KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

POLITEKNIK MALAYSIA
SULTAN SALAHUDDIN ABDUL AZIZ SHAH

2023 EDITION

CMET - TRIC - ADMC

BULLETIN IMET

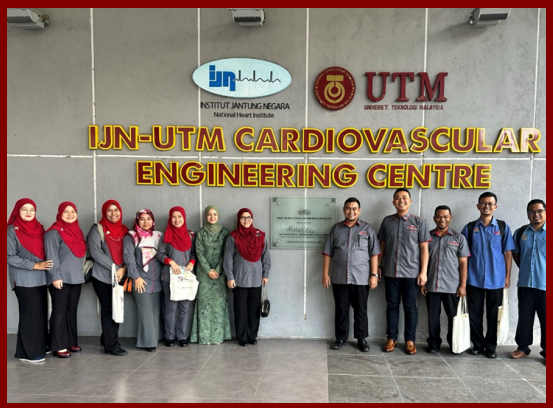
INSTITUTE OF MEDICAL ENGINEERING TECHNOLOGY

MAIN ARTICEL

EXPLORING COLLABORATIVE OPPORTUNITIES:

IMET's Milestone Visit to IJN-UTM Cardiovascular Engineering Centre

On August 8, 2023, the Institute of Medical Engineering Technology (IMET) embarked on a landmark visit to the IJN-UTM Cardiovascular Engineering Centre at Universiti Teknologi Malaysia, Skudai, Johor.



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IMET MANAGER'S NOTE

EXCITING NEWS
INTRODUCING THE IMET BULLETIN VOLUME 3!

Dear Team,

I am thrilled to announce the release of the third volume of our bulletin for the year 2023. This edition marks a significant milestone as we proudly unveil the transformation of the Center of Medical Electronic (CMET) Bulletin into the Institute of Medical Engineering Technology (IMET) Bulletin.

The IMET was established with a visionary purpose: to evolve from a calibration center to a hub for the maintenance and repair of medical equipment, fueled by cutting-edge technologies such as robotics, Internet of Things (IoT), and additive manufacturing.

Within the realm of IMET, three distinct centers have been forged, each specializing in vital aspects of our mission. These include the Center of Medical Electronic (CMET), the Technology Robotic and IoT Center (TRIC), and the Additive Manufacturing Center (ADMC).

Our commitment to staying at the forefront of technological advancements is not only reflected in our name change but also in our curriculum. We are embracing a multidisciplinary approach to education to support medical engineering technology, fostering the development of future talents aligned with the New Industrial Master Plan 2030.

As we navigate the Fourth Industrial Revolution (4IR) and the demands of 21st-century learning skills, IMET will play a pivotal role as a TVET collaboration hub and Reskilling and Upskilling center. We aim to be the catalyst for training future skills, ensuring that our team remains adaptable and proficient in the dynamic landscape of medical engineering technology.

Let's embark on this exciting journey together and continue to make IMET a beacon of excellence in the field.

Best regards,

Somchai A/L Enoi

Manager
Institute of Medical Engineering Technology
Politeknik Premier Sultan Salahuddin Abdul Aziz Shah

ABOUT IMET

The Institute of Medical Engineering Technology (IMET) stands as a pioneering institution at the convergence of cutting-edge technologies, seamlessly integrating the realms of Robotics, IoT, Additive Manufacturing, and Medical Electronics Calibration. This comprehensive center of excellence is committed to advancing healthcare through innovation, research, and education.

IMET under TRIC conducts collaborative research in the fields of robotics and the Internet of Things (IoT), focusing on applications in medical engineering (Rehabilitation). The integration of these technologies enhances the precision, efficiency, and connectivity of healthcare systems.

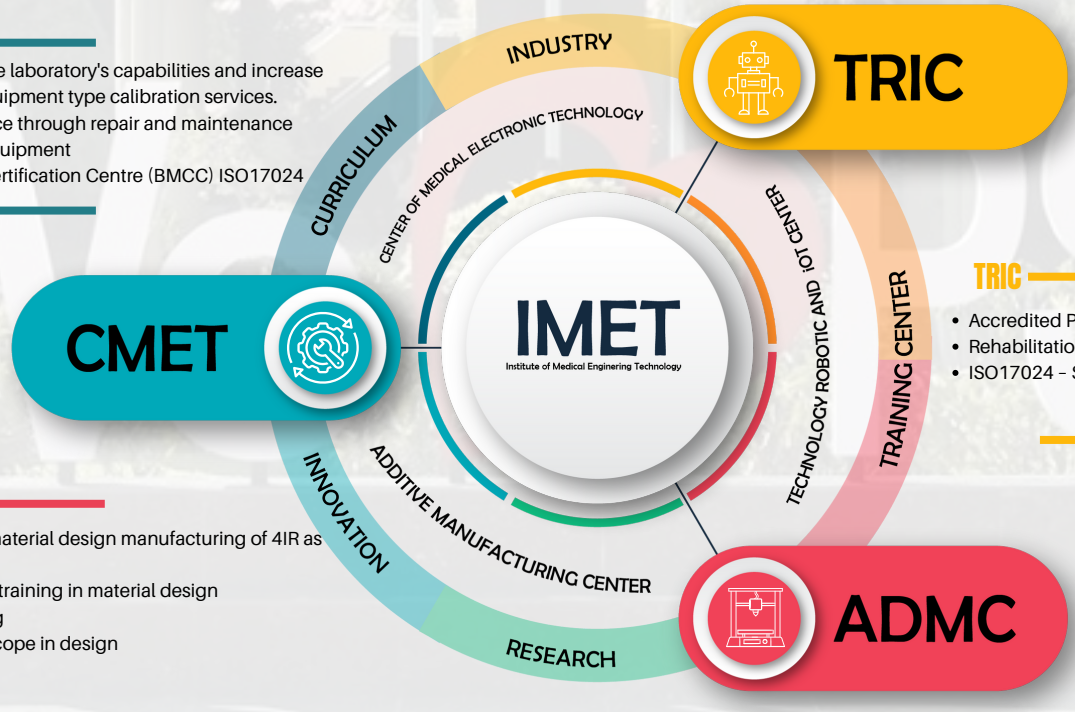
IMET's state of the art Additive Manufacturing Center (ADMC) focuses on research and development in 3D printing technologies applicable to medical engineering. This includes the exploration of new materials, prototyping services, and the creation of patient-specific medical devices.

IMET, through its Center of Medical Electronic (CMET), plays a pivotal role in upholding the quality and reliability of medical electronic devices. By offering precise calibration services, the institute contributes to the enhancement of patient safety, the accuracy of medical diagnoses, and the overall efficiency of healthcare delivery.

INSTITUTE OF MEDICAL ELECTRONIC TECHNOLOGY (IMET)

CMET

- Strengthen the laboratory's capabilities and increase number of equipment type calibration services.
- Improve service through repair and maintenance biomedical equipment
- Biomedical Certification Centre (BMCC) ISO17024



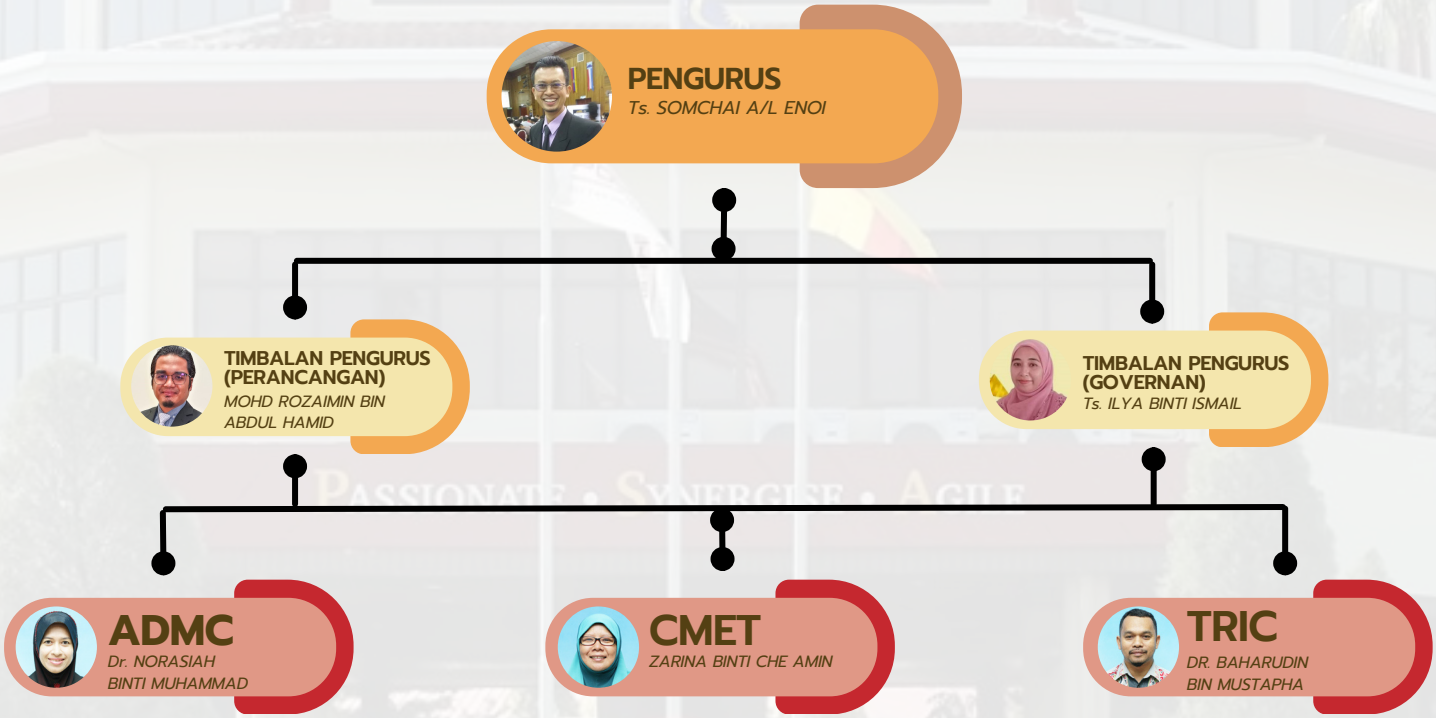
TRIC

- Accredited Personnel Certification Body in IoT
- Rehabilitation technology competency training
- ISO17024 - Scope in IoT

ADMC

- Develop the material design manufacturing of 4IR as niche are.
- Offer certified training in material design manufacturing
- ISO17024 - Scope in design

IMET
ORAGNIZATION CHART



IMET Institute of Medical Engineering Technology (IMET) Strategic Planning Workshop

20 - 21 JULY 2023

The Institute of Medical Engineering Technology (IMET) conducted a strategic planning workshop on July 20 - 21, 2023, aimed at charting the course for the future of IMET. Chaired by Dr. Norhayati Binti Zakaria (Director), the workshop included key figures such as Ts. Dr. Ahmad Aftas Bin Azman (Deputy Academic Director), Mr. Mohd Mubarak bin Shamsuddin (Deputy Director of Academic Support), Dr. Nazratulhuda Binti Awang @ Hashim (Head of Strategic Management Center), Ts. Somchai A/L Enoi (IMET Manager), and other prominent IMET members.

IMET's core team comprises Ts. Ilya Binti Ismail (Deputy Manager), Mr. Mohd Rozaimin Bin Abdul Hamid (Deputy Manager), Ms. Zarina Binti Che Amin (Head of CMET), Dr. Baharuddin Bin Mustapha (Head of TRIC), and Dr. Norasiah Binti Muhammad (Head of ADMC).

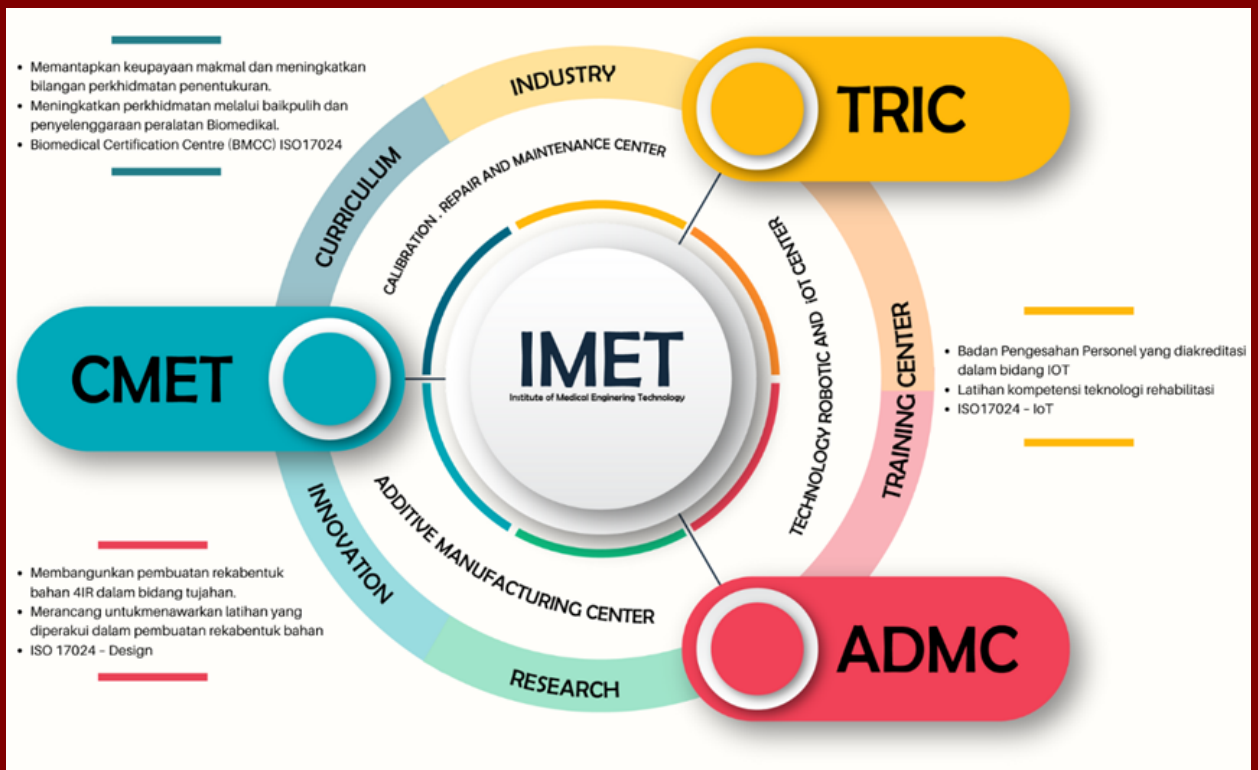
The strategic planning workshop laid the groundwork for IMET's comprehensive and forward-looking long-term strategy. With a dedicated focus on the latest advancements in technology, IMET aspires to become a center of excellence in fields such as advanced manufacturing, robotics, Internet of Things, maintenance, and overhaul within the realm of medical engineering technology. The strategy also underscores IMET's role as a pivotal skills training center with a strong emphasis on industry collaboration.

IMET Institute of Medical Engineering Technology (IMET) Strategic Planning Workshop

IMET's Key Performance Indicators (KPIs) align with KPI 8 of the JPPKK 2023 KPI Dictionary, specifically focusing on the Industry Education Center achievement performance score. KPI 8 encompasses seven crucial elements, including collaboration, research and innovation, expert services, publication, recognition, teaching and learning, as well as income generation.

Looking ahead, IMET aims to attain ISO 17024 Certification Body for Persons recognition in the fields of biomedical maintenance, advanced manufacturing technology, and the Internet of Things. This recognition holds paramount significance in supporting medical engineering technology's endeavors to cultivate future talent in alignment with the New Industrial Master Plan 2030.

The outcomes of this strategic planning workshop set a solid foundation for IMET's progressive journey, emphasizing innovation, collaboration, and a commitment to excellence in advancing medical engineering technology. IMET remains dedicated to shaping the future landscape of the industry through strategic foresight and continuous improvement.

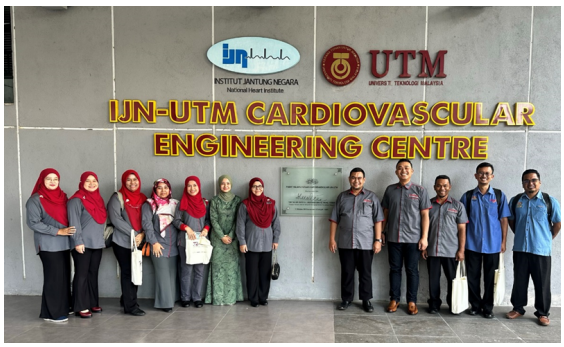


IMET

Exploring Collaborative Opportunities: IMET's Milestone Visit to IJN-UTM Cardiovascular Engineering Centre

8 AUGUST 2023

On August 8, 2023, the Institute of Medical Engineering Technology (IMET) embarked on a landmark visit to the IJN-UTM Cardiovascular Engineering Centre at Universiti Teknologi Malaysia, Skudai, Johor. The delegation of 26 participants, led by Director Dr. Norhayati Binti Zakaria, included members of the management committee and IMET stakeholders.



Established in 2013 through a collaboration between the National Heart Institute (Institut Jantung Negara) and Universiti Teknologi Malaysia, the IJN-UTM Cardiovascular Engineering Centre has been at the forefront of developing cutting-edge cardiovascular devices and products. These include wearable health monitors, mobile health assistants, telecardiology systems, stents, and image-guided interventions.

Situated under the umbrella of the Institute of Human Centered Engineering (iHumEn), the IJN-UTM Cardiovascular Engineering Centre operates within a multidisciplinary research institute. iHumEn brings together experts from various faculties, spanning computing, electrical/electronic engineering, robotics, mechanical engineering, and biomedical engineering.

iHumEn's mission revolves around exploring the potential of human-centered technology to enrich, benefit, and transform our lives. Apart from the IJN-UTM Cardiovascular Engineering Centre, research centers such as the Media and Games Innovation Centre of Excellence (MaGICX), Medical Devices and Technology Centre (MEDiTEC), and Sports Innovation Technology Centre (SITC) are integral components of iHumEn.

During the visit, fruitful discussions and management insights were shared between the two institutes. Opportunities for collaborative activities between IMET and the IJN-UTM Cardiovascular Engineering Centre were explored, paving the way for potential joint initiatives and partnerships. This milestone visit underscores the commitment of IMET to foster collaboration, share knowledge, and contribute to the advancements in medical engineering technology.

IMET

Exploring Academic Collaborations: IMET's Academic Visit to Selangor Technical Skills Development Centre (STDC)

15 SEPTEMBER 2023

On September 15, 2023, IMET conducted an academic visit to the Selangor Technical Skills Development Centre (STDC) to discuss potential collaborations between PSA and STDC in student skill training. The delegation was led by Ts. Dr. Ahmad Aftas Bin Azman (Deputy Academic Director), En. Mohd Mubarak Bin Shamsuddin (Deputy Director of Academic Support), En. Muhammad Faiz Bin Abdullah (Head of Mechanical Engineering Department), Ts. Norazlina Binti Jaafar (Head of Electrical Engineering Department), along with IMET members and representatives from PSA.

The visit was organized under the guidance of Hjh Norita binti Mohd Sidek, Chief Executive Officer of Menteri Besar Selangor Incorporated (MBI), serving as the Industry Advisory Committee for PSA. The PSA delegation was warmly received by Dr. Ir Muhidin Arifin, the Chief Operating Officer of STDC. The visit included a tour of training laboratories such as the Siemens Lab, Automation Lab, and the Apple Academy.

STDC offers professional courses from renowned providers such as Festo, Siemens, and Apple. The delegation had the opportunity to explore the training facilities and gain insights into the programs offered. The collaborative discussions focused on potential partnerships in skill development and training initiatives, enhancing the academic and practical aspects of education for students. This visit marks a significant step towards fostering partnerships between IMET, PSA, and STDC, aiming to provide students with industry-relevant skills and knowledge.

CMET VISITS WONJU AND KRIVET, SOUTH KOREA

17 FEBRUARY 2023

Krivet is a government-funded research institute under the Prime Minister's Office. It was established in 1997 to promote vocational education, training and enhance the nations vocational competencies. Itresearched human resources development to present practical policy for developing Korean Lifelong skills development. It's functions as a valuable research institute meeting the demands of the times.

WMIT is a foundation to promote and support Wonju Medical Device Company which is funded by the state government.

The services include idea consulting about prior technology by diversified analysis, designing, planning and prototype production, Test inspection,Certification Support and Total Marketing Support for global competitives improvement.

CMET VISITS WONJU AND KRIVET, SOUTH KOREA

OBJECTIVES OF THE VISITS - WMIT

- Exploring opportunities for support to affiliate medical devices, research institutes, and Polytechnic for the purpose of local medical device industry development both in Malaysia and in Gangwon province of the Republic of Korea
- Exploring opportunities for the rapid commercialization of affiliated institutions, mutual R&D, and operating mutual supporting programs.
- Sharing expertise and facilities to facilitate the implementation of activities related to collaboration.

ACTIVITIES OF THE VISITS - WMIT

- Welcoming speech by WMIT President
- Introduction speech by Deputy Director of PSA
- Presentation about WMIT by Deputy President of WMIT
- Discussion and Q&A Session
- LOI Signing ceremony

CMET VISITS WONJU AND KRIVET, SOUTH KOREA

OBJECTIVES OF THE VISITS - KRIVET

- Enhancing policy research for the digital and transition and the social inequity.
- Improving research outcomes base on the research network.
- Building flexible and stable system for lifelong education.
- Shaping a happy workplace for all staff and families.

CMET 365 DAYS IN FRAMES: OUR YEARLY ACTIVITY SHOWCASE

CALIBRATION CERTIFICATE REVIEW AND ANALYSIS SEMINAR OPENING CEREMONY BY PSA DIRECTOR SEMINAR PARTICIPANTS ARE FROM HEALTHCARE INDUSTRIES

VISIT FROM RIGEL MEDICAL UNITED KINGDOM ON 7 SEPTEMBER 2023 (DISCUSSED ON CALIBRATION SERVICES AND R&D)

VISIT FROM YBM DS KHALED NORDIN ON 11 SEPTEMBER 2023

CMET 365 DAYS IN FRAMES: OUR YEARLY ACTIVITY SHOWCASE



VISIT FROM PUAN AZLINDA BINTI AZMAN
SETIAUSAHA BAHAGIAN (SUB) PEMBANGUNAN ON 19 OCTOBER 2023



VISIT FROM DR KIM SAING YOUNG , KRIVET ON 16 NOVEMBER 2023



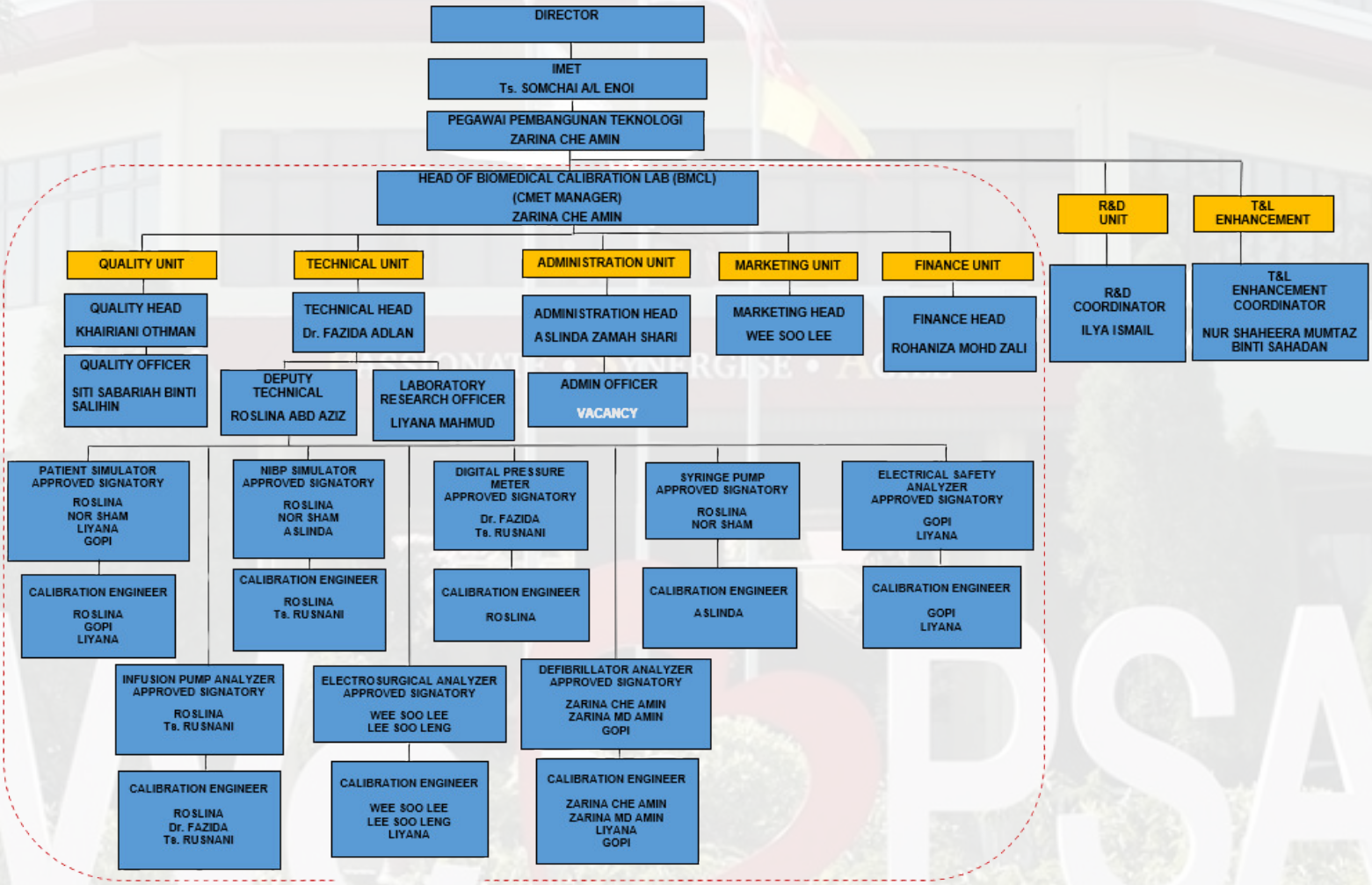
HALA TUJU TRANSFORMAS IPOLITEKNIK, PICC, 4 DISEMBER 2023

CMET 365 DAYS IN FRAMES: OUR YEARLY ACTIVITY SHOWCASE

AN EXHIBITION IS BEING HELD TO WELCOME THE NEW MINISTER OF HIGHER EDUCATION OF MALAYSIA ON 20 DICEMBER 2023

CMET MANAGEMENT REVIEW MEETING ON 21 DECEMBER 2023

CMET NEW ORGANIZATIONAL CHART



TRIC

OVERVIEW OF THE TECHNOLOGY ROBOTIC AND IOT CENTER

The Technology Robotic and IoT Center (TRIC) at PSA is a cutting-edge facility dedicated to the exploration, innovation, and advancement of technology, with a focus on Robotics and the Internet of Things (IoT). This center serves as a hub for interdisciplinary research, education, and development in the rapidly evolving fields of robotics and IoT, fostering a collaborative environment for technological enthusiasts, researchers, and industry professionals.

1. **Research and Development:** The center conducts pioneering research in the realms of robotics and IoT, exploring novel solutions and pushing the boundaries of technology. Research initiatives span from developing autonomous robotic systems to creating smart, interconnected devices that enhance efficiency and connectivity.
2. **Educational Programs:** Offering comprehensive educational programs, the center provides training and workshops to students, professionals, and enthusiasts. These programs cover a spectrum of topics, including robotics programming, IoT architecture, and hands-on experience with state-of-the-art technologies.
3. **Innovation Hub:** The center serves as an innovation hub, encouraging startups and entrepreneurs to bring their ideas to life. It provides resources, mentorship, and a collaborative ecosystem where innovative projects can thrive, contributing to the evolution of technology.
4. **Collaborative Initiatives:** Facilitating collaboration between academia and industry, the center engages in partnerships and joint initiatives. This collaborative approach ensures that research findings are translated into practical applications, fostering technology-driven solutions for real-world challenges.

The Technology Robotic and IoT Center (TRIC) stands as a beacon of technological advancement, fostering research, education, and innovation in the exciting realms of robotics and the Internet of Things. Through its multifaceted approach, the center is poised to shape the future of technology, empower individuals, and contribute to the broader technological landscape.

TRIC TEAM MEMBERS

DR BAHARUDDIN BIN MUSTHAPA

Manager

TS. DR. MOHD ELIAS BIN DAUD

Member

ILMI BIN MOHD ARIFFIN

Member

ASRI BIN MAT DESA

Member

ADMC

OVERVIEW OF THE ADDITIVE MANUFACTURING CENTER

The Additive Manufacturing Center stands as a dynamic hub at the forefront of innovation, dedicated to the advancement and exploration of additive manufacturing technologies. This cutting-edge facility integrates research, education, and industry collaboration to propel the transformative potential of additive manufacturing, also known as 3D printing and industry in material testing.

1. **Advanced Research Initiatives:** The center spearheads groundbreaking research in additive manufacturing, exploring new materials, techniques, and applications. Researchers collaborate to push the boundaries of 3D printing, addressing challenges and unlocking new possibilities for industries ranging from mechanical part to healthcare.
2. **State-of-the-Art Facilities:** Equipped with state-of-the-art 3D printing technologies, the center provides a collaborative environment for engineers, scientists, and industry experts. Access to cutting-edge printers and materials accelerates prototyping, product development, and the creation of complex structures with precision.
3. **Educational Programs:** The center offers comprehensive educational programs and workshops, empowering students and professionals with the skills needed to leverage additive manufacturing. Courses cover design principles, material science, and practical hands-on experience with 3D printing technologies.
4. **Industry Partnerships:** Fostering collaboration between academia and industry, the center establishes partnerships with companies seeking to integrate additive manufacturing into their processes. These collaborations facilitate technology transfer, ensuring that research findings contribute directly to real-world applications.
5. **Prototyping Services:** The center provides prototyping services for businesses and startups, offering a cost-effective and efficient means to bring concepts to life. From rapid prototyping to customized design solutions, the center supports the development of innovative products across various industries.

Additive Manufacturing Center serves as a catalyst for innovation in 3D printing, driving advancements in research, education, and industry collaboration. Through its multifaceted approach, the center contributes to the evolution of additive manufacturing, positioning itself as a key player in the transformative landscape of modern manufacturing technologies.

ADMC TEAM MEMBERS

DR. NORASIAH BINTI MUHAMMAD
Manager

Ts. SOMCHAI A/L ENOI
Member

MOHAMAD KHIRUDIN BIN AMDAN
Member

DR. KHAIRULNIZAM BIN KASIM
Member

SHARIZA AZWIN BINTI YAHAYA
Member

SKH MUHAMMAD BIN SKH ABD RAHIM
Member

MOHD ZULKARNAEN BIN MOHD IBRAHIM
Member

ROSLAN BIN KAMARUDIN
Member

MOHD NASIR BIN KAMARUDDIN
Member

NUR FARAHAIZAN BINTI IDRIS
Member

DR. SITI KHALIJAH BINTI JAMAL
Member

NORSA'AIDAH BINTI SA'AID
Member

MOHD SHARIZAN BIN MOHD SHARIF
Member

Ts. MUHAMMAD HANIFF BIN SELAMAT
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Member

ARTICLE

IMPROVEMENT OF SKIN TEMPERATURE SENSOR FOR PATIENT WARMING SYSTEM

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Abstract - Hypothermia is a medical emergency that occurs when your body loses heat faster than it can produce heat, causing a dangerously low body temperatureAs a result, the Patient Warming System (PWS) is employed to regulate the patient's core temperature prior to the procedure, keep it stable throughout, and then restore it as the patient recovers. PWS is one of the crucial pieces of equipment utilised in the hospital's general surgery department. By including a skin temperature sensor, which enables the machine to detect the actual body temperature of the patient and then control the best heat to the patient's body, this study seeks to build an enhancement for PWS that has been employed in Hospital Sultanah Bahiyah(HSB), Alor Setar. and provide a properly technical intelligent report. Hence, the collection of data on PWS in HSB was carried out in terms of rate and type of unscheduled maintenance, previous study, and user perceptions of the warming device. As a result of the data analysis, with the improvement of features on this machine, it can have a good impact on its use in terms of effectiveness and ease of use as well as can save maintenance costs in the future.

Keywords - Patient Warming System, Forced-Air Warming, Hypothermia, Temperature, Surgery

1.0 Introduction

1.1 Background of Study

A patient warming system in an operating room is a piece of equipment that uses a heated surgical table pad and an optional over-body blanket to keep the patient warm before, during, or after surgeries. A growing number of body warming devices have been created to prevent unintentional peri-operative hypothermia[1]. Hypothermia (HT) is described as a body temperature that is below normal [2]. In practice, every patient with a temperature of fewer than 35 degrees Celsius should be treated with extreme caution. Under anaesthesia, patients are unable to regulate their body temperatures, which can drop dangerously low during the surgery. Every patient who has a temperature of less than 35 degrees Celsius should be handled carefully in real life. Patients cannot control their body temperatures when under anaesthesia, which might cause them to go dangerously low during operation. On patients, HT has a variety of impacts. The procedure makes the blood more viscous, which makes it possible for drugs to accumulate in the body. A patient's temperature increases as their response to medicine decreases (their liver metabolism starts to decrease). According to the National Institute for Health and Care Excellence's systematic literature analysis, body warming significantly lowers the frequency of surgical site infections.[3].

ARTICLE

IMPROVEMENT OF SKIN TEMPERATURE SENSOR FOR PATIENT WARMING SYSTEM

1.2 Problem Statement

Although hospitals have a variety of equipment to warm patients, past studies have proven Forced Air Warming has the best output in terms of maintaining patient temperatures at optimal levels. While no accidents happen to the patient because of the patient's heating system, it is better to prevent them from happening. With today's technology, PWS -Type Forced Air Warming allows the medical practitioner to select the temperature level required by the patient's body to maintain an optimum temperature of 37 degrees Celsius.

Furthermore, in present clinical practice in Malaysia, the process of warming patients is performed by directing a hose under the patient blanket and setting it to their desired temperature. With this method, the machine can be resulted in burns and overheating in the patient body.

Therefore, this study aims to develop an autoregulate system for temperature selection for patient warming system, which can be used to improve the efficiency of the machine during their usage in the Operating Room. Skin temperature will be utilized to sense actual patient body temperature. Therefore, an efficient warming process can be achieved to address the problem of overheating in the patient.

1.3 Objectives of Study

The objectives of this study are as follows:

i)To design an efficient warming process for patients using a combination of skin temperature sensor and Patient Warming System;

ii)To develop a model of a Patient Warming System with auto-regulated temperature selection;

iii)To analyze the functionality and dependence of the developed features.

1.4 Scope and Limitation of Study

The scope of this study is to form a comprehensive improvement of the Forced-Air type of Patient Warming System in areas that have been used in Hospital Sultanah Bahiyah. Furthermore, it also covers the idea, design, previous studies, breakdown requests by the user, and user perceptions towards the improved idea of the PWS machine at Hospital Sultanah Bahiyah, Alor Setar, Kedah. Currently, with the quick advancement of medical technology, there are sort of patient warming machines in the industry, which have their benefit and drawback. So, by this improvement that we have performed, we can pick and propose a better machine that has greater dependability for user handling and easier maintenance.

1.5 Significance of Study

The detail and careful design of improvement of skin temperature sensor for the patient warming system to achieve the optimum heat delivered to the patient before, during, and after the surgical procedure without the risk of the patient's body having to overheat led to skin burn. The device should have a compatibility usage and be easy to use which will progressively improve the process of the heating patient. Furthermore, this device will allow healthcare staff less monitor the temperature of the machine before, during, or after the surgery procedure.

ARTICLE

IMPROVEMENT OF SKIN TEMPERATURE SENSOR FOR PATIENT WARMING SYSTEM

2.0 Literature Review

2.1 Hypothermia

A body temperature that is below normal is referred to as hypothermia (HT) [2]. Every patient who has a temperature of less than 35 degrees Celsius should be handled carefully in real life. Patients are unable to control their body temperatures when under anaesthesia, which might cause them to dangerously low levels during the procedure. On patients, HT has a variety of impacts. The procedure makes the blood more viscous, which makes it possible for drugs to accumulate in the body. A patient's temperature increases as their response to medicine decreases (their liver metabolism starts to decrease).

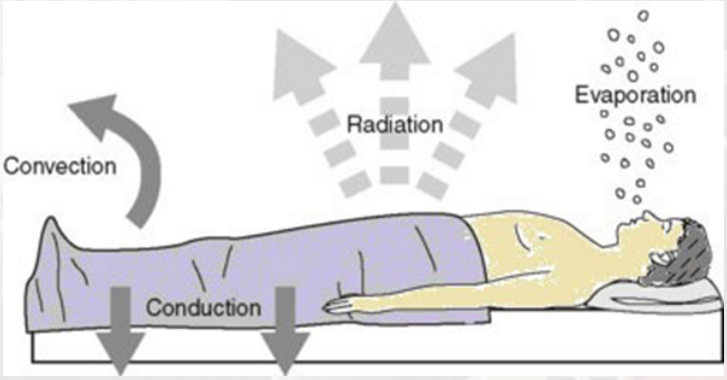

Figure 2.0: Forced-Air Patient Warming System

When a patient has hypothermia, their core temperature is below 36.0°C. Between a successful patient outcome and a challenging recovery, there may be a degree of difference [4]. The skin's surface accounts for around 90% of heat loss, with convection and radiation often playing a larger role than evaporation or conduction. Figure 2.0 illustrates the four ways that heat from the patient is transferred to the environment: conduction, radiation, convection, and evaporation [5]. Conduction is the process through which a patient's heat is transferred by making direct physical contact with objects like a bed or a theatre table. Radiation is the term used to describe the heat produced and released by the patient's metabolism (radiated heat). Convection is the removal of heat from a patient by moving air. The process of evaporation, which takes place frequently when a patient breathes, is a potent technique to remove heat from the body.

Perioperative Hypothermia

Common but preventable surgical complication is unintentional perioperative hypothermia. It can lengthen hospital stays and recovery times, increase the risk of Surgical Site Infection (SSI), and increase fatality rates [5]. On the other side, hypothermia may be easily prevented if the body's temperature is tracked and proactive warming strategies are used throughout the perioperative procedure, starting before anaesthesia is given. If you keep your body temperature regular, you may be able to avoid some of the unpleasant effects of accidental hypothermia, including:

- Surgical site infection is more likely to occur.
- Blood loss and the need for transfusions
- Cardiovascular complications
- Drug metabolism is slowed.
- Shivering and a feeling of being too hot

Hypothermia in trauma patients receiving immediate care is a frequent occurrence. Hypothermia's known side effects include slowed wound healing, heart issues, hemodynamic instability, reduced immune function, and increased blood loss.

2.2 Patient Warming System

In the operating room, a patient warming system is a piece of equipment that uses a heated surgical table pad and an optional over-body blanket to keep the patient warm before, during, or after surgeries. A growing number of bodies warming devices have been created as a means of preventing unintentional perioperative hypothermia. Some examples of these devices include forced air warmers, water-filled mattresses, circulating water garments, electric warming blankets, radiant warmers, carbon fibre, resistive polymer blankets, electric heating pads, plastic garments, thermal exchange chambers, and circulating sleeves. In the Sultanah Bahiyah Hospital, there are three main forms of patient warming technologies.

The equipment used to keep patients warm in the operating room before, during, and after surgeries. This type of equipment is seen in general operating rooms, maternity operating rooms, intensive care units, and paediatric intensive care units (PICU). The setup comprises of a blanket and a warming device. Through a connection cable, the warming unit's heating element and customised blanket link to heated blanket. To prevent the patient's body temperature from decreasing throughout the process, the blanket is placed over him or her.

ARTICLE

IMPROVEMENT OF SKIN TEMPERATURE SENSOR FOR PATIENT WARMING SYSTEM

2.2.1 Forced-Air Warming

The patient's body is covered by a heated airflow produced by forced-air warming equipment. By forcing heated air over the skin, forced air warming (Figure 2.1) encourages convective heat transmission. Electric coils are used to draw air in from the surroundings and warm it [6]. The patient is warmed by convection as a result of the blower's warm air circulation through the blanket.

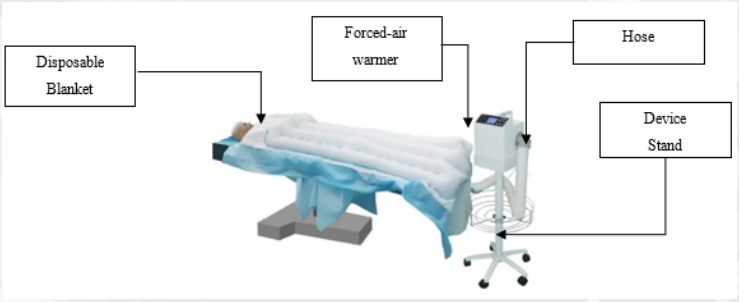

Figure 2.1: Forced-Air Patient Warming System.

2.2.2 Resistive Heating Warming

This technique uses a heated surface, usually a blanket or pad, the patient's body is in constant contact with. As seen in figure 2.2, a resistive heating system transforms electrical energy into heat and warms the patient by conduction. Non-disposable carbon polymer fibre cloth strips provide efficient warmth. The control unit monitors and regulates the temperature of the applied part(s) while also supplying low voltage electrical current to the part(s) [7].

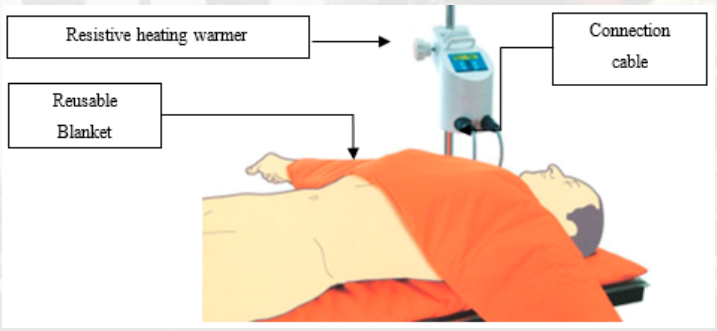

Figure 2.2: Resistive Heating Patient Warming System

2.2.3 Circulating-Water Systems

A patient's blanket and pad are wrapped in a heat pump that circulates warm water. The system, when used in conjunction with the appropriate water pads, enables simple yet effective temperature control of patients, both during pre- and post-operative warming and cooling. The sterile filtered tap water is continually circulated through the water pad by a centrifugal pump as shown in figure 2.3 after being chilled or heated in a water tank inside the device using thermoelectrical elements.

Figure 2.3: Circulating-water Patient Warming System

3.0 Research Methodology

3.1 Introduction

The overall research methodology for the proposed study is illustrated in Figure 3.0. There are three phases that are involved in this research along to the objectives that has been stated earlier.

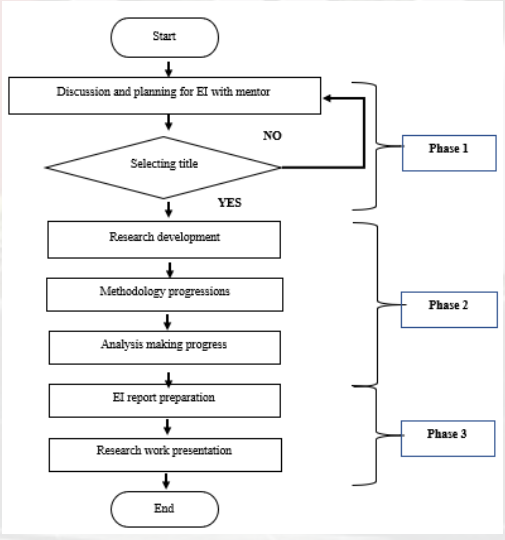

Figure 3.0: Overview of Proposed Research Methodology

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Based on figure 3.0, phase 1 of the flowchart shows the initial procedure that has been carried out where the process of choosing suitable title for the assessment. In the addition, technical discussion has been made between the student and mentor to recognize suitable process, system or equipment for this research. Phase 2 progressed by receiving data and information from previous studies on Forced-Air warming system. According to ASIS [8], the air forced warming system is the most widely used type of warming device in Sulatanah Bahiyah Hospital. Following the collection of data, a procedure is developed to analyse all of the data of Forced-Air warming system in Hospital Sultanah Bahiyah. The final phase of the evaluation was to compile a technical report by preparing a patient warm -up model using Arduino IDE and Proteus 8 software to determine the level of dependability and functionality of the proposed idea so that it could be recommended for hospital use. The research was then carried on by completing a graphic analysis and preparing a thorough technical evaluation report on the subject.

3.2 Block Diagram

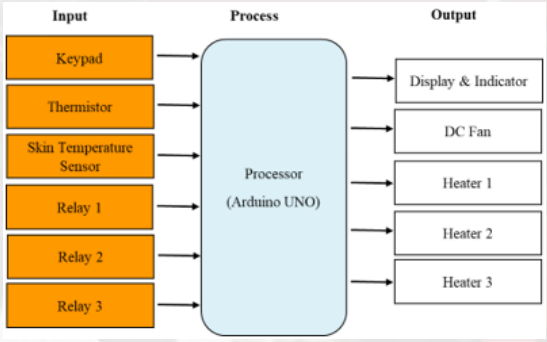

Figure 3.1: Block Diagram of Proposed Idea

Figure 3.1 shows block diagram of proposed idea for this study. It consists an electronic component that has been used to make this device workable. It has 3 elements namely input, process and output. The first is the input, it has a keyboard to control the temperature on the machine. Next, a thermistor is used to detect the temperature of the air released from the machine. In addition, Skin temperature sensor is used to detect the temperature on the patient's body. Finally, relays 1, 2 and 3 are used to control the input voltage and current on heaters 1, 2 and 3. For the process part, it has an Arduino UNO component that will be used as the brain of the device that controls it and run the uploaded program. For the last element, the output element, it includes a display and an indicator that is used to signal that the machine is running and displays the set temperature. Next, the DC fan serves to circulate the air and Heaters 1,2 and 3 serve to heat the air that passes through it.

3.3 Flow Chart

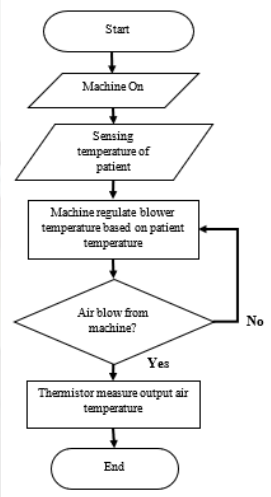

Figure 3.2: Flowchart of Proposed Idea

Figure 3.2 shows flowchart about how the device is programmed to responds to changes in body temperature and sets the optimal temperature emitted by it. First, the device will be turned on to be in a standby state. Second, the device will determine the patient's body temperature through a skin temperature sensor. After identifying the ideal air temperature for the body, the machine will control the blower temperature to the temperature set by the processor. Next, the air blown by the machine will be channelled to the patient through a disposable blanket. Finally, the thermistor will measure the temperature of the air delivered by the machine.

3.4 Model Development

3.4.1 Circuit Diagram

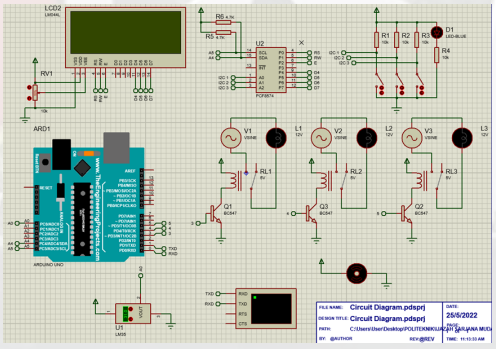

Figure 3.3: Circuit Diagram of Development Model

Figure 3.3 shows schematic that used to design patient warming system in Proteus 8 software. It contains of Arduino UNO microcontroller, temperature sensor, relay, lamp, LCD display and DC fan.

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3.4.2 Design Diagram

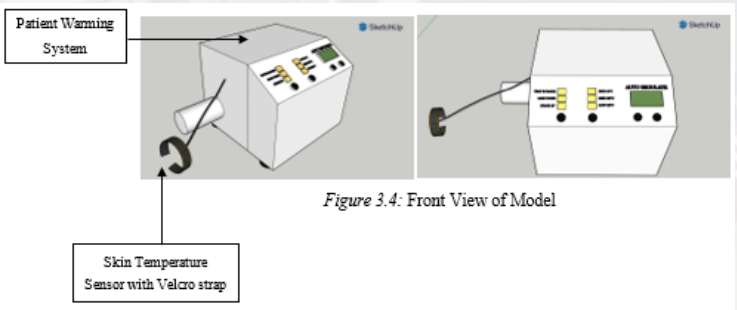

Figure 3.4: Front View of Model

Figure 3.4: Front View of Model

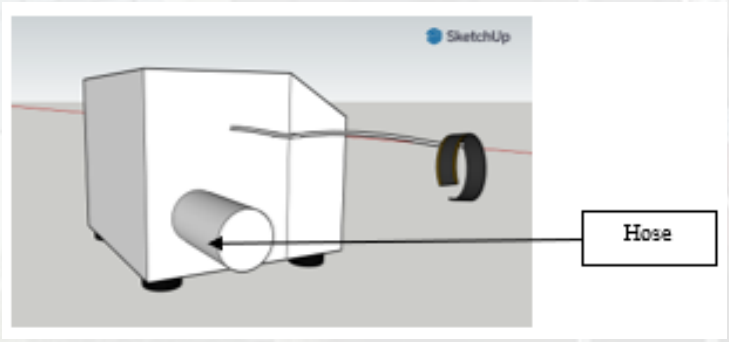

Figure 3.5: Side View of Model

Figure 3.4 and 3.5 shows a design diagram for the development model for this study. it is drawn using the SketchUp software application. From the figure, it shows the front and side views.

4.0 Data Analysis and Result

The results and analytical findings for this study are detailed in this section. The arrangement of the section will be split down into subsections. Work on this evaluation is progressing, and it will include a previous study about patient warming system, a type of breakdown for patient warming system and a user perception on this improvement idea.

4.1 Previous Study

Several research journals related to patient warming system have been reviewed to support the implementation of this study. Each journal studied has its own objectives, methods and findings.

Table 4.0: Analysis of Previous Study related to Patient Warming System.

No.	Titles	Descriptions	Method	Findings
1.	Forced-Air Warming Maintains Intraoperative Normothermia Better Than Circulating-Water Mattresses *(Andrea Kurz, MD, Martin Kurz, MD, Gerald Poeschl, MD, Barbara Faryniak, MD, Gerhard Redl, MD, and Werner Hackl, MD)* [9]	The hypothesis that forced-air warming preserves core temperature better than circulating-water mattresses was tested in: (a) 16 adults undergoing major maxillofacial surgery, including radical node resection and flap reconstruction; (b) 53 adults undergoing hip arthroplasty, having -25% of their body surface area available for warming; (c) 20 infants undergoing minor maxillofacial surgery; and (d) 10 young children undergoing pelvic or femoral osteotomies.	Patients having each type of surgery were randomly assigned to forced-air warming (40°C) or conductive warming using a full-length circulating-water mattress at 40°C.	A **temperature reduction was required** in most patients. Consequently, the core temperature differences between the treatment groups would have exceeded that observed had we not actively intervened.
2.	Forced-air warming: technology, physical background and practical aspects *(Anselm Bräuer and Michael Quintel)* [10]	There is an ever-increasing number of forced-air warming devices available in the market. However, there is also a paucity of studies that have investigated the physical background of these devices, making it difficult to find the most suitable ones.	By referring to previous studies about physical background and practical aspects, they conclude that heat transfer from the blanket to the body surface depends on the heat exchange coefficient, the temperature gradient between the blanket and the body surface and the area that is covered.	The efficacy of a forced-air warming system is mainly **determined by the design of the blankets**. A good forced-air warming blanket can easily be detected by measuring the temperature difference between the highest blanket temperature and the lowest blanket temperature. This temperature difference should be as low as possible.
3.	Meta-analysis: effectiveness of forced-air warming for prevention of perioperative hypothermia in surgical patients *(Hsiao-Chi Nieh & Shu-Fen Su)* [11]	Perioperative hypothermia commonly occurs in patients receiving anaesthesia during surgeries. However, the effectiveness of warming systems requires verification. The aim of this study was to evaluate the effectiveness of forced-air warming for preventing perioperative hypothermia.	Cochrane methods, Quality of evidence (GRADE) assessments and Jadad Quality Score were used.	Evaluation of the effectiveness of Forced-Air Warming should take into account the type of surgery, anaesthesia method, timing of insulation/warming intervention, insulation/warming method, **temperature setting** and core temperature measurement sites (Horosz & Malec-Milewska 2013)
	Resistive-Heating and Forced-Air Warming Are Comparably Effective	Serious adverse outcomes from perioperative hypothermia are well documented. Consequently, intraoperative warming has become routine. We thus	Twenty-four patients undergoing open abdominal surgery lasting approximately 4 h were randomly	Intraoperative core-temperature perturbations depend on numerous factors, including ambient temperature, the type of surgery, and morphometric characteristics. **Core**
4.	*(Chiharu Negishi, MD*, Kenji Hasegawa, MD*, Shihoko Mukai, MD*, Fumitoshi Nakagawa, BS*, Makoto Ozaki, MD*, and Daniel I. Sessler, MD‡)* [12]	evaluated the efficacy of a novel, nondisposable carbon-fiber resistive-heating system.	assigned to warming with 1) a full-length circulating water mattress set at 42°C, 2) a lower body forced-air cover with the blower set on high, or 3) a three-extremity carbon-fiber resistive-heating blanket set to 42°C.	**temperature in the remaining patients increased** throughout the remainder of surgery.

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From the table 4.0, previous study shows that a setting of temperature plays an important role in warming the patient's body. Next, the use of blankets is important to make a Patient Warming System device work efficiently. Finally, the effectiveness of Patient Warming System depends on type of surgery, anaesthesia method, timing of insulation/warming intervention, insulation/warming method, temperature setting and core temperature measurement sites.

4.2 Unscheduled Maintenance (Breakdown)

Data for unscheduled maintenance(breakdown) for Forced-Air Warming models were collected from the ASIS system. 4 equipment with different asset numbers were analysed in terms of unscheduled maintenance and the type of breakdown suffered.

Table 4.1: Analysis of Unscheduled Maintenance for Patient Warming System at Hospital Sultanah Bahiyah

Asset No.	Breakdown	Description
052083267	28-Apr-2022	Replace new hose
	30-Oct-2019	Clean filter
	22-Oct-2019	Sensor problem
	04-Jun-2019	Replaced power cord
	09-May-2019	Repair on/off switches
052083063	02-Jun-2022	Clean filter
	14-Jun-2020	Replace new hose
	24-Nov-2019	Replace new main board (control panel)
	31-Oct-2019	Clean filter
052084195	05-Jun-2022	Change new temperature sensor
	27-Dec-2021	Replace new hose
	07-Oct-2018	Replace new hose
	05-Aug-2018	Replace new filter
	04-Mar-2018	Control panel and internal board problem, fixed by vendor
052083268	16-Jan-2022	Clean filter
	23-May-2021	Replaced new filter
	24-Nov-2019	Machine not functioning well. Clean blower fan
	03-Oct-2019	Service temperature sensor
	05-Aug-2018	Replace new component at control panel board

From the table 4.1, all assets have shown at least 1 breakdown related to failure of control panel and switch of the device. This damage can be overcome if the control panel or switch on the device does not need to be tampered with before, during or after the device is used. With the features that will be tailored to this device, there will only be a button to turn the machine on and off. The rest will be evaluated and determined by the device itself.

5.0 Conclusion and Recommendation

In conclusion, because hypothermia is the most frequent and least recognised adverse event in patients following surgery, Patient Warming System (PWS) is crucial in preventing it. Turning to the study's goals, we can see a number of beneficial possibilities if these advancements are made, including allowing medical practitioners to concentrate more on surgical operations, facilitating their usage of equipment on patients, and offering safety features to the patient. Technically, by lowering the rate of component failures on control panels, this upgrade feature allows technicians to save cost.

In the future, we propose that this patient heating system be enhanced by adding an air quality sensor that may be put on the machine hose. The purpose is to guarantee that the device can give clean air to the patient throughout the duration of the machine's use. With the enhancement of this feature, the rate of infection in the body part receiving surgery can be reduced.

Correspondence author was a WBL student in February to July 2023

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ARTICLE

DEVELOPMENT OF VOLTAGE MONITORING SYSTEM FOR OPERATING TABLE BATTERIES

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Abstract - The surgical table (or surgical table) is utilized in the working space to put patients during medical procedure. It comprises of the principal stage on which the patient sits and sets down and can be isolated into a few segments. The focal base changes the level and slant of the stage. The surgical table requires a power source to control different settings, for example, table level and bed surface slant. The primary objective was to empower biomedical specialists to get definite data about battery voltage and return the surgical table to typical activity in case of a disappointment rapidly. In this review, we will break down past disappointments by means of an ASIS framework that records significant information to foster a voltage observing gadget for surgical table batteries. The discoveries show that the technique created in this concentrate altogether works on the productivity of surgical table hardware fixes, guarantees that architects get the right data about excess battery power, and diminishes surgical table activity free time. It demonstrates the way that it very well may be finished. Research in its present status will be a full help highlight for surgical table fixes. Both recreation and survey results show that the new framework is quick and prudent regarding productivity and cost investment funds, and is exceptionally viable for fix the board frameworks.

Keywords – Operating Table, Battery, Voltage Monitoring, Breakdown, Downtime.

1.0 Introduction

The surgical table is the table on which the patient lies during a medical procedure. The surgical table, some of the time alluded to as the surgical table or surgical table, is commonly utilized in emergency clinic working rooms or divisions, short term a medical procedure habitat, or other clinical offices where medical procedure is performed. The surgical table can be moved from one space to another, either fixed or portable. The surgical table is utilized in different sorts of mediations. B. Heart chest, muscular health, hindrance stunts, robots, urology, and so forth. The utilization of the surgical table relies upon its plan and details. For instance, a few surgical tables are intended to carry out various techniques, while others are explicitly intended for muscular systems. During medical procedure, the patient lies on the surgical table. The reason for the surgical table is to keep the patient set up while the working group is working, utilizing the surgical table accomplices to move various pieces of the body and access the careful site.

1.1 Problem Statement

The main issue that needs to be highlighted and improve is the batteries voltage of the operating table that could not be viewed unless the base cover is removed in order to access the batteries compartment. This idea of improvement could ease the BEMS technical personnel to monitor the batteries' voltage left during planned preventive maintenance (PPM) or repair corrective maintenance (RCM) of operating table without removing the base cover. Figure 1.2 shows the table base main electrical components of an operating table. The main focus here is part number 6 in which the batteries are located.

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1.2 Objective

The objectives of this study are as follows:

- To identify the common breakdowns for operating table.
- To develop a voltage monitoring system for operating table batteries.
- To aid BEMS technical personnel in reducing the downtime for operating table during breakdown.

1.3 Scope of Study

This study will primarily focus on voltage monitoring of operating table batteries and its effect in reducing downtime during breakdown. This study will also focus on a specific model of operating table which is Eschmann T20 as it is the main model used in Hospital Sultanah Nora Ismail, Batu Pahat.

2.0 Operating Table

The operating table is the table on which the patient lies during surgery. The operating table, sometimes referred to as the operating table or operating table, is typically used in hospital operating rooms or departments, outpatient surgery centres, or other medical facilities where surgery is performed. The operating table can be moved from room to room, either fixed or movable. The operating table is used in various types of interventions. B. Cardiac chest, orthopaedics, barrier tricks, robots, urology, etc. [1].

The plan of a surgical table can influence its utilization, contingent upon its particulars. Surgical tables can be intended for various purposes, while others are planned explicitly for muscular techniques [2]. During medical procedure, the patient lies on the surgical table. The motivation behind the surgical table is to keep the patient set up while the working group is carrying out procedure, and the surgical table frill are utilized to move various pieces of the body for simple admittance to the careful site.
Numerous systems are performed on the surgical table. These incorporate cardiovascular, gynaecological, paediatric, muscular and paediatric medical procedures. Because of the range of types and methods of surgical tables, there are limitations on weight and level to guarantee patient security during medical procedure.

2.1 Classification of Operating Table

There are three main categories of operating tables. General operating table, orthopaedic table and radiographic table.

A general operating table is used for various surgical procedures, such as cardiovascular, paediatric, gynaecological surgery, gallbladder and plastic surgery, as shown in Figure 2.1. In general, the operating table has no specialties. Instead, it is designed for flexibility and adaptability to a variety of tasks. The overall operating table can be adjusted in height and length and can be tilted in any direction or horizontally. Most general-purpose desks have a removable body and a variety of attachable headrests.

The second type of operating table, the orthopaedic table, is designed to facilitate the manipulations and manipulations required for orthopaedic surgery, as shown in Figure 2.2. Successful orthopaedic surgery requires careful control and flexibility as the surgeon moves the patient. Orthopaedic tables allow this flexibility of access and movement. [2]-[3].

The third sort of surgical table is a radiographic imaging table, as displayed in Figure 2.3. This sort of mass is for negligibly obtrusive methodology that require fluoroscopy. A portion of these techniques can be endovascular, vascular or pain relieving [3]. Radioluminescence imaging tables are great for strategies that require clear, top-notch pictures.

Figure 2.1: General surgical table

Figure 2.3: Imaging table

Figure 2.2: Orthopaedic table

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2.2 Measurement of Operating Table Battery Capacity

Surgical tables require a wellspring of ability to control the different settings like the level of the table or the tendency of the dozing surface (table top). We can in this manner recognize:

- Electric surgical tables: the table developments are done by means of an electric actuator, most frequently constrained by a controller.
- Pressure driven surgical tables: are fuelled by a water powered wellspring of energy and are by and large constrained by a pedal.

At times the surgical table can join different working modes, for instance with an electrically movable dozing surface and a using pressurized water flexible headrest.

It should be noted that the operation of the operating table affects not only the ease of daily use, but also the installation conditions and maintenance restrictions.

The operating table consists of large parts. These are; Fixed pole base and mobile transport trolley with remote control, mobile countertop and wheels. At the bottom of the fixed pole is a 24 V battery. In this electromechanical drive system, the remote control can raise, lower or operate the table top by a jack mechanism. The fixed legs are removable and the wheels can be held in place. There is an automatic locking and lowering system between the fixed base and the table top. The table top has a back and bottom with electrically operated hinges. The remote control has an automatic disconnect switch to prevent battery discharge, all switches are housed in a sealed, shock-resistant housing [4] - [5]. Figure 2.4 shows the voltage level measurement of a rechargeable battery.

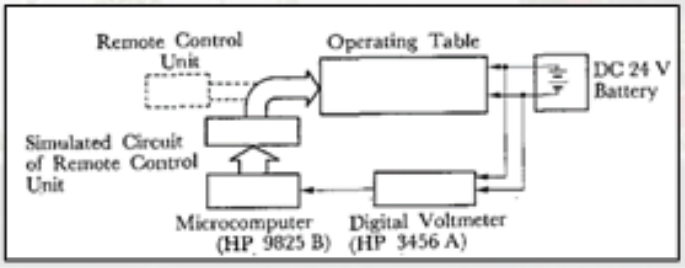

Figure 2.4: Measurement of voltage level in rechargeable batteries

3.0 Methodology

This section will go through the research approach that was used during the evaluation. The layout of the sections will be broken down into various subsections. The progress work on this assessment, which consists of a flowchart on overall research activity, is one of the primary sections. The discussion will then move on to an explanation of the methodologies that were used to complete this technical assessment.

3.1 Introduction

The overall research methodology for the engineering improvement is illustrated in Figure 3.1. This study will consist of several phases. The first phase will start with proposing the idea for improvement, the next phase is constructing suitable methodology and performing data analysis, and end with simulation development as the final phase.

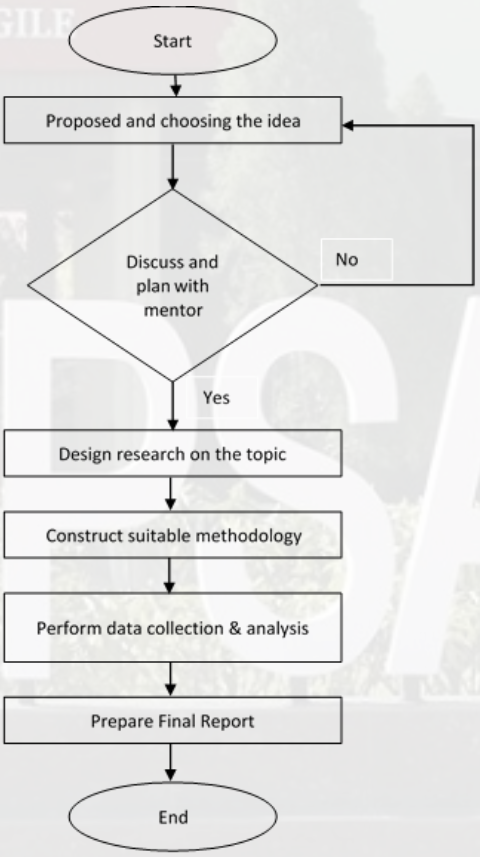

Figure 3.1: Research Methodology in Engineering Improvement

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The first phase of this engineering improvement will involve proposing suitable medical equipment to be improve. After several discussion, we agreed that the suitable equipment would be operating table that is widely used in operating theatre and emergency department. Next phase would be constructing suitable methodology to complete this engineering improvement. In this case, the methodology used is study the specifications of operating table from Eschmann T20 manufacturer's manual, collect data of breakdown history from ASIS and get feedback from BEMS technical personnel regarding this engineering improvement. A block diagram will be constructed to further aid in developing the simulation. The next phase would be development of simulation for the engineering improvement system through Proteus software. Data analysis will be presented in graphical analysis.

3.2 Data Collection

Collection of data for this study will be mainly focused on three sources which are ASIS system, biomedical engineering maintenance services personnel and the service manual that is issued by the manufacturer.

As for the data from biomedical engineering maintenance services personnel, the data included are the model of operating table used in the specific hospital, the total number of breakdown frequency and also survey for the feasibility of this engineering improvement idea.

For the service manual, it is the primary source of this study to ensure all the improvement intended on the operating table is consistent with the technical aspects of the operating table. The service manual soft copy was obtained from the manufacturer's website, Eschmann and was published in July 2005. The vital data gathered from this source is the full diagram of equipment parts, the circuit diagram of electrical parts and also the specifications of the operating table.

3.3 Data Pre-processing

The data from both sources will be interpreted into a general block diagram that focused on the section that will be improved which is the electrical supply section. Figure 3.2 shows the block diagram of the main components which is highlighted in blue and also the voltage monitoring system, highlighted in green. Figure 3.3 shows the block diagram of improvement system.

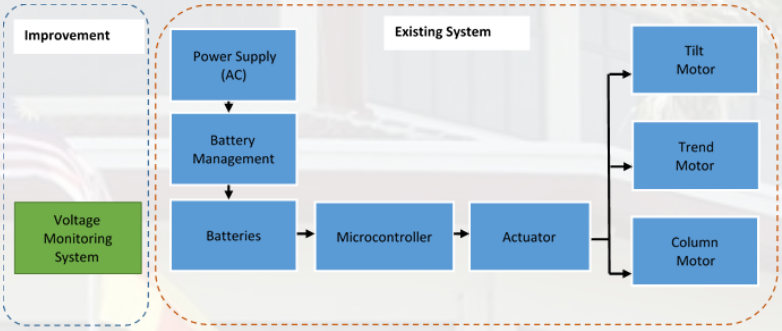

Figure 3.2: Block diagram of operating table

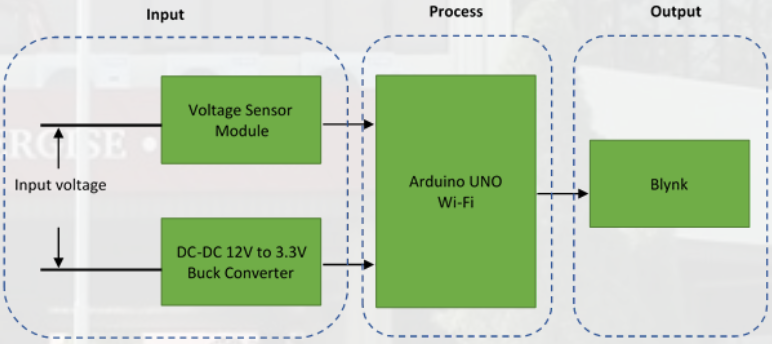

Figure 3.3: Block diagram of voltage monitoring system

Based on Figure 3.2, there are several blocks of parts that is involved in the operation of an operating table. The first one is the AC power supply. This operating table is battery operated, so the AC power supply is only used to charge the batteries of the operating table. Next is the battery management. This is the sub microcontroller which its function is to regulate the voltage and current flowing to charge the batteries of the operating table.

The third one is the batteries. There are total of 4 lead acid batteries in the operating table, 2 for main operation and another two for backup. These batteries are rated at 12V, 10.0 Ah for main batteries and 12V, 1.2 Ah for backup batteries. As for the improvement idea which is the voltage monitoring device, it will be monitoring the two main batteries' voltage and display them through a display.

Furthermore, the microcontroller acts as the brain of this equipment.

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It controls all the operation and movement of the equipment, especially the motors. It also limits the voltage and current to the actuator that generate mechanical movements. An actuator is a part of operating table that helps it to achieve physical movements by converting energy, often electrical or hydraulic, into mechanical force. Simply put, it is the component in any machine that enables movement.
Lastly, there are three main motors of an operating table which reflect three different movements of an operating table which are the tilt motor, trend motor and column motor. As stated earlier, all of these motors were battery operated so that low level of electrical leakage is ensured, and safety of patient were not compromised.

Based on Figure 3.3, there are three parts of voltage monitoring system which are the input, process and output. The input part consists of input voltage from the batteries itself, the voltage sensor module to detect the input voltage and the DC buck converter to power up the microcontroller, Arduino UNO Wi-Fi.
As for the process, there is Arduino UNO Wi-Fi that act as the microcontroller to receive the input and also process the output. It performs the calculation for the voltage sensor module as it applies the voltage divider rule before an output could be produced. The output of this project would be wirelessly through the Blynk application that is connected to the Arduino microcontroller. It will display the voltage in real time.

4.0 Result and Analysis

This section will be shown the results of the Development of Voltage Monitoring System for Operating Table Batteries project. It includes the circuit connection in Proteus, the simulation output through Proteus and Blynk, and then display graphical analysis of questionnaire.

4.1 Circuit Diagram

Figure 4.1 shows the circuit diagram of this project. There are several parts and components that played major role in the operation of this project.

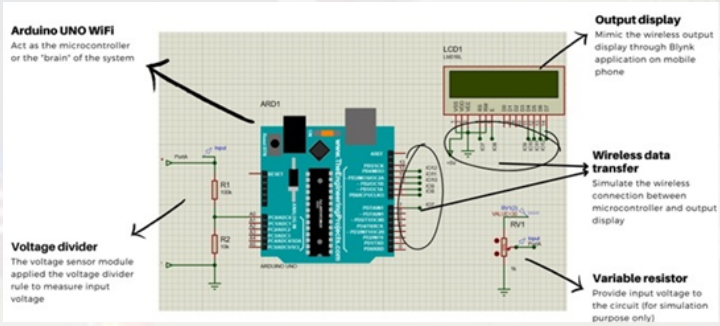

Figure 4.1: Circuit diagram of voltage monitoring system

Based on Figure 4.1, the circuit diagram was developed using Proteus software, a simulation software that contains a lot of modules and component that will be easily simulated with the aid of Arduino IDE coding software. In this circuit diagram, there are several components that was created to match with the actual components such as voltage sensor. A voltage divider circuit was developed to mimic the actual voltage sensor since they were operated on the same principle.

4.2 Arduino IDE

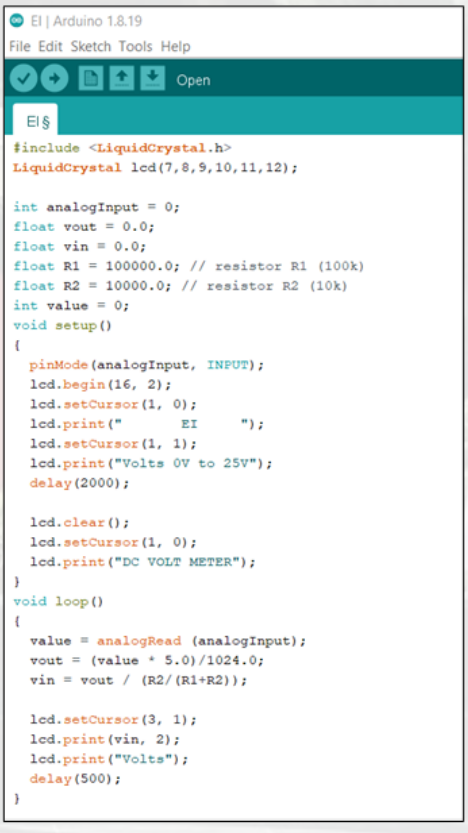

Figure 4.2: Arduino IDE programming for Engineering Improvement Project

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Figure 4.2 shows the Arduino source code programming to operate this project. The input and output were declared to make sure the value type is accurate to ensure smooth and precise operation of this project. When the voltage sensor detects the input voltage, it will display accordingly to the LCD display by applying the voltage divider rule.

4.3 Simulation Results

Figure 4.3 and Figure 4.4 showed the simulation output for the operation of the voltage monitoring system for operating table batteries.

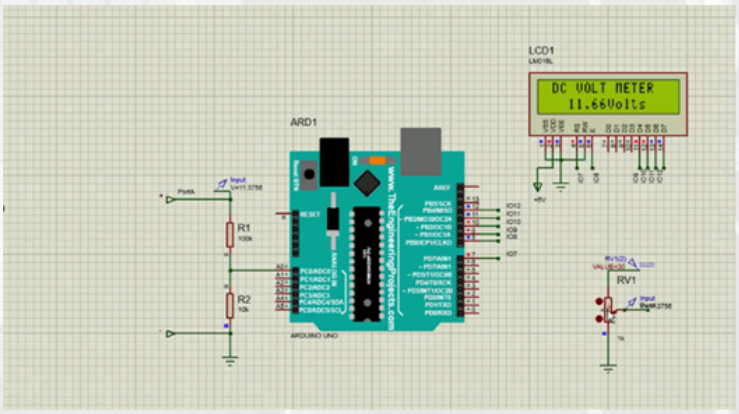

Figure 4.3: Simulation output through Proteus software

Figure 4.4: Simulation output through Blynk software

5.0 Conclusion and Recommendation

In conclusion, this development of voltage monitoring system is capable to display operating table batteries voltage at any given time and reliable to be used in medical environment with high accuracy.

Based on the significant feature of voltage monitoring, a comprehensive planned preventive maintenance and repair corrective maintenance task can be provided to the operating table to ensure prolong lifetime of the equipment and ease the technical personnel involved.

**Correspondence author was a WBL student in February to July 2023*

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THE DESIGNING OF A BUILT-IN SUCTION UNIT FOR INFANT RADIANT WARMER

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Abstract - Radiant warmers provide infrared heat in a controlled manner to neonates and infants who are unable to maintain appropriate thermo-regulation based on their own physiology. Radiant warmers are regularly used in delivery rooms, neonatal intensive care unit (NICU) and operational theatre (OT).The care of every infant at birth includes warmth, clearing the airway (positioning and suctioning as necessary), and support of breathing. When a new-born is unable to breathe enough in the first few minutes of life, birth asphyxia may occur. One way that this occurs is when the infant still has fluid in the airway. Therefore, suction machine is used to clear the airways, allowing the new-born to breathe properly and prevent asphyxia. The main problem is existing radiant warmer is not equipped with the suction unit. Therefore, it's difficult for the clinicians to do procedure by using portable suction due to compact space at Labour room and Operational Theatre. Next, the amount of fluid that sucks by the suction pump couldn't achieve the targeted value. Hence, the main objective of this project to design and improvise radiant warmer by adding a suction unit. Hence, collection of data was carried out in term of visiting the site, interview the user, and previous study. The research for this project is done by providing questionnaire to the qualified personnel (doctors, nurses) and the biomedical engineers of Hospital Penang. By adding the suction unit, the user can use all in one portable radiant warmer which does not consume more space and get the desired pressure level.

Keywords - Radiant warmer, Suction machine, Compact Space, NICU, Built-in suction Introduction

1.1 Background of Study

A medical procedure known as a radiant warmer warms the body by generating heat. The baby's body temperature is maintained, and the device's metabolism is controlled. In order to both offer external heat and allow access to new-borns, radiant warmers are frequently utilised in birth rooms, neonatal care facilities, and operating theatres. Infants are commonly placed under the warm, radiant light shortly after birth to assist maintain their temperature until they can regulate it on their own. Unnecessary new-born fatalities are still brought on by a lack of attention to thermoregulation. Every new-born needs warmth, airway clearance (positioning and suctioning if needed), and assistance for breathing through drying and tactile stimulation.

Birth asphyxia may happen when a new-born is unable to breathe adequately in the first few minutes of life. When the baby still has fluid in his or her airway, this might happen. In order to clear the airways and allow the new-born to breathe normally and avoid suffocation, a suction machine is employed. High vacuum pressures, however, can injure the developing airway tissues. The aspirator's controlled negative pressure, which removes obstruction-causing fluids from the nasal and buccal cavities, is hence its most crucial feature. The vacuum that is formed in the airways is controlled by negative pressure. A negative pressure level of 80–100 mmHg is advised for new-borns according to published airway suction recommendations (25, 26). For a new-born nasal aspirator, these specs prescribe a maximum negative pressure of 100 mmHg. Additionally, ISO advises that a low-flow device have a vacuum of no more than 20 kPa (150 mmHg).

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1.2 Problem Statement

The main problem is existing radiant warmer is not equipped with the suction unit. Therefore, it's difficult for the clinicians to do procedure by using portable suction due to compact space at Labour room and Operational Theatre. This is because many device in the room it occupies more spaces and the place become compact. Furthermore, the amount of fluid that sucks by the wall suction pump couldn't achieve the targeted value. This is because even though most in-wall suction systems are designed with filters and overflow traps to keep materials from entering the pipelines, dust, lint and fluids may still get into the system. This can cause the equipment to not function properly and a decrease in the applied suction

1.3 Objectives of Study

The objectives of this study are as follows:
i. To design and improvise radiant warmer by adding a suction unit;
ii. To compare the space consume by the existing device and improvised device;

1.4 Scope and Limitation of Study

The primary focus of this study will be on the built-in suction unit to the radiant warmer, which enables the user to remain cool and comfortable in a small space while doing procedures for the neonate. The Neonatal Intensive Care Unit (NICU) and labour room are where radiant warmers are most frequently utilised while delivering babies. Atom Infant Warmer Model 103 will be the focus of this study. It also discusses the concept, design, prior research, prototype, and user opinions about the improvement of a built-in suction unit to the radiant warmer machine at Hospital Penang.

1.5 Significance of Study

I. The combination of a built-in suction unit is a user-friendly equipment that allows the user to remain cool and comfortable in a small area while performing new-born procedures.

II. The combination of the built-in suction to the radiant warmer helps to obtain the desired level of fluid suction.

2.0 Literature Review

2.1 Radiant Warmer

Radiant Warmer is a body warming appliance that provides heat to the body. The baby's body temperature is maintained, and the device's metabolism is constrained. Heat tends to move in a direction that follows the heat gradient, which is from high temperature to low temperature. Some premature new-borns lose heat quickly, therefore body warmers offer an artificial assistance to maintain body temperature. Babies are maintained on radiant warmers for a few hours just after delivery in some regions with extremely chilly climates to make sure the infant is stable. [1]

Radiant Warmers have an open tray where the infant is kept, and an above heating device provides artificial heating. The heating system uses quartz to generate the required heat and a reflecting system to direct it to the infant tray. A temperature measuring knob that is permanently fastened to the baby's body can measure the temperature of the skin. A tiny LCD panel that displays the body temperature continually also shows the fluctuation in skin temperature. Radiant warmers are fitted with an alarm to signal a change in temperature, drawing the attention of the attending medical personnel. The heat generated may be regulated manually or automatically based on the Radiant Heat Warmer. [1]

2.2 Routine care and initial steps of resuscitation

The care of every infant at birth includes warmth, clearing the airway (positioning and suctioning) and support of breathing with drying and tactile stimulation [2].

- **Provide warmth**

There are three techniques to keep a baby warm:
- After fully drying the baby, lay it on the mother's chest or abdomen and cover them both with warm linen.
- Dry the new-born completely under a radiant heat source, then take off the damp bedding.
- Cover preterm children who were born before 28 weeks of pregnancy from the shoulders to the toes in a polyethylene sheet or bag of food-grade plastic (without drying), leaving the right arm exposed for the installation of the pulse oximetry probe, and place under a radiant heat source.

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- **Position and clear the airway**

There are four ways to position and clear the airway on infant:

- Ensure that the infant's neck is slightly extended when positioning him or her on the mother's chest; wipe secretions from the mouth and nose or clear the airway with a bulb suction device if secretions are blocking the airway.
- Position the infant supine and flat with the neck slightly extended. A rolled blanket or towel may be used under the shoulders.
- Turn the head (or the head and body) to the side to allow secretions to pool in the check, and then remove with a suction device. Suction the mouth and then the nose to clear the airway. The mouth is suctioned first to clear the largest volume of secretions; when the nasopharynx is suctioned, a reflex cough, sneeze, or cry often results.
- Deep pharyngeal suction in an infant not requiring positive-pressure ventilation or intubation should not be performed during the first few minutes after birth to avoid vagal stimulation, resultant bradycardia, and delay in rise in Pao2.

- **Stimulate and Reposition**

Three techniques exist for stimulating and moving an infant:

- After drying, provide babies who are not breathing or crying tactile stimulation by lightly caressing their backs.
- Keep gently massaging the new-born's head, feet, or torso to stimulate early breathing attempts.
- Maintain an open airway by keeping the head and neck in a slightly stretched position.

2.2.1 Care of the baby in the delivery room

The umbilical cord is clamped and severed just below the navel after delivery. This eliminates the infant's need on the placenta for nutrients and oxygen. Air enters the baby's lungs as it takes its first breath. The lungs require less blood flow before birth since they are not habituated to exchanging oxygen and carbon dioxide. Through unique connections in the heart and big blood veins, the foetal circulation diverts the majority of the blood flow away from the lungs. The shift in lung pressure that occurs when a new-born begins breathing air at birth aids in closing the foetal connections and rerouting blood flow. In order to aid in the exchange of oxygen and carbon dioxide, blood is now pushed to the lungs. Some infants' lungs overflow with fluid. The fluid can be suctioned from the nose and mouth by massaging and caressing the baby's skin to get them to cry [3].

- **Care for the new-born after a C-section**

Immediately upon birth, C-section babies are often examined by a nursery nurse or medical professional. In the operation room, this is frequently done directly next to you. C-section new-borns may require additional suctioning of the nose, mouth, and throat because they may struggle to discharge some of the lung fluid and mucus. They could require deeper suctioning in the windpipe in some circumstances. A nurse will lovingly wrap a new-born after it has been examined and bring it to you so you may view and touch it. Many hospitals mandate that new-borns delivered through C-section be observed for a brief period of time in the nursery. There, the typical processes like weighing and administering medications are carried out. [4].

- **When a baby has trouble after birth**

After delivery, all of the baby's bodily systems must cooperate in a different way. A new-born may occasionally struggle with the change. A baby's health can be determined by tests like the Apgar test, which is performed shortly after birth. Treatment might be administered in the birth room if there are any indications the infant is not doing well. To assist the infant expel extra fluid and begin breathing, the healthcare practitioner or midwife collaborates with other members of the healthcare team [3]. Premature babies, babies who had a difficult delivery, and babies who were born with birth defects are all examples of babies that might experience issues during birth. Fortunately, these infants can get special care. The neonatal intensive care unit is a particular area of the hospital where new-born who require intensive medical care are frequently admitted (NICU) [2].

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2.4 The Existing Method For Suctioning Infant

The medical wall suction unit that used for infant after birth is as shown in Figure 3. This equipment mostly available in Neonatal intensive care unit, Operational theatre and labour room.

Figure 2.0: Medical-wall Suction

The medical suction jar shown in Figure 2.0 is made to safely collect the secretions produced by medical suction. Pair with a wall-mounted vacuum regulator, a bedhead device, or use electric suction regulators. The suction bottle has two hose ports, one of which is linked to the vacuum output and the other to the operating chamber. When the vacuum outlet is switched on, air in the suction bottle will create a negative pressure that will force dirt (such mucus and blood) from the hose into the bottle.

3.0 Research Methodology

3.1 Introduction

The overall research methodology for the proposed study is illustrated in Figure 3.0. This study will consist of four main stages. The first stage will start with the data collection, the next stage is proposed block diagram and end with design development as the final stage.

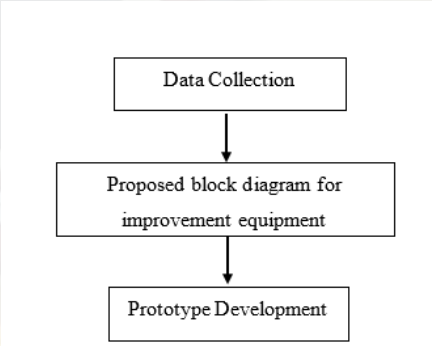

Figure 3.0: Overview of Proposed Methodology

The initial phase of this investigation will include gathering technical data from biomedical engineering maintenance services staff and by consulting the service guidebook for the Atom Model 103 radiant warmer. The information gathered at this step will then be converted into a general block diagram to give a more comprehensive view of this engineering innovation. The design will be developed using Autodesk Inventor which is 3D CAD software, and a prototype has already been created.

3.2 Data Collection

The procedure for data gathering is depicted in Figure 3.1. Data for this study will be gathered primarily through four sources: discussions with biomedical engineering maintenance services staff, site visits, manufacturer service manuals, and feedback forms issued to users. The data from biomedical engineering maintenance services workers include the model of new-born radiant warmer utilised at the Hospital Penang, concerns with the existing suction unit, and a survey to determine the viability of this engineering improvement suggestion. The service manual is the key source of this research to guarantee that any improvements proposed for the radiant warmer are consistent with technical elements. The service manual soft copy was got from Atom's website and was released in September 2017. The information acquired from this source includes the complete schematic of equipment parts, the circuit diagram of electrical parts, and the radiant warmer parameters. An informal interview is done to get information from users regarding problems encountered in the department. The interview was conducted with a medical assistant from the labour room, the new-born critical care unit, and the operation theatre department. The interview focuses on device performance in terms of dependability, usability, and difficulties with current equipment.

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Figure 3.1: Method of data collection

3.2 Hardware Development

The process flowchart for hardware development is shown in Figure 3.2 below. First, we design the product using 3D CAD software. The product design is then completed. We redesign the product if the design has been flawed. Following that, we locate the appropriate components for the product. We complete the product within the timeframe specified. Finally, the prototype is polished.

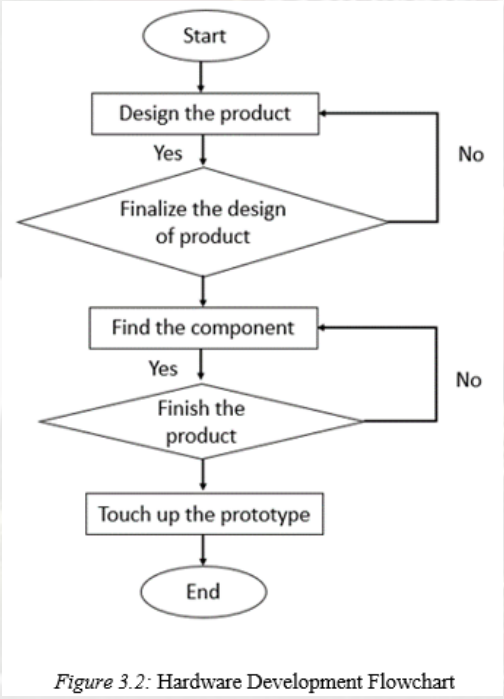

Figure 3.2: Hardware Development Flowchart

3.2.1 Battery 9V

Figure 3.2 shows 9V battery. A nine-volt battery, is usually used in small portable appliances. The built-in suction machines are equipped with 9V battery to ensure that they can deliver suction in sufficient amount.

Figure 3.3: 9V Battery

3.2.2 Vacuum Pump (DC motor)

Figure 3.4 shows a vacuum pump (DC motor). A type of electric machine known as a DC motor transforms electrical energy into mechanical energy. Direct current (DC) motors use electrical power and transform it into mechanical rotation. This is what creates negative pressure and is required for a suction machine to work properly. The vacuum pump is connected to the collection canister by a connection tube. It should never come into contact with the contents of the collection canister.

Figure 3.4: Vacuum Pump

3.2.3 Vacuum Regulator

Figure 3.5 shows a vacuum regulator controls the pressure by adjusting the rate at which the vacuum pump evacuates the chamber while atmospheric air enters at a constant rate.

Figure 3.5: Vacuum Regulator

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3.2.4 Vacuum Gauge

A vacuum gauge is a pressure measuring device that measures pressure in a vacuum, as shown in Figure 3.6. This pressure is often lower than atmospheric pressure. The air pressure is 101.325 kPa, which is the usual pressure at sea level. Pressure is often expressed in bar or psi. The expression for vacuum pressure (Pvac) with relation to atmospheric pressure is a negative number. A vacuum is an area where a gas has a lower pressure than the surrounding atmosphere.

Figure 3.5: Vacuum Gauge

3.3 Project Design

Figure 3.6 and Figure 3.7 below show the design of the project. We used Autodesk Inventor which is 3D CAD software to design the project.

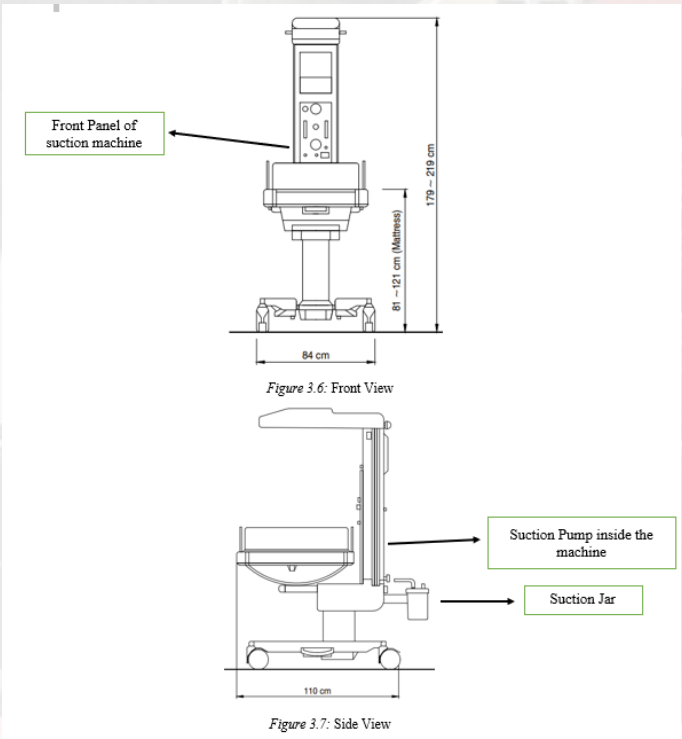

Figure 3.6: Front View

Figure 3.7: Side View

3.4 Block Diagram

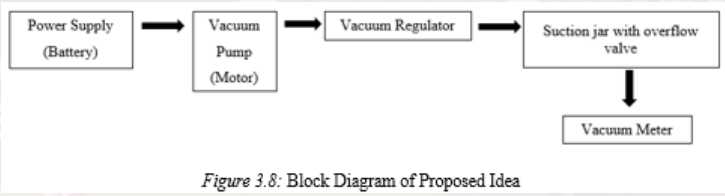

Figure 3.8: Block Diagram of Proposed Idea

Figure 3.1 shows block diagram of proposed idea for this study. It consists an electronic component that has been used to make this device workable. Suction machines are outfitted with batteries to ensure that they can provide suction capabilities. Next, the vacuum pump is often located inside of the radiant warmer. This is what causes negative pressure and is necessary for a functioning suction machine. The vacuum regulator controls the pressure by adjusting the rate at which the vacuum pump evacuates the chamber while atmospheric air enters at a constant rate. The disposable canister holds the patient's secretions and often provides overflow protection capabilities in case too much fluid is suctioned out of the patient. Finally, the vacuum meter is a pressure measuring instrument that measures pressure in a vacuum. Test the vacuum level by pinching the suction tubing and watching the vacuum meter. It should rise to the surgical vacuum level (± 2 mm Hg + 8%).

4.0 Result and Analysis

In this chapter, we will look at data collection preparation and results. The findings are gathered when the hardware prototype has been completed. This chapter goes into detail about the findings, including data collecting and analysis. The results are essential for establishing the efficiency of built-in suction on the radiant warmer for user usage.

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4.1 Prototype Connection

The prototype connection of suction unit is shown in Figure 4.0 and Figure 4.1 below.

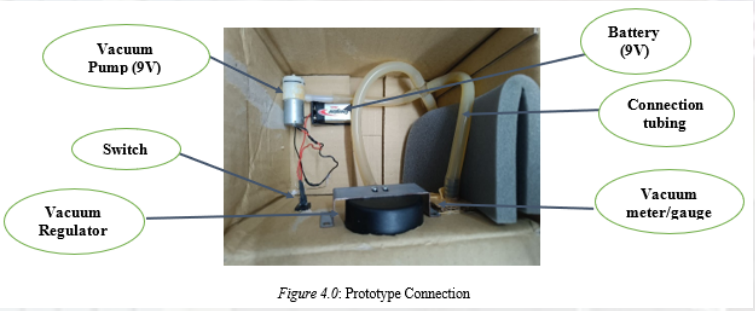

Figure 4.0: Prototype Connection

Figure 4.1: Front view of Prototype Connection

Based on figure 4.0 is a hardware connection of the project. Placed all the components on the cardboard. Made a holes in the cardboard to place the switch, vacuum regulator and vacuum gauge. Connected the tubing from input port of the vacuum pump to the vacuum regulator, vacuum meter and collection canister using T-connector. The positive poles of 9V battery connected to the one side of switch. The negative poles of battery connected to the negatives poles of vacuum pump. The other side switch connected to the positive poles of vacuum pump. Finally, arranged all the components in the cardboard correctly and neatly based on figure 4.0 and figure 4.1.

4.2 Result Display

In this subtopic will be shown the result display in vacuum meter/gauge through the pressure gauge after the suction machine switch on.

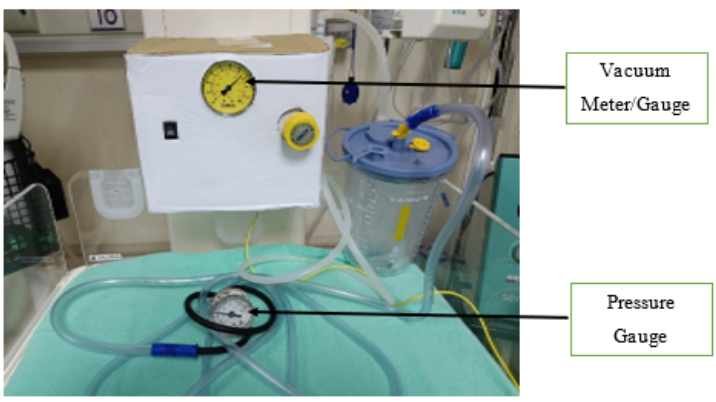

Figure 4.2: Result Displayed

Based on Figure 4.2 shows the result displayed on vacuum meter/gauge. Once switch on the suction machine, the vacuum pump start to run according to the pressure that set which is 250mmhg. Connected the pressure gauge to the patient tubing to check the accuracy of the pressure that delivered by the suction pump. From the figure 4.2 the pressure gauge shows 10 inch of mercury (inHg) value. Express pressure from inch of mercury (inhg) to millimetre of mercury (mmHg). The formula to express pressure is multiply the pressure value by 25.4 mmHg where 1inHg = 25.4mmHg. The value of 10 inHg multiply by 25.4 is equal to 250.4 mmHg which it has ±5 tolerance. From here, we can concluded the amount of fluid that sucks by the suction pump achieve the targeted value and accurate.

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5.0 Conclusion and Recommendation

In conclusion, the objective of this project is achieved. Based on the first objective for this project, it can be concluded that adding suction unit to removes obstruction-causing fluids from the nasal and buccal cavities has been designed successfully. The project prototype has been developed successfully by improvised the radiant warmer by adding suction unit. It helps the user to do procedure easily in comfortable zone. Furthermore, the built-in suction unit also achieved the level of performance required by the clinician.

In the future, the ideal patient safety device will passively increase safety while the physician does the surgery, removing as many clinician variables as feasible. The clinician's activity to occlude the system to establish maximum pressure has traditionally been necessary for the best safety of controlled vacuum pressure. We suggest enhancing this suction device by including an intermittent suction unit (ISU), which automatically closes the system when the doctor changes the pressure level. By eliminating the clinician variable and preventing unwanted, uncontrolled pressure spikes during suction operations, this produces an efficient, passive safety mechanism. The "push to set" option gives the practitioner the assurance that the patient won't be exposed to pressure that is more than what has been set on the regulator. Any vacuum regulator's quick adjustment to full vacuum mode when an emergency arises and a speedy evacuation is required is another crucial safety feature. With only two turns of the knob on the vacuum regulator, the clinician may reach full vacuum when necessary and manage vacuum levels more accurately in the clinical range of 0-200 mm Hg thanks to the dual-spring construction of the regulating module housed within the vacuum regulator. The radiant warmer machine may be equipped with a flow indicator for air.

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CMET (CENTRE for MEDICAL ELECTRONIC TECHNOLOGY)

Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA) is one of the three polytechnics conferred with the status of Premier Polytechnic. One of the major KPI for Premier Polytechnic is setting up Centre of Excellence in Technology (CoT) based on each respective niche areas as identified by Ministry of Education, Malaysia. Also in line with the agenda of transformation for polytechnic, PSA has taken the initiative to develop the CoT in the field of medical electronics, also known as Centre for Medical Electronic Technology (CMET). Three development plan of CMET are: establish an accredited biomedical calibration laboratory , research and development and training centre for teaching and learning in the field of medical electronics.

BIOMEDICAL CALIBRATION SERVICES

FOR TESTER / SIMULATOR & ANALYZER

New and upgraded biomedical equipment are constantly being introduced in the healthcare industry to meet increasing demand for better healthcare services. These equipment require proper maintenance and calibration to deliver standard and optimum level of performance. Center for Medical Electronic Technology (CMET) - Biomedical Calibration Lab (BMCL) collaborates with SST to provide biomedical calibration services for Medical Equipment analyzers. BMCL obtained accreditation under Malaysia Laboratory Accreditation Scheme for calibration, MS ISO/IEC17025 awarded by Department of Standards Malaysia. It is our promise to provide calibration services with the highest level of accuracy and reliability possible.

CALIBRATION CAPABILITIES

- Patient Simulator
- Infusion Pump Analyzer
- Defibrillator Analyzer
- Ultrasound Wattmeter
- Non-invasive Blood Pressure (NIBP) Analyzer
- Electrical Safety Analyzer
- Pulse Oximetry Analyzer
- Electrosurgical Analyzer
- Gas Flow Analyzer

ADVERTISING BOARD

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ABOUT US

The Centre for Medical Electronic Technology (CMET) was established in 2010 as the Centre of Technology (COT) under Premier Polytecnic flagship CMET serves as a hub for references, research and innovation as well as a nexus for national and international colaboration specialized in medical electronics. The formation of CMET is one of the iniatives of Polytechnic Transformation Plan (2010-2015) to strengthen and restore public confidence in the polytechnic TVET education system CMET was recognized as the first ISO/IEC 17025 accredited biomedical calibration laboratory in Southest Asia in 2014.

CMET
CENTRE for MEDICAL ELECTRONIC TECHNOLOGY
Feel the Quality.You're Worth it

Advanced Equipment With Qualified Professional

GET IN TOUCH WITH US

Centre for Medical Electronic Technology (CMET), Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan, Seksyen U1, 40150 Shah Alam, Selangor Darul Ehsan

CMET
CENTRE for MEDICAL ELECTRONIC TECHNOLOGY
Feel the Quality.You're Worth it

Why Choose Us

- MS ISO/IEC 17025 accredited
- Calibration within 5 days turn around time
- Competitive price
- Priority service offered and details available upon customer request
- Provide quality services
- Experience and Qualified Professional

Contact

https://psa.mypolycc.edu.my

cmetcalab@psa.edu.my

03-51634199 (Training)
03-51634144 (Calibration & Maintenance)

MEDICAL

ANALYSER CALIBRATION EQUIPMENT MAINTENANCE AND TRAINING SERVICES

We Offer Quality Services

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BIOMEDICAL EQUIPMENT MAINTENANCE AND SAFETY TRAINING FOR DEFIBRILLATOR, ELECTROSURGICAL UNIT (ESU) & PULSE OXIMETER

Date : 6th - 8th May 2024
(Monday to Wednesday)
8:00 am - 5:00pm

CMET Training Room,
Politeknik Sultan Salahuddin Abdul Aziz Shah, Shah Alam

Minimum
Participant: 7 pax
Maximum
Participant: 10 pax

Objectives

At the end of the training the participant will able to :

- Describe the operation principles of biomedical equipment.
- Understand the operation principles of biomedical equipment with reference to human physiology.
- Assess possible hazards associated with the use and maintenance of biomedical equipment
- Perform electrical safety test to verify the safe use of medical equipment.
- Perform routine maintenance and performance testing on medical equipment

Introduction

This training aimed at new entrants to the healthcare sector who will be involved in maintaining biomedical equipment

Aim

The training is to provide participants with a good undestanding of biomedical principles, applications and maintenance procedures

Prerequisites

The prerequisite for this course is that candidates should have as a minimum a diploma in an engineering discipline preferably Electrical or Electronic Engineering or equivalent work experience

Mdm. Wee Soo Lee
Medical Electronic Lecturer

Mdm. Fariza
Medical Electronic Lecturer

Ms. Fatin Affiqah
Medical Electronic Lecturer

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