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Shaking and Weight of the Blood Bag

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Annotation: The blood bag shaking machine is an important device in blood donation process. Usually, when the blood flows out of the body, it is clotted. Thus, it is necessary to shake the blood in the bag with anti-clot solution and many factors which affect blood quality. The shaking machine for blood donation process is imported and expensive. This paper presents the design of a shaking machine for shaking the blood bag and volume estimation without sensor. The amount of blood in the bag is related to load torque on the vibration motor . The volume of the blood bag increases in blood donation process until the desired volume, which the current increases too. The current and load torque can be used to estimate volume of the blood bag and blood flow rate at the same time via the principles of closedloop speed control system, observer and adaptive compensator.

Aim of the work

- A device that vibrates and weighs the blood bag at the same time and prevents blood from clotting and damage
- there are not enough employees who provide service by incessantly shaking the mixture of blood and solution. As blood bag shaking machines which must be imported from aboard are very expensive, the blood donation site has limited machines to adequately use for service.

1.1 Introduction

Criteria for blood donor selection, only individuals in good health should be accepted as blood donors. Good health is difficult to define, but certain associated parameters may be established from a brief medical history, observation and simple tests. Staff undertaking donor health and risk assessment should be well-trained in the observation of donor appearance and detection of signs of ill health. Staff should receive explicit guidance on what to look for and when to refer a donor to a health-care professional for further medical attention. Weight of donor is important to set weight limits for blood donation to protect donors from adverse effects, in particular vasovagal episodes and anemia. Low body weight and low blood volume have been shown to be independent predictors for vasovagal reactions. In determining a lower weight limit for blood donors, the blood transfusion services (BTS) should consider norms for the weight of the population; if a significant proportion of the donor population weighs less than 45 kg or 50 kg, collection volumes may be reduced accordingly, while ensuring that blood collection bags and their anticoagulant content are adjusted to be compatible with the volumes collected prospective donors of whole blood donations should weigh at least 45 kg to donate 350 ml %10± and 50 kg to donate 450 ml ± %10. In assessing whether pulse, temperature or blood pressure (BP) should be measured routinely, selectively or not at all at the time of blood donation, the BTS should consider:

- Clinical value of these parameters in the blood donation setting (refers weight of donor)
- Availability of adequate equipment (calibrated and sterile, where appropriate), space and time. If blood pressure is used as a selection criterion for blood donation, arbitrary acceptable limits of systolic BP of 100–140 mmHg and arbitrary acceptable limits of diastolic BP of 60–90 mmHg are suggested.
- Competence and experience of staff and their ability to perform techniques correctly. Moreover, if the blood components , there are 3 types of blood donation you can make 1- whole blood donation 2- plasma donation 3- platelet donation

Blood banks store freshly donated blood for up to six weeks before it is considered outdated and thrown away. But some recent studies suggest that people who receive transfusions of blood older than two or three weeks may suffer adverse effects. Some patients received transfusions with packed red blood cells that had been donated at least 29 days earlier well within the allowable shelf life. Others received fresher red blood cells, stored 28 days or less. Patients who received "older" blood were three times as likely to have suffered infections of the bloodstream, respiratory system, heart valves and other organs. Furthermore, there are still many factors which affect blood quality and also burden employees with hard work. At present, for blood donation either in places or outside places, there are not enough employees who provide service by incessantly shaking the mixture of blood and solution. As blood bag shaking machines which must be imported from aboard are very expensive, the blood donation site has limited machines to adequately use for service.

This article has presented the process of torque estimation and that of electricity affecting vibration motor. When the volume of blood bag changes by using the process of adaptive compensator to estimate load torque with adaptive observer which is built according to the principle of Gradient Method working under the scope of stable system which provides a range of information including the volume of blood bag varying with time without any additional sensor installation.

2.1 Previous studies

2.2 By Punkkhuntod Jaroonsak, et all (2015)

The blood bag shaking machine is an important device in blood donation process. Usually, when the blood flows out of the body, it is clotted. Thus, it is necessary to shake the blood in the bag with anti-clot solution and many factors which affect blood quality. The shaking machine for blood donation process is imported and expensive. This paper presents the design of a shaking machine

for shaking the blood bag and volume estimation without sensor. The amount of blood in the bag is related to load torque on the DC motor. The volume of the blood bag increases in blood donation process until the desired volume, which the current increases too. The current and load torque can be used to estimate volume of the blood bag and blood flow rate at the same time via the principles of closed-loop speed control system, observer and adaptive compensator.

2.3 By R Carmen. (1993)

The procedures used in the preparation of blood components together with the processes used in the manufacture of multiple blood bag systems impose a unique combination of requirements that severely limits the selection of plastics. Plasticized PVC, the plastic used in the first blood bags introduced by Carl Walter over 40 years ago, remains the material of choice today. Blood bag material research has focused on two areas: (1) the development of containers with increased gas permeability for the storage of platelet concentrates; and (2) the reduction or elimination of plasticizer contamination of stored blood components. This research has led to the development of several second-generation containers that have improved the quality and extended the allowable storage period of platelet transfusion products. Plastics virtually free of extractives are available for the storage of platelets and plasma, but elimination of plasticizers from RBC products has not yet been achieved

2.4 By M. Lozano & J. Cid (2013)

The invention of the plastic container represented a major advance in haemother-apy that opened the door to blood component preparation and transfusion. Later, it was found that the plasticizer di-2-ethylhexylphthalate (DEHP) used in combi-nation with polyvinylchloride (PVC), leached to the blood component contained in the plastic bag and that in the case of the red blood cells, stabilized the mem-brane allowing the extension of storage up to 49 days, depending on the additive solution used. This extraction of the plasticizer to the components provokes that not only the recipients of transfusions are exposed to significant levels of Debut also plasma and platelet apheresis donors are exposed. Although clear-cut human toxicity has not been identified, for some the precautionary principle should be evoked and in front of the current available data, particularly in neo-nates and children, only DEHP-free disposable should be used in bags containing blood components for transfusion. For platelets this has already been accomplished for most of the containers and for plasma it should not be a problem to attain it. However, for the most often transfused blood component, red blood cells concentrates, continues to be an unresolved challenge, although in recent years some new plasticizers.

3.1 blood donation

It is a voluntary medical procedure that takes blood or one of its compounds from a healthy person to a sick person who needs blood. This procedure is needed by millions of people every year; It is used during surgery, accidents, or some diseases that require transfusion of some blood components.

3.2 CRITERIA FOR SELECTION OF DONORS

Following guidelines should be observed in order to determine that the blood donation will not be detrimental to the donors/recipients.

1- Physical Examination

A medical officer should certify the donor fit for blood donation.

2- General Appearance

The prospective donor should appear to be in good health.

3- Age

Donors should be between the age of 18 and 65 years.

4- Weight

Blood collection from donors weighing 45-55 Kg should be 350 ml blood and from those weighing

55 Kg and above should be 450 ml.

5- Blood Pressure

The systolic blood pressure should be between 100 and 160 mm of mercury and the diastolic pressure should be between 60-90 mm of mercury.

6- Temperature

Temperature should not exceed 37.5°C/ 99.5°F

7- Pulse

Pulse should be between 60 to 100 beats per minute and regular.

Examination of respiratory system, cardiovascular system and abdomen should be carried out it necessary.

3.3 Blood

Blood cells are made in the bone marrow (1). The bone marrow is the spongy material in the center of the bones that makes all types of blood cells (2). There are other organs and systems in our bodies that help regulate blood cells. The lymph nodes, spleen, and liver help regulate the production, destruction, and function of cells(3). The production and development of new cells in the bone marrow is a process called hematopoiesis(4).

Blood cells formed in the bone marrow start out as stem cells. A stem cell (or hematopoietic stem cell) is the first phase of all blood cells. As the stem cell matures, several distinct cells evolve (5). These include red blood cells, white blood cells, and platelets. Immature blood cells are also called blasts. Some blasts stay in the marrow to mature (6).

Others travel to other parts of the body to develop into mature, functioning blood cells. The main job of red blood cells, or erythrocytes, is to carry oxygen from the lungs to the body tissues and carbon dioxide as a waste product, away from the tissues and back to the lungs (7).

Hemoglobin (Hgb) is an important protein in the red blood cells that carries oxygen from the lungs to all parts of our body (8). The main job of white blood cells, or leukocytes, is to fight infection.

There are several types of white blood cells, and each has its own role in fighting bacterial, viral, fungal, and parasitic infections (9).

The main job of platelets, or thrombocytes, is blood clotting. Platelets are much smaller in size than the other blood cells (10. They group together to form clumps, or a plug, in the hole of a vessel to stop bleeding. Some blood products are manufactured from non-human components using genetic engineering (11). These are called recombinant products and are alternatives to some fractionated plasma products. Recombinant clotting factors are increasingly used in place of plasmaderived clotting products to treat people with haemophilia (12)

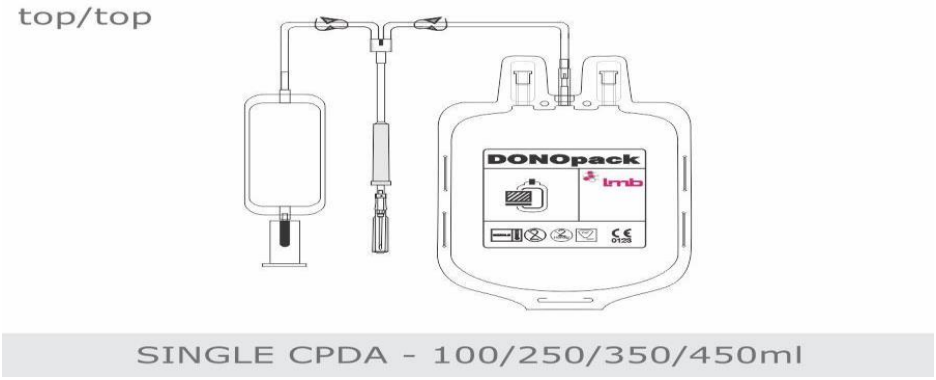
3.4 Blood bag

First invented by Dr.Carl Waldemar Walter. Dr Walter was a surgeon, inventor, and professor at Harvard Medical School (13). Walter has been called "a pioneer in the transfusion and storage of blood" He is also credited with founding one of the world first blood banks and invention of the first blood collection bag. Blood bags are designed for the collection, processing and storage of whole blood and blood components (14). They help in providing aseptic conditions for the separation of blood components. It acts as a closed system reducing the chances of contamination. Blood bags are made with high molecular weight PVC to ensure better tensile strength and weld strength (15). Validated sterilization process is used. The process is monitored automatically with a data logger which confirms the product sterility (15). Triple filtration of anticoagulant is done and is filled in the bags automatically to ensure accuracy (16). Advanced and standardized coiling method is used to prevent kinks, which ensures a free flow during collection and separation (17).

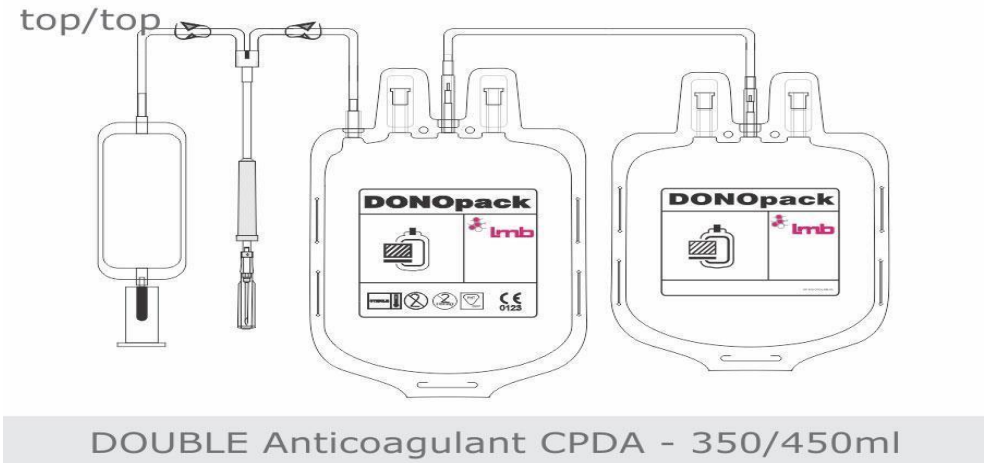
3.5 Types of blood bag

AdvaCare manufactures four types of Blood Transfusion Bags in the AccuPoint range (18):

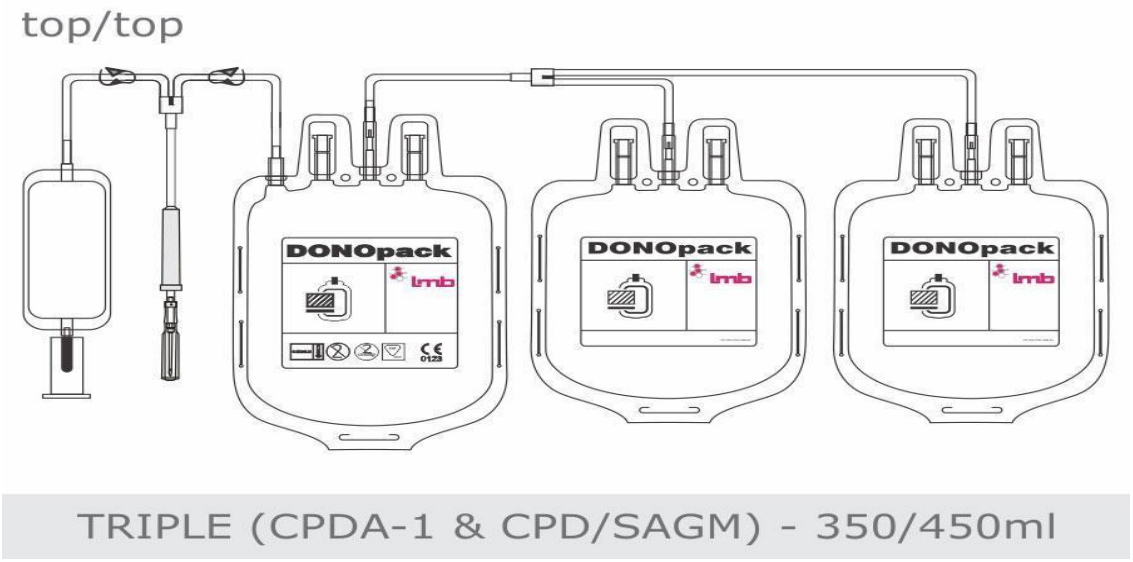
1. **Single Blood Bag:** used for collection, preservation, and transfusion of human blood.



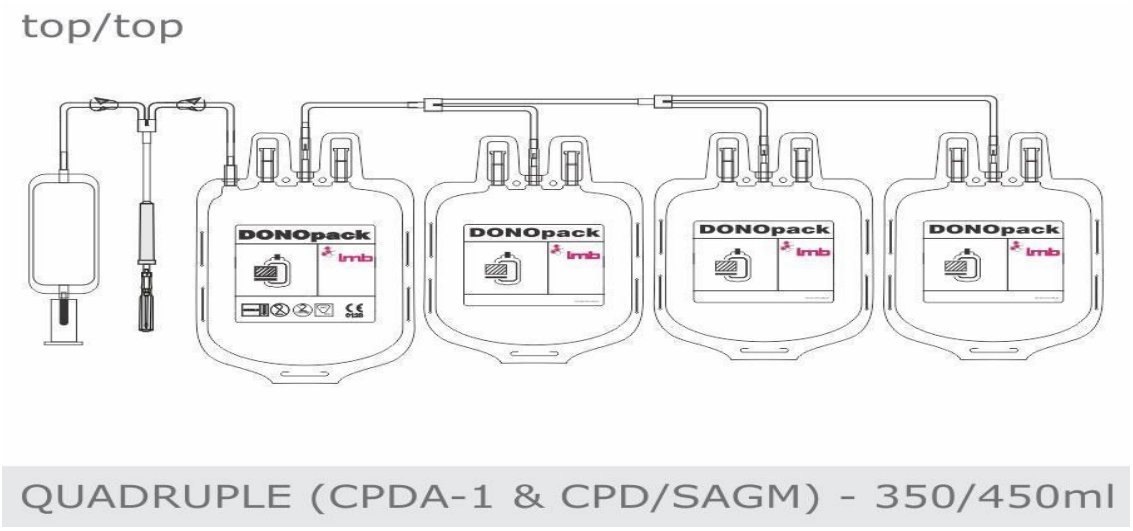
2. **Double Blood Bag:** separates red blood cells and plasma. It includes a primary bag and a satellite bag.



3. **Triple Blood Bag**: this system separates red blood cells, plasma and buffy coat (includes leucocytes and platelets). It is made of a primary bag and two satellite bags.



4. **Quadruple Blood Bag:** separates red blood cells, plasma, buffy coat (poor platelet) and platelets. AdvaCare blood bags are manufactured using high-quality materials and preservatives and are available in different volumes



3.6 Method of drawing blood from donors

- ✓ Open the outer wrap at the tear nicks and take off one blood bag system.
- ✓ Apply the blood pressure cuff on the donor's arm, identify injection site and release the cuff.
- ✓ Disinfect the injection site. Cover the area with sterilized gauze.
- ✓ Hang the tube onto patient's wrist in order to not compress the needle.
- ✓ Apply the needle immediately.
- ✓ Tie the needle to the patient's arm.
- ✓ Make sure there is continuous blood flow. If so, the blood collection is expected to be completed in around 12 minutes.
- ✓ Collect the quantity of blood following the instructions indicated on the bag label. Monitor the blood being drawn; • After blood collection is over, collect the blood needed and stop the collection by fastening the blood collection tube.

- ✓ Untie the lace or deflate the blood pressure cuff.
- ✓ When the procedure is done, hold the hub with one hand to remove the needle while holding the sterile gauze with the other hand. Pull the hub without exerting too much pressure. Let the patient keep sterilized gauze on the injection site.
- ✓ Hold the needle with one hand to keep the tip in the upper position and wait for the blood to flow off through the tube. • Clamp the bag tube.
- ✓ Make sure all the patient information required are written on the label of the blood transfusion bag.

3.7 The shelf life of blood

Blood bags have a specified shelf life depending on the anti-clotting substance in the bag as follows :-

1. Blood bags containing clot blocker (CPDA1) are valid for 35 days from the date of donation
2. Blood bags containing clot blocker (SAGM) are valid for 42 days from the date of donation

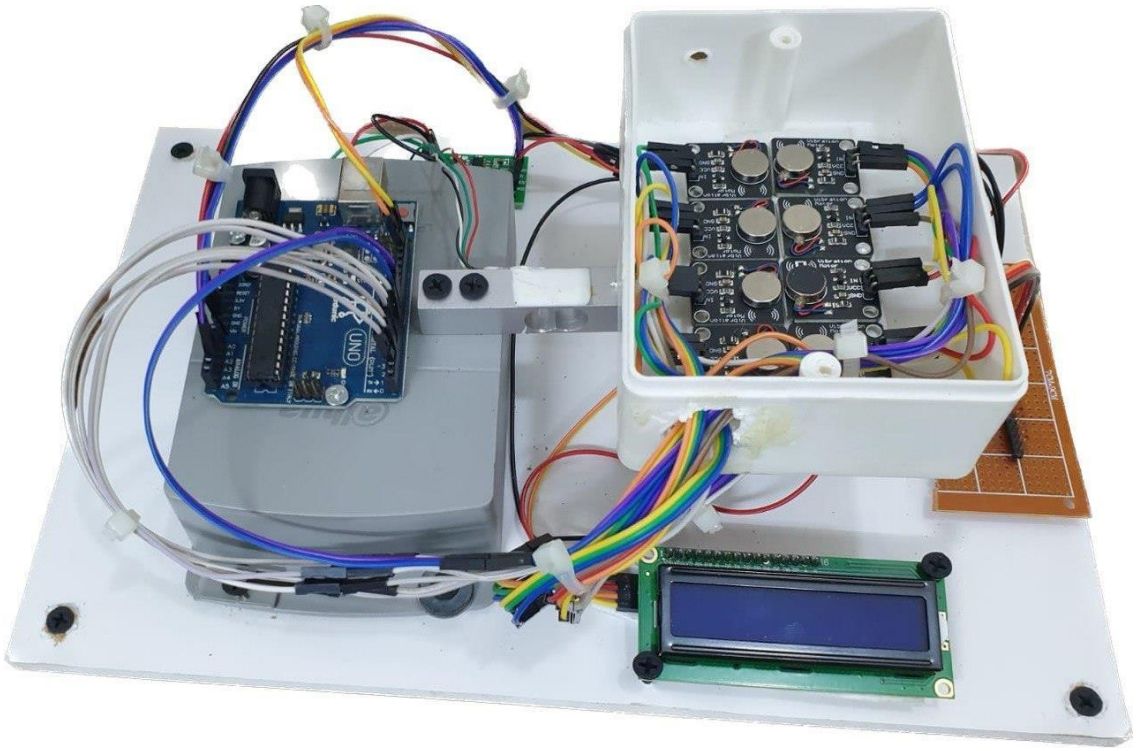
The rest of the blood ingredients are valid as follows:

Platelets: validity 5 days from donation day

Fresh frozen plasma: validity one year from donation day

4.1 Shaking and weight of blood bag

The blood bag shaking machine is an important device in blood donation process(19). Usually, when the blood flows out of the body, it is clotted. Thus, it is necessary to shake the blood in the bag with anti-clot solution and many factors which affect blood quality (20) There is an anticoagulant in the blood bag, which keeps the blood from clotting; it MUST be clear of clots (21). As the blood slowly enters the bag, the bag is ‘rocked’ so that there is immediate blending of the blood and anticoagulant; it MUST be well mixed (22). When the pint of blood is put into the special ‘blood bank refrigerator’, it is in the upright position. It will then ‘settle’; the Rbc’s (red blood cells) contain iron, and go down to the bottom. The lighter plasma is above it. Sitting on top of the RBC’s is a thin white line of platelets and white blood cells. When a pint of blood is called for, it is removed from the refrigerator, and gently inverted to mix, returning the blood to it’s ‘whole blood’ state (23). The blood and anticoagulant should be mixed gently and periodically (at least every 60 seconds) during collection. Mixing should be achieved by manual inversion of the blood pack, or automatically by placing the blood pack on a mechanical agitator or by using a rocking device (24). The volume of blood withdrawn must be controlled to protect the donor from excessive loss of blood and to maintain the correct proportion of anticoagulant to blood (25) . The most efficient way of measuring the blood volume in plastic bags is by weight. The mean weight of 1 mL of blood is 1.06 g, and therefore, for example, a unit containing 470 mL of blood should weigh 470 × 1.06 g plus the weight of the pack(s) and the anticoagulant (26). If it is not possible to adjust the weighing device in use for the tare weight of the container and anticoagulant solution it is advisable to record the minimum and maximum weight for the brand of pack in use as products from different manufacturers may vary considerably (27). Several kinds of weighing equipment are available and such devices should be used according to the manufacturer’s instructions for weighing blood into its plastic pack and periodically calibrated by appropriate techniques (28). An anticoagulant must be used and added to the bag. It is injected into the bag through the "Y"site injection point. A standard dose is 15ml of anticoagulant for every 100 ml of wholeblood. The entire length of tubing going to the donor must be coated with anticoagulant. This will help to greatly reduce clot formation. (29,30) The anticoagulant in the bag should be positioned so that the blood flows into it



4.2 Experimental part

In this project we design shaking and weight of the blood bag by using :

1. Microcontroller (Arduino UNO)
2. weight sensor(HX711)
3. LCD (16*2)
4. vibration motor(no.8)
5. wires

1. **microcontroller (Arduino uno) :-** Arduino Uno is a microcontroller board based on the microcontroller. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. The Uno board is the most popular board in the Arduino family and is the reference model for the Arduino platform. It offers a wide range of features and is used in a variety of projects and applications.

2. **weight sensor(HX711):-** The HX711 is a precision 24-bit analog-todigital converter (ADC) designed for weigh scales and industrial control applications. It provides two differential input channels for signal amplification, and a programmable gain amplifier (PGA) with gains up to 128. The HX711 communicates with your microcontroller through a serial interface, and can be powered by a single 2.7V to 5V power supply. The

HX711 is commonly used in weigh scale applications, where it can measure the output of a load cell and convert it into a digital value that can be read by a microcontroller. To use the HX711,

you will need to connect it to your load cell and microcontroller. There are several libraries available that can simplify the process of interfacing with the HX711, such as the HX711 library for Arduino. This library provides an easy-to-use interface for reading data from the HX711, allowing you to quickly integrate it into your project. Overall, the HX711 is a reliable and accurate weigh scale ADC that can be used in a wide range of applications

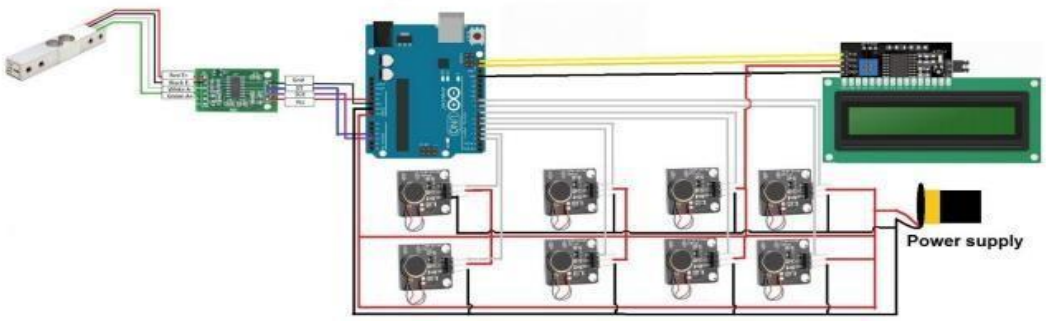
3. **LCD (16*2) :-** LCD 16x2 is a type of alphanumeric display commonly used in electronic projects. It consists of 16 columns and 2 rows of characters, each capable of displaying 16 different characters. To use an LCD 16x2 with a microcontroller, you will need to connect it to the microcontroller pins. The connections typically include power, ground, and several data pins for sending commands and data to the display. You can also use a library to simplify the process of programming the display. The most commonly used library for this purpose is the LiquidCrystal library, which is available for most microcontrollers. Once you have connected the LCD 16x2 to your microcontroller and programmed it, you can display text and other information on the display. This can be useful for displaying sensor readings, status messages,

and other important information in your project.

4. **vibration motor(no.8) :-** This tiny, button-type, vibrating motor shakes with a vibration amplitude of 0.75g and draws approximately 60 mA when 3 V is applied to its leads. The shaftless design keeps this motor small:

4.3 Connecting parts of the device

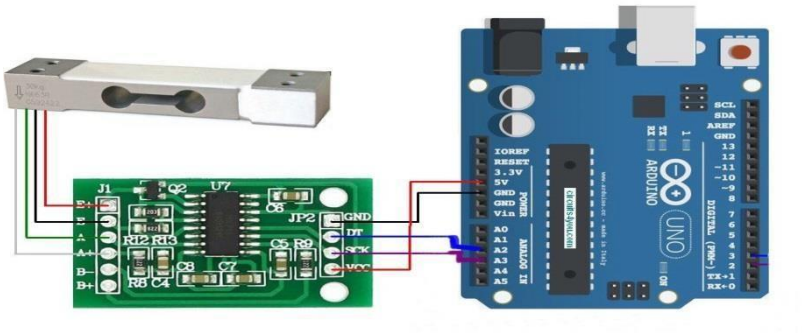
We connected all part together according to Figure below: -



Where :

1. weight sensor: We connecter red wire of sensor to E+ in drive card, black wire of sensor to E- in drive card, white wire of sensor to A- in drive card, green wire to A+ in drive card.

2. drive card of weight sensor:- We connected vcc of card to vcc of power supply or vcc in Arduino also GND connected with GND of Arduino, DT pin of drive card connected to A3 pin in Arduino, SCK pin of drive card to A2 pin in Arduino



3. LCD 16*2: We connected vcc to vcc of power supply and GND to GND of power supply,we connected SDA and SCL of LCD to SDA and SCL pins of Arduino.

4. Vibration motors: - We used 8 number of motors and each motor card consist of three pins Vcc connected to vcc of power supply, GND for each motors also connected to GND of power supply and IN pins for 8 motors connected sequentially to pins Arduino (from pin 2 to pin 9).

4.4 Working principle: -

A load cell is a physical element (also called a transducer) capable of translating pressure or force into an electrical signal. Load cells are used to measure weight and are part of our daily lives. There are load cells everywhere, in our cars, lifts or in the weight measuring machines in supermarkets. They do not attract our attention because they are hidden inside other devices.

There are three ways a load cell is capable of translating a force or pressure into an electronic signal

Hydraulic load cell: As its name suggests, it is a load cell with a hydraulic system consisting of a piston and a cylinder. When a force is exerted on the piston, a fluid is compressed inside the cylinder and this corresponds to a pressure

Pneumatic load cell

In this case, the load cell uses air pressure through a diaphragm. The pressure exerted is measured with a manometer

Strain gauge based load cell: - Finally, the load cell based on strain gauges, which are the ones we are going to use in this tutorial.

A strain gauge is a sensor that changes its resistance depending on the pressure exerted on it due to the piezo resistive effect.

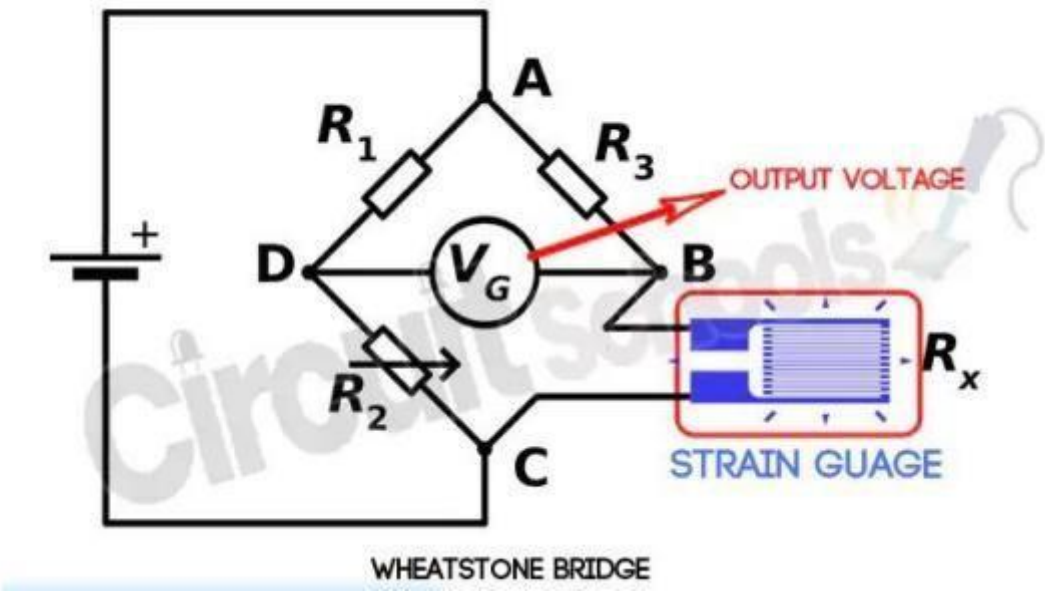
In the case of the strain gauge, the resistance changes due to the pressure, load or deformation of the material.

Basically if you take a strip of conductive metal and stretch it, it will get thinner and longer and the resistance will increase. On the contrary, if the metal strip contracts under a force, the resistance decreases. This strain gauges allows us to relate the force to an electrical signal (a voltage) and therefore we can measure the electrical voltages to calculate the weight. There are different load cells based on strain gauges but they all work more or less

the same. They vary in material, size and mechanical configuration which makes each load cell have different sensitivities, and maximum and minimum measuring capacities.

A strain gauge is made up of a very thin wire or sheet configured in such a way that there is a linear change in electrical resistance when strain is applied in a specific direction. So measuring the resistance of the strain gauge can give weight, but sometimes the resistance changes are really small. For example, if the resistance is 120Ω, the changes that can be produced with a considerable weight is 0.12Ω.

This is a real problem as we would need a device capable of measuring these small changes in resistance or take that small change and amplify it. This is where the Wheatstone bridge comes into play, a very simple circuit that will allow you to detect those small variations in resistance.



WHEATSTONE BRIDGE

From the above circuit knowing the source voltage and measuring the voltage VG , the value of the resistor Rx can be obtained.

In Arduino code if the weight large than 3 gm and less than 100 gm turn on one motor else if the weight large than 200 gm and less than 300 gm turn on two motors else if the weight large than 300 gm and less than 400 gm turn on three motors else if the weight large than 400 gm and less than 500 gm turn on four motors else if the weight large than 500 gm and less than 600 gm turn on five motors else if the weight large than 600 gm and less than 700 gm turn on six motors else if the weight large than 700 gm and less than 800 gm turn on seven motors else if the weight large than 800 gm and less than 5kg turn on eight motors. In all cases the motor turns on 1000 ms and turn off 1000 ms continuously The weight and the vibration level displayed on LCD.

Conclusion

5.1 conclusion

- The blood bag shaking machine is an important device in blood donation process. Usually, when the blood flows out of the body, it is clotted. Thus, it is necessary to shake the blood in the bag with anti-clot solution and many factors which affect blood quality
- Blood bags are used for the reliable collection, separation, storage and transport of blood. Rounded blood bag design prevents blood coagulation and ensures the blood and anticoagulants are properly mixed during separation and transfusion
- From the research background as mentioned above, this research has presented the design, and built the innovation of blood shaking machines by simultaneously weighing and shaking blood using the principles of volume estimation or workload changes of blood tray supporting blood bags related to the volume or weight of blood. Such mentioned workload changes will make changed torque which interfere working sensors - In practice, changed torque cannot be directly measured but it can be estimated
- In Arduino code if the weight large than 3 gm and less than 100 gm turn on one motor else if the weight large than 200 gm and less than 300 gm turn on two motors else if the weight large than 300 gm and less than 400 gm turn on three motors else if the weight large than 400 gm and less than 500 gm turn on four motors else if the weight large than 500 gm and less than 600 gm turn on five motors else if the weight large than 600 gm and less than 700 gm turn on six motors else if the weight large than 700 gm and less than 800 gm turn on seven motors else if the weight large than 800 gm and less than 5kg turn on eight motors In all cases the motor turns on 1000 ms and turn off 1000 ms continuously The weight and the vibration level displayed on LCD.

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