Utilizing Load Cell Sensor Technology for the Hanging Scales as a Detector of Infusion Fluids Volume as a Prevention to Embolism in Patients

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Abstract — Infusion as one of vital factors which is used to support health has become an integral component for health care providers. In addition to the infusion mostly used by patients, health care providers, such as hospitals, have to work effectively to optimize the distribution of it to the patient. However, the number of infusion must be distributed to all the patients in turn are not comparable with the capabilities and the number of medical personnel to effectively distribute. The impact to this is that many patients who is hospitalized will be suffering from emboli, the worst case is failing of vital organs function and death. This paper will describe the explanation of the creation of hanging scales named Nurse Warning Notification (WARNET) which can detect the volume of IV fluids and give a signal to the patient and the nurse when the bag is almost empty. This tool uses three essential components, namely load cell as the pressure sensors, HX711 which acts as stress risers for the load cell, as well as the Arduino Uno as intermediaries to apply the program. The three main components are assembled into a hanging scales to which infusion fluid can be hung and later will forward a signal which can be heard and seen by the patient and of course the nurse. In brief, WARNET can act as an important factor in reducing the likelihood of embolism in patients and increase the effectiveness of the performance of nurses in a health-care provider.

Keywords — health, infusion, sensor, weight, load cell
I. INTRODUCTION

Nowadays, hospitals in Indonesia are expected not only to be able accommodate their patients and provide care to them, but they also have to provide service as quick and as efficient as possible considering the number of medical personnel available are not always comparable to the patients accommodated. So, it's fair if the two-way communication between the patient and medical personnel in hospitals often inarticulate quickly even for the purposes of the fundamental needs of patients who, if not responded to in a swift, can lead to fatal; one of them in the case of substitution infusion.

Many people do not realize that the intravenous fluid replacement is crucial for patients who are undergoing hospitalization. Infusion which serves to balance fluids in the body is used by almost all patients who are hospitalized. So, if the average a patient to replace infusion bottle is twice a day, the frequency of the nurses who have to replace the Intravenous bottle in a day in a hospital which has to treat hundreds of patient will be really high. From this phenomenon, we can conclude that it is not impossible if some patients often do not get a quick response or do not even notice if the IV fluid is running low. As a result, this incident can lead cases such as embolism to happen. Embolism is a condition when air enters the blood vessel. When a patient is experiencing embolism, panic usually begins to occur and only call the nurse when it has happened. One of the worst cases, if embolism occurs at night while the patient is asleep, it might lead to death because there is air that enters into the blood vessels and can be distributed to the heart and brain.

Until now, there is no best solution to minimize the occurrence of emboli in patients at the hospital. The patient still have to manually check for the availability of intravenous fluids or the nurses themselves must go to patients’ room to control the replacement of the infusion bottle. In this case, a preventive action or a device that can monitor the availability of intravenous fluids and give a good reminder to the patient concerned and to the nurses when that infusion was about to run out are crucially required.

This project targets health-care providers as WARNET has utility as follows:

1. It detects the volume of infusion fluids.
2. It converts the remaining substance of infusion fluids by transferring sensors to signal.
3. It transforms these signals into alarm.
II. LITERATURE REVIEW

Infusion aims to balance fluids in the body, the infusion is different depending on the indication of the patient. Infusion is conducted through vein or blood vessel in which the liquid will flow to follow the blood circulation to the designated places [1]. Intravenous fluids may drip because of the pressure inside infusion fluids bag. The infusion fluid is connected to the Intravenous line serves to drain the fluid infusion. The infusion fluids is hung with a specific position which should be higher than the transfixion. It aims that the infusion fluid can flow smoothly.

III. METHODOLOGY

- **Load cell Sensor**

  A Load cell Sensor is an electrical device testing tool that can convert energy into another form of energy and is commonly used to convert energy into an electrical signal. The change from one system to another does not directly occur in two phases, but has to go through the stages of mechanical arrangement so that the energy can undergo a change of its condition in the strain gauge (load cell) or commonly called the deformation strain gauge. Strain gauge measures changes in the strain that affects and acts as a signal of a significant change which occurs in the load electric wire barriers. A cell / load slot generally consists of four aspects of strain gauges in a Wheatstone Bridge configuration system [2]. Cells / slot load originate from one strain gauge or two strain gauges. The output of electrical signal usually provides few millivolts and requires amplification by an instrumentation amplifier before it can be used.

  A Load cell Sensor may have a cable with four or six cables. A Load cell Sensor with six cables, besides having positive and negative signal it also has positive and negative voltages. Load cell Sensor also have a sense of positive and negative sense. These strips of sense will be connected to the sense path indicator. The lines of the cables will indicate the voltage on Load cell sensor. Sometimes there is a voltage drop between the indicator and Load cell sensor. The rising sense provides information or feedback back to the indicator. The indicator will adjust its voltage to replace the voltage which it lost or the amplifier voltage signal back to replace the loss of power for the Load cell Sensor. Color codes on the Load cell Sensor will connect automatically. Datasheet Load cell Sensor which is in the form of datasheet in the Load cell Sensor contains a color code on the Load cell Sensor.

  Each Load cell Sensor is equipped with a data sheet or a calibration certificate. This sheet provides relevant data about the Load cell Sensor. Data sheet is adapted to the Load cell Sensor with the model number, serial number, and capacity. Other information found on a typical calibration data sheet is output which is written in mV / V as the unit, the excitation voltage, non-linearity, hysteresis, zero, input resistance, output resistance, the effect of temperature for the output, insulation resistance, and the cable length. Cable color code is also included for the calibration data sheet.

  The process of making hardware consists of a pressure sensor, Load cell Sensor and HX711 (module scales), which has a working principle to convert a measurable change in the resistance change
and convert them into the amount of voltage through the existing circuit. The module communicates with the computer / microcontroller via TTL232 with ATMega based minimum system 328P as the controller.

Arduino Uno microcontroller is also made during this software making. Whereas, the application uses Arduino Uno with interface C # with visual studio.

Given that WARNET aims to prevent embolism in patients, here are some explanations of aspects of health:

Air embolism is a condition where there are bubbles of air that enter the blood vessel and causes a blockage of blood flow. When air enters the blood vessel, the air will flow with the blood to the brain, heart, lungs, and other organs which is passed through by the blood, it can cause some serious illnesses.

The process of giving or adding fluid through the infusion should be done very carefully to prevent the presence air. Before the injection of the needle is done, the nurse or anyone responsible should remove the air in the infusion fluid.

IV. RESULTS

We completed the process of making WARNET in approximately 2 months, in accordance with our timetable – even faster than our initial set target which was 5 months of work. As of present, we have
completed the WARNET device that will be mounted on an intravenous pole wherever the intravenous bag to be hanged under that instrument. Other than that, we have as well finished the WARNET application to be the operated along with the device by the authorized medical workers in the control room.

The WARNET application will be installed in computer or laptop, in which the medical workers are required to enter the username and password that have been determined, thus the application cannot be accessed by just any party. Once logged in, we will find patients’ data such as name, gender, date of birth and the disease being suffered as well as the remaining volume of intravenous fluid in each patient room. There will also be an indicator bar that reflects the volume of infusion in each patient room. When the infusion volume decreases, the indicator bar in the application will be decreased, and a round-shaped LED will automatically turn into yellow whenever the volume of intravenous fluid is decreasing low. Further, the LED will turn red by the time the volume of the infusion fluid reaches a certain minimum or critical point that we have decided before. As the result, our WARNET instrument could help medical workers in tracking the volume of infusion fluid as indicated by the changing colours of the LED in the application as well as the stated remaining volume of the infusion fluid.

V. DISCUSSION & CONCLUSION

DISCUSSION

Arduino Uno, Ethernet shield, and the HX711 amplifier module are assembled using a breadboard and jumper cables. Ethernet arduino shield serves to connect to the server, so that data on Arduino can be accessed on a local database and online databases via a computer server, while the HX711 amplifier module serves as a sensor load cell amplifier so that the output value can be read on Arduino Uno. Once assembled, Arduino Uno will be connected by using a USB cable ISP. Thereafter, open the application of arduino IRE to programe the arduino.

Then, the first next thing to do is to create a program for calibration of the sensor load cell; of which the pure weight is 1000 grams, for comparison after a gain calibration value or its value is 0 [3]. Load cell creates programs that arduino can display the weight value with precision. Furthermore, the program is made to connect the arduino to the LAN network that can be accessed via a computer database server or website online. Connect the Ethernet shield using UTP cable or LAN, then create a local database and online database after the program is completed the data from the sensor load cell can be accessed by calling the shield arduino Ethernet IP address in a web browser.

a. Flow Diagram of Product Creation Process

![Flow Diagram of Product Creation Process](image_url)
b. Flow Diagram WARNET’s Circuit Making Process

- Design the LayOut Arduino Shield PCB using EAGLE software
- Print design LayOut Arduino Shield PCB to PCB
- Installing and soldering components
- Assembling Arduino Shield, Ethernet Shield and Arduino UNO

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c. Flow Diagram of WARNET Program and Application Creation Process

- Arduino connects to the PC using a USB cable.
- Make software program using the Arduino IDE WARNET
- Make WARNET on Application Programming Arduino
- Make a Load cell Sensor Reading Program
- Make Program for Calibration Load cell Sensor.
- Connecting Ethernet Shield using a LAN cable
- Make Application Program Interface WARNET using Visual Studio software
- Make local database to store patient data connected with the application WARNET

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d. Flow Diagram of the WARNET’s Packaging Process

- Design the Packing WARNET using Corel Draw software
- Print design packing with acrylic using laser cutting
- Installing the hook on the load cell sensor
- Installing 2 hooks on the top of the packing WARNET
- Installing a series of WARNET to packing WARNET.

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e. Flow Diagram of WARNET’s Calibration Process

- Pair the WARNET in Intravenous stand
- Run the load cell sensor calibration program in Arduino IRE
- Hang the pure weight of 100 grams
- Enter value of calibration results to program the load cell sensor readings in Arduino IRE
- Re-run the load cell sensor calibration program in Arduino IRE
f. **Flow Diagram WARNET’s Testing Process**

- Pair WARNET in Intravenous stand
- Pair infusion in WARNET
- Open Applications WARNET
- Login on the application WARNET

**CONCLUSION**

Form the project that we have been working on, we see that WARNET could be a significant help for medical environment. By substituting the role of medical workers in the manual checking procedure of infusion fluid volume, we are expecting this invention to be a more efficient alternative for the medical staff – especially in regards to embolism occurrence that has been our concern in the manual procedure. Not only that this invention may bring great contribution to medical world, we truly hope that WARNET could also be such a motivation for students and/or anyone to create such innovation in any kind of sectors especially technology, science, and medic. Last but not least, highly expected is that many potential parties would be willing to cooperate with us on this invention for the greater good of technology, scientific, and medical purposes.

**VI. REFERENCES**


