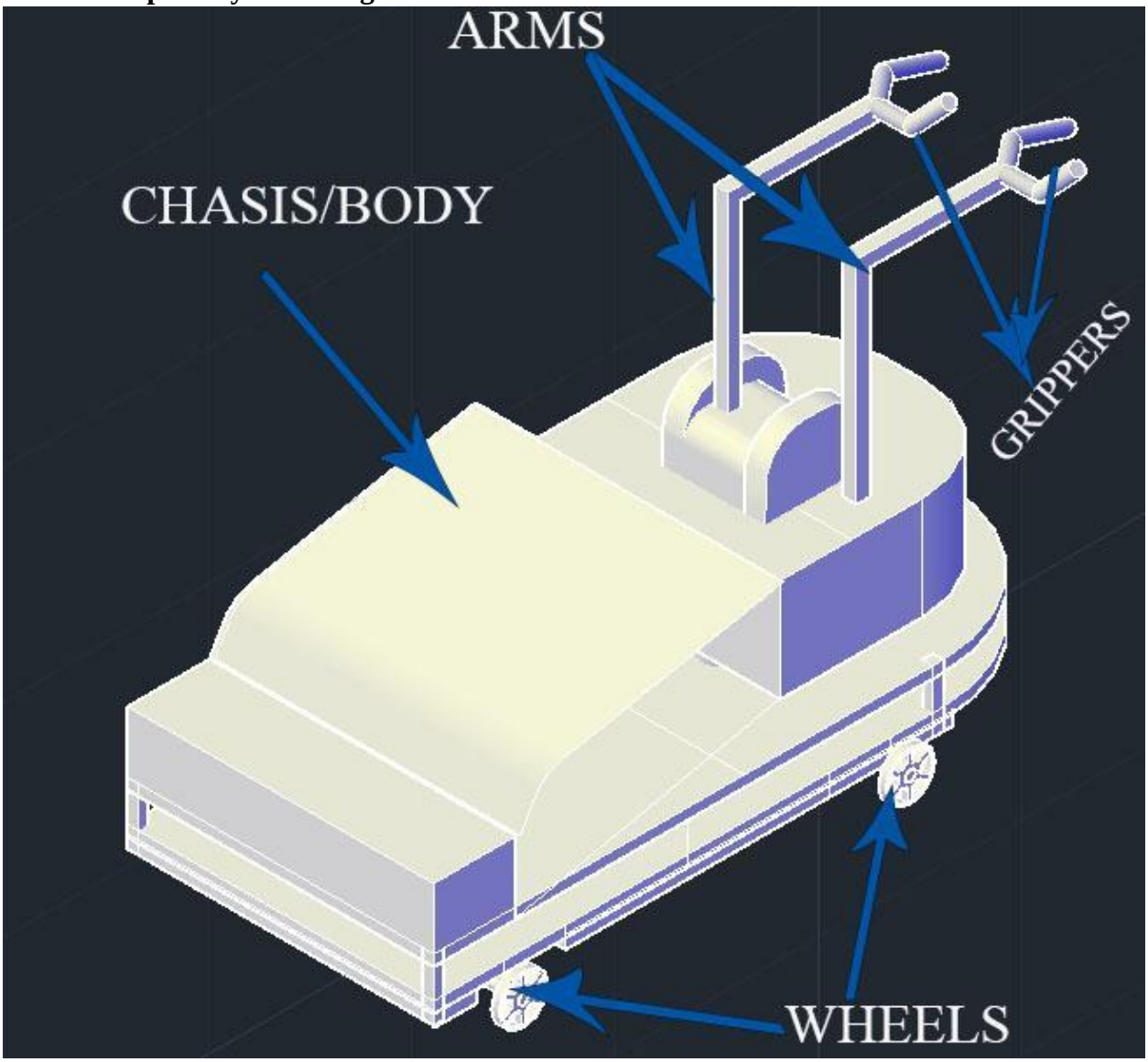

Figure 3 Conceptual system design

CHAPTER FOUR: SYSTEM ANALYSIS AND DESIGN

4.0 Introduction

This chapter provides a description and analysis of the developed system, requirements, design and its implementation to achieve its main objective.

4.1 Functional Analysis

The system was analyzed and was able to move with the help of IR remote control, the arm was able to lift the corpse and hold the injecting niddle.

4.2 Requirement Analysis

Requirement analysis was done to determine functional requirements and non-functional requirement that favor or hinder functionality of the system.

4.2.1 Functional Requirements

Functional requirements are those which are related to the technical functionality of the system and thus serve as the basis for the system testing and validation. The main functional requirements for this project include;

- The system's ability to move with the aid of an IR remote.
- The system's ability to move the arm in different directions.
- The system's ability to lift the corpse.
- The system's ability to do injections.

4.2.2 Non-Functional Requirements

These requirements include those that are not directly seen while the system is in execution and are therefore considered as the properties of the system.

i. Response time: The system is able to receive commands from the remote and respond to it in a minimum time.
ii. Environment requirements: This includes the range of conditions in which the system should operate like a flat area with no potholes.
iii. Usability: The system is easy to use.
iv. Maintainability: How easy it is to maintain the system.
v. Security: The system is secure to use because its operated by the mortuary attendant.

4.3 System design.

System design is the process of defining the architecture, components, modules, interfaces and data for a system to satisfy specified requirements. It can be seen as the application of systems theory to product development.

The system architectural design gives a high-level view of the system with the main components of the system, the services each component provides and how the different components communicate to the system.

4.4 Data flow model

This shows the movement of signals, how data is transformed from inputs to produce outputs, how to make decisions depending on commands and the start and stop of the program.

Flowchart reveal relationships among and between the various components in a program of the system. Flowcharts are an important technique for modeling a system's high-level detail by showing how input data is transformed to output results through a sequence of functional transformations. Below is a flowchart for the system.

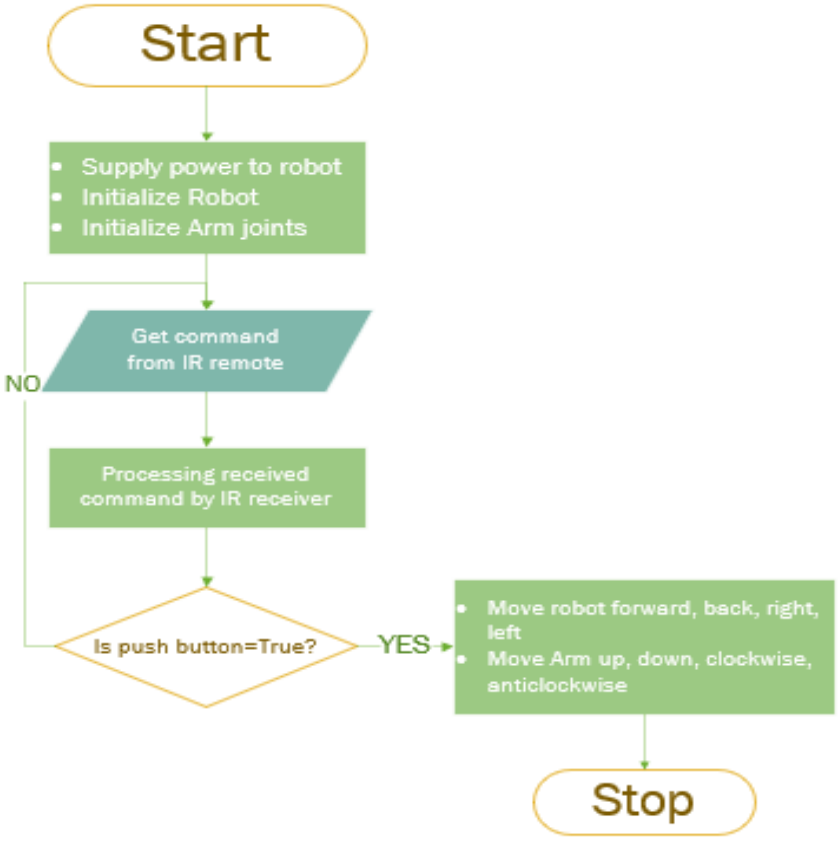

Figure 4 Dataflow Diagram

4.5 Logical and Physical design of the system.

A logical design defines what takes place but not how it is accomplished. It does not address the actual methods of implementation. In contrast, a physical design provides details of how the system is implemented. Thus, the physical design of the entire system was used to come up with system development and design.

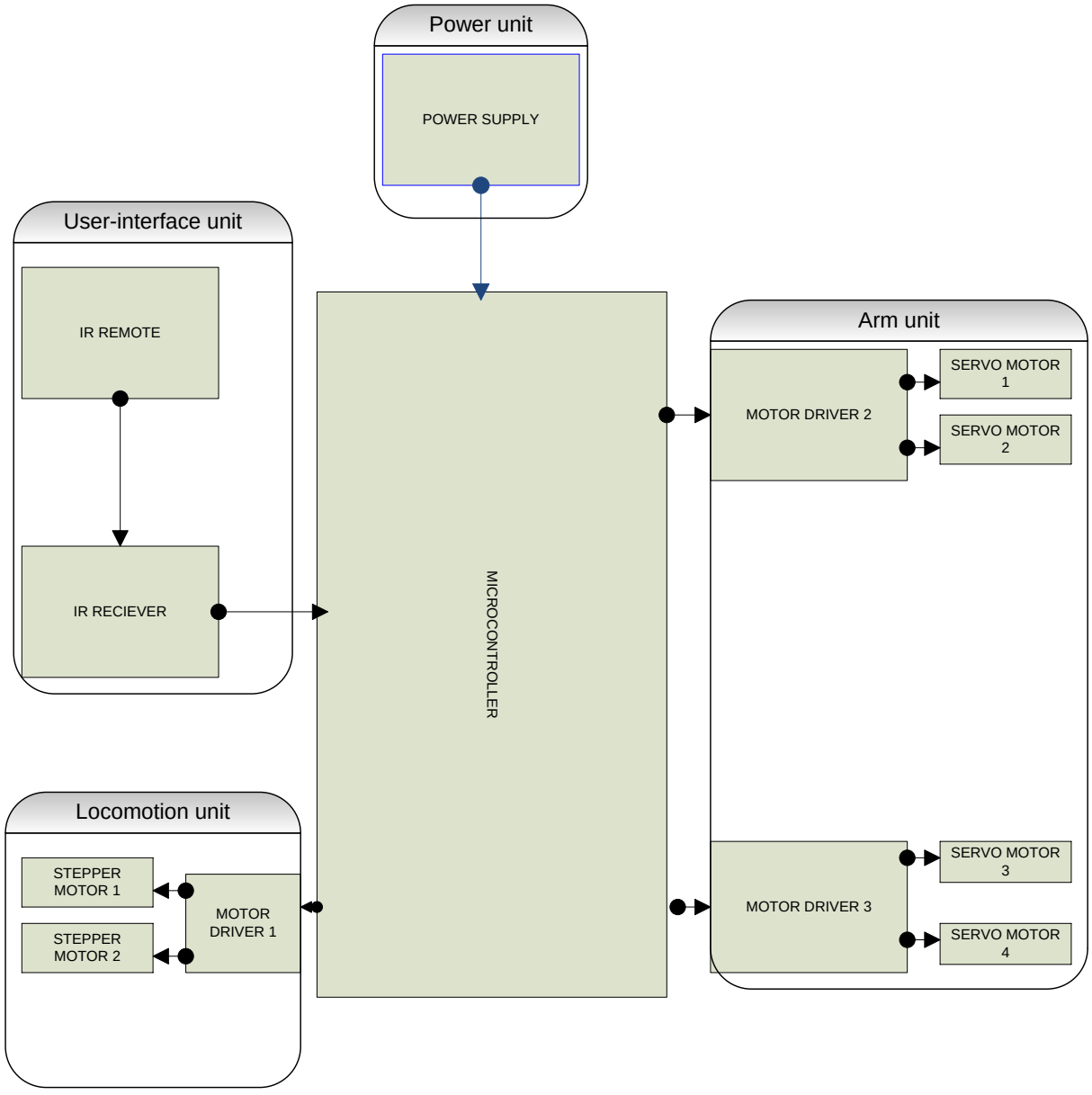

Figure 5: Physical design

CHAPTER FIVE: SYSTEM IMPLEMENTATION AND DESIGN

5.0 Introduction

This chapter describe the different tools used while developing the system, the minimum hardware requirements needed for the deployment of the system, how the system will operate and how it is used.

5.1 Development Platforms

This describe all the platforms which were used to design and develop the system. They include both the simulation and development platforms.

5.1.1 Arduino

Arduino is an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

5.1.2 Arduino Uno Microcontroller

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals.

The Arduino Uno is a microcontroller board based on the ATmega328. Program memory in the form of flash is also often included on chip, as well as a typically small amount of RAM.

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

Figure 6 Arduino UNO Programming board

5.2 Code Design

During the implementation of the system, the system codes were written using Arduino programming language basically. Below are sample codes with an explanation of what they do.

5.2.1 Robot locomotion Codes

```
void loop() {

// code for moving the locomotion part of the robot
if (irrecv.decode(&results))//have wereceived an IR signal
{
irrecv.resume();

if (results.value == 83587215) // type button 2 forward robot control
{
 // this function will run the robot in forward  directions at a fixed speed
 Serial.println("Button vol+ forward robot");
```

```
  // turn on motor A
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);
  // set speed to 200 out of possible range 0~255
 analogWrite(enA, 60);
  // turn on motor B
  digitalWrite(in3, HIGH);
  digitalWrite(in4, LOW);
  // set speed to 200 out of possible range 0~255
  analogWrite(enB, 100);
```

code for moving and running the arm

```
//servo
//sholder motor
 //if(results.value == 83583135){ //  //commanding servo
// this function will run servo forward

  //

//  myservo1.write(180);
//  delay(4000);

    if(results.value==83583135){
  Serial.println("Button1 Turn 90 and open the claw");
  for (pos = 0; pos <= 100; pos += 1) { // goes from 0 degrees to 180 degrees
    // in steps of 1 degree
    myservo1.write(pos);              // tell servo to go to position in variable 'pos'
```

5.3 Testing.

Testing is one of the most important phases that the system had to go through and it was aimed at detecting malfunctions within the system as a whole. Testing was done in phases below.

5.3.1 Unit testing.

This step involved testing the functionality of the individual units of source code to see whether they function perfectly. The servo motors, IR sensor, IR remote and high torque DC motors together with the motor drives were tested individually to check their proper functionality.

5.3.2 Integration testing.

The different components were assembled together and coded for as a single system and tested for combined functionality. This was to help to know how the combined unit works as a whole.

5.3.3 System testing.

This was conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. It was performed on the entire system in the context of a Functional Requirement Specification and System Requirement Specification. The system was tested by myself, students, and my university supervisor.

5.4 System verification.

The system has been verified and the modules are able to communicate among themselves, that is; the locomotive module, the user interface module, the arm unit module.

5.5 System validation

The system was finally validated to ensure that it operates in accordance with the specified functional and non-functional requirements.

5.6 System evaluation.

The developed system met all the required objectives that included:

- Being able to carry out embalming.
- Being able to move inside the mortuary.
- Being able to clean the corpse.
- Being able to lift the corpse.

CHAPTER SIX: DISCUSSION AND RECOMMENDATIONS

6.0 Introduction

This chapter discusses the results of the system, conclusion as derived from the observation and findings from the study, design, implementation, testing and validation of the system. Then it gives recommendations for further study and improvements.

6.1 Summary of the work

The main objective of this project is to design and develop a Remote-Controlled Mortuary Robot that carries out the embalming process, wash the corpse and lift the corpse to the storage place.

6.2 Critical analysis /appraisal of the work

The Remote-Controlled Mortuary Robot was successfully designed as per objectives.

i. The system is easy to use as most of the operations is under user commands from the remote.
ii. The system allows for low operation cost since it is driven by battery and not fuel.
iii. The system guarantees safe health to the mortuary attendant since in this case there is no direct contact of the mortuary attendant with the corpse.
iv. Very efficient and effective for mortuary use.

6.3 Recommendations

The system needs to be improved such that it can perform its tasks automatically with the help of artificial intelligence ad machine learning without full involvement of mortuary attendant and also it could have two arms for it to perform the embalming, the carrying and the washing with ease and efficiently.

6.4 Conclusion

This project will help the health sector to curtail cases of health personnel infections during performance of the mortuary attendant tasks in the mortuary.

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APPENDIX

6.5 Circuit diagram

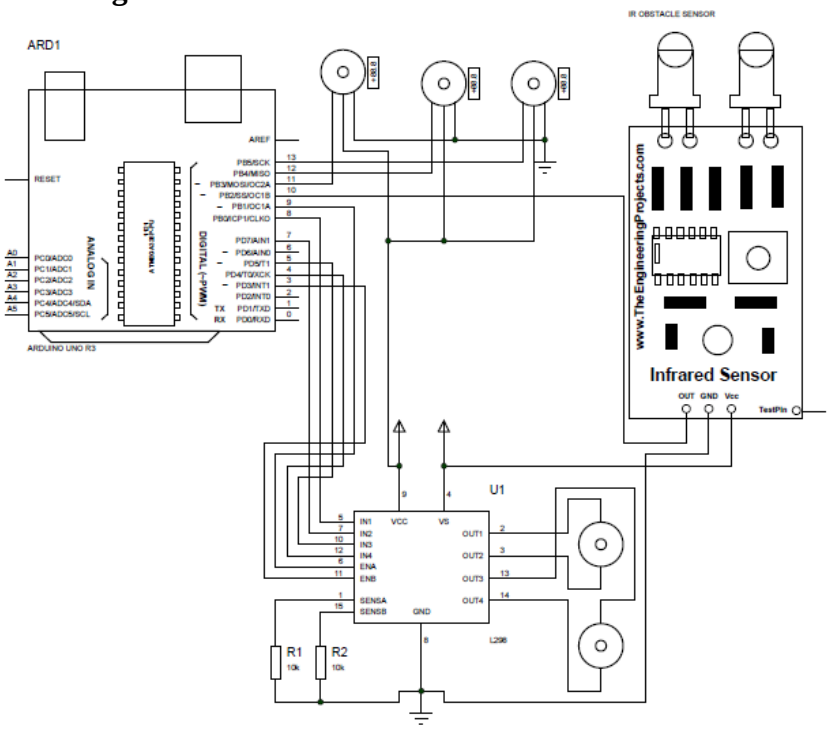

Figure 7 Circuit Diagram

6.6 Physical design

Figure 8 the developed system

6.7 Code design

```
#include <boarddefs.h>
#include <IRremote.h>
#include <IRremoteInt.h>
#include <ir_Lego_PF_BitStreamEncoder.h>

#define SEND_<PROTOCOL_NAME>
#define DECODE_<PROTOCOL_NAME>
#include <IRremote.h>
#include<Servo.h>
Servo myservo1;
Servo myservo2;
Servo myservo3;
char command;
int receiver_pin = 11;   //Connect the output pin of IR receiver at pin 4
IRsend irsend;
IRrecv irrecv(receiver_pin); //create instance of irrecv
decode_results results;
// connect motor controller pins to Arduino digital pins
// motor A
int enA = 9;
int in1 = 10   ;
int in2 = 7;
// motor B
int enB = 3;
int in3 = 5;
int in4 = 4;
int servo1=13;
int servo2=12;
```

```
int servo3=2;


int pos;//initialise position of servo
int val;              //rotation angle
bool cwRotation, ccwRotation;  //the states of rotation
void setup()
{
Serial.begin(9600);
pinMode(receiver_pin,INPUT);
irrecv.enableIRIn();//start the reciever
myservo1.attach(13);
myservo2.attach(12);
//myservo3.attach(2);
// set all the motor control pins to outputs
  pinMode(enA, OUTPUT);
  pinMode(enB, OUTPUT);
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  pinMode(in3, OUTPUT);
  pinMode(in4, OUTPUT);
  //pinMode(13, OUTPUT);
  //pinMode(vcc, OUTPUT);
 // pinMode(gnd, OUTPUT);
// Initializing vcc pin high
// digitalWrite(vcc, HIGH);
```

```
}
void(* resetFunc) (void) = 0; //declare reset function @ address 0

void loop() {
if (irrecv.decode(&results))//have wereceived an IR signal
{
irrecv.resume();

if (results.value == 83587215) // type button 2 forward robot control
{
 // this function will run the robot in forward  directions at a fixed speed
 Serial.println("Button vol+ forward robot");
  // turn on motor A
  digitalWrite(in1, LOW);
  digitalWrite(in2, HIGH);
  // set speed to 200 out of possible range 0~255
 digitalWrite(enA, 10);
  // turn on motor B
  digitalWrite(in3, LOW);
  digitalWrite(in4, HIGH);
  // set speed to 200 out of possible range 0~255
  digitalWrite(enB, 0);
}else if(results.value == 83558655){ // type button ch+  turn backward direction robot control
 // this function will run the robot backward directions  motor B stop
   Serial.println("Button CH+ TURN backward");
  // turn on motor A
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);
```

```
  // set speed to 200 out of possible range 0~255
  digitalWrite(enA, 0);
  // turn on motor B
  digitalWrite(in3, HIGH);
  digitalWrite(in4, LOW);
  // set speed to 200 out of possible range 0~255
digitalWrite(enB, 10);

}else if(results.value == 83607615){ // type button 1 rotate left robot control
 // this function will run robot to the right directions  motor B in backward directions
  Serial.println("Button Ch- TURN Right Direction");
  // turn on motor A
  digitalWrite(in1, LOW);
  digitalWrite(in2, HIGH);
  // set speed to 200 out of possible range 0~255
 digitalWrite(enA, 20);
  // turn on motor B
  digitalWrite(in3, LOW);
  digitalWrite(in4, LOW);
  // set speed to 200 out of possible range 0~255
digitalWrite(enB, 20);

} else if(results.value == 83621895){ // type button 8 backward robot control

// this function will run ROBOT TO THE LEFT directions
  // turn on motor A
   Serial.println("Button EQ Turn LEFT");
  digitalWrite(in1, LOW);
```

```
  digitalWrite(in2, LOW);
  // set speed to 200 out of possible range 0~255
digitalWrite(enA, 20);
  // turn on motor B
  digitalWrite(in3, LOW);
  digitalWrite(in4, HIGH);
  // set speed to 200 out of possible range 0~255
  digitalWrite(enB, 20);
}else if(results.value == 83581095){ // type button 5 stop robot control
// this function will stop both motor A and motor B
  // turn on motor A
   Serial.println("Button VOL- stop ");
  digitalWrite(in1, LOW);
  digitalWrite(in2, LOW);
  // set speed to 200 out of possible range 0~255
 digitalWrite(enA, 0);
  // turn on motor B
  digitalWrite(in3, LOW);
  digitalWrite(in4, LOW);
  // set speed to 200 out of possible range 0~255
 digitalWrite(enB,0);


  //resetFunc();


}
//servo
//sholder motor
 //if(results.value == 83583135){ //  //commanding servo
```

```
// this function will run servo forward
//  myservo1.write(180);
//  delay(4000);
    if(results.value==83583135){
  Serial.println("Button1 Turn 90 and open the claw");
  for (pos = 0; pos <= 120; pos += 1) { // goes from 0 degrees to 180 degrees
    // in steps of 1 degree
    myservo1.write(pos);              // tell servo to go to position in variable 'pos'
    delay(15);                       // waits 15ms for the servo to reach the position
    //irrecv.resume();  //receive the next value
    }
  }
// move 0 degrees
 if(results.value==83619855){
  Serial.println("Button7 Turn 70 ");
  for (pos = 0; pos <= 50; pos += 1) { // goes from 0 degrees to 180 degrees
    // in steps of 1 degree
    myservo1.write(pos);              // tell servo to go to position in variable 'pos'
    delay(15);                       // waits 15ms for the servo to reach the position
    //irrecv.resume();  //receive the next value
    }
  }


 //movin it back to 0 degrees
 }else if(results.value == 83612205){
  Serial.println("Button2 Turn 90 degrees up ");
 myservo1.write(60);
```

```
 }
 //discrete angles
 else if(results.value == 83559165){
 Serial.println("Button3 Turn 135 Arm go up");
myservo1.write(0);

 }

 //Gripper
 else if(results.value == 83615775){
 Serial.println("Button4 Close  Claw");
myservo2.write(130);

 }
else if(results.value == 83616285){
 Serial.println("Button5 open  Claw");
myservo2.write(0);
 }
}
```