SMART BUBBLE DETECTOR FOR INFUSION PUMP

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BY

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ABSTRACT

We utilized infrared light to create and test an optical imaging framework to distinguish air bubbles, The IR district of the electromagnetic range has both optical and thermic conduct. machine vision frameworks have been exhibited to be an extremely significant choice to effectively play out the acknowledgment procedure, despite the fact that the optical investigation of air pockets has not been define as the principle objective of the exploratory office, anyway recognition of close separations utilizing infrared sensor will be more exactness for distinguishing the air bubble.

Chapter 1: Introduction

When any human become ill whatever the illness is simple or serious we go to hospital, there are some ways to get the medication one of them is by using infusion pump which can be used in houses as well if the patient is not able to go to hospital. In the infusion pump many problems may occur such as air bubble that can lead to blockage in blood that can lead to fatal.

Our project aims to make a system which is able to detect air bubble in the tube of an infusion pump because a small air bubble may block the blood stream and lead to death, the device will stop pumping immediately when a bubble is detected and an alarm will turn on so the nurse can fix it. We will not only design the detector system but also the infusion pump itself. The detector will consist of a transistor and receiver which will detect any difference in the density of the medium between them, and send a signal to stop the motor and turn the alarm on.

FIGURE 1.1 Infusion pump device

Chapter 2: Literature Review

2.1. Fluid therapy

FIGURE1.2: FLUID THERAPY

is the administration of fluids to a patient as a treatment or penetrative measure, 60% of body weight is accounted for total body water.

Fluid therapy is indicated either when there is loses in the body or there is a risk of loss of fluid, influence the choice of fluid and the speed at which it must be managed. If the therapy is performed as a treatment then it is necessary to diagnose and treat the underlying condition.

- Indications:
    1. Hypervolemia.
    2. Hypotension.
    3. Electrolyte, metabolic and acid base disorder.
    4. Decrease oxygen delivery.
    5. Geriatric patient at risk of organ failure.

- Example of infusion pump problems: -
    1. Software problems
    2. Inadequate user interface design
    3. Battery failures
    4. Alarm errors

The imbuement direct neglects to create a capable of being heard alert for basic issues like air bubble that causes impediment.

An air embolism happens when at least one air bubbles enter a vein or corridor and square it. At the point when air bubble enters a vein, it's known as a venous air embolism and when an air bubble enters the corridor it's called a blood vessel air embolism. These air pockets can go to the mind, heart, or lung and causes heart assault, stork, respiratory disappointment.

Specialists utilize hardware that screen aviation route sound, breathing rate, circulatory strain, heart sound to recognize air embolisms amid medical procedures. In the event that the specialists presume that the patient has an air embolism they can play out a ultrasound or CT steam to affirm its quality while likewise recognizing its correct anatomical area in the patient body.

2.2. Treatment for an air embolism

An air embolism happens when air or gas is conceded into the vascular framework; it can happen iatrogenic by means of interventional methods however has likewise been depicted as a confusion from an assortment of conditions.

The physiologic impacts that outcome rely upon the volume of air that has entered the framework. A patient side effect may extend from asymptomatic to cardiovascular crumple and demise, doctors in all strengths ought to know about this as an iatrogenic intricacy

Etiology: air embolism is an uncommon yet conceivably deadly event and may come about because of an assortment of methods and clinical situations, it can happen in either the venous or blood vessel framework relying upon where the air enters the fundamental dissemination, venous air embolism happens when gas enters a venous structure and goes through the correct heart to the aspiratory flow. Conditions for the section of gas into the venous framework are the entrance of veins amid the nearness of negative weight in these vessels; this is most normally connected with focal venous catheterization.

As the potential for negative weight exist in the thoracic vessels because of breath. It can, notwithstanding, happen in numerous clinical situations.

A blood vessel embolism happens when air enters a conduit and goes until the point that it end up caught, for air enter a shut framework an association must happen between the gas and the vessel and a weight angle must exist that empowers stream of the air into the vessel. This isn't just because of negative weight slopes however positive gas insufflations can likewise cause air embolism additionally, a venous air embolism dependably can possibly turn into a blood vessel embolism if an association between the two frameworks exists if a privilege to left weight angle exists, the gas would then be able to go from the venous to the blood vessel course for leave a potential has a patent foramen alveoli which is available in 30% of the overall public, this can bring about air going from the low weight right chamber to the blood vessel framework if a weight inclination happens.

Moreover, air embolism most generally happens with surrounding air however it has likewise been accounted for to happen with an assortment of gasses including helium nitrogen and carbon dioxide.

How would we dispose of them? How would we forestall them? Furthermore, do we have to stress over them in any case? Much of the time I require no less than 50ml of air

to bring about genuine hazard to life, there are a few examinations in which 20ml or less of air quickly implanted into the patient's dissemination has brought about a lethal air embolism. We can't make sure that lone an extensive volume of air in the line causes life danger of air embolism, little measure of air knows as miniaturized scale bubble, can float through the assembly of the heart and dwell in the aspiratory vascular, the issue isn't that they are effectively retained however at whatever point we have substantial quantities of quickly collect they may relate into bigger embolism and present hazard.

- Make beyond any doubt we have made preparations chamber.
- Make beyond any doubt we have made preparations.
- Always close the roller clasp before evolving bayous.
- Don't add air to the IV narrows while infusing added substances.
- Keep the inlet hanging vertically.
- Don't make the inlet squirm.
- Drive out all air from syringe when infusion into line.
- Keep the IV bung shut well in the event that we have an air pocket so

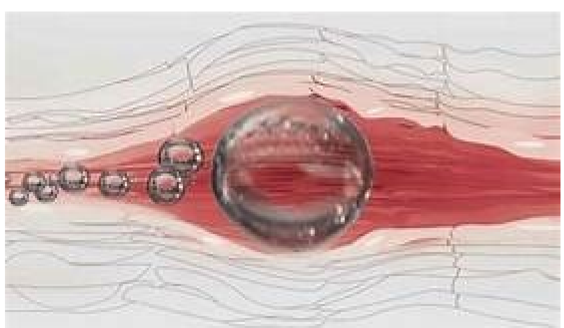

FIGURE2.2: Bubble blockage veins and arteries

There are a several ways to remove air bubbles from IV line

1. Purge

- Stop the mixture. Cinch the line and expel it from the pump.

- Disconnect the line from the patient cannula at that point run enough liquid through to flush out the air pocket.

watch the air pocket chamber to ensure there will be no more rises in the wake of doing this.

- Ensure clean strategy

- Reconnect the IV line to re-build up the mixture

2. Flick and coast

Normally compelling for little air pockets that have set off the IV pump to alert

- stop the implantation. Clasp the line beneath the IV pump.

- Remove the tubing from the pump.

- Holding the IV line, over and over flick the line with your fingernail, coasting it up the line.

- Once the air pocket is close to the highest point of the tubing you can put your pen additionally down the tubing and wrap the line firmly around it, driving the rise into the dribble load.

- Once the air pocket is cleared, delicately unwarp the line from your pen and reconnect to the pump. Proceed with the imbuement

3. Syringe technique

Numerous IV lines have a Y infusion port. By joining a 10 or 20ml syringe to this port you can draw the air rise into it without disconnecting the IV line or expel it from the pump. In any case, you need to guarantee that the IV line is all around braced and you didn't accidently include air from the syringe.

- Stop the imbuement

- Clamp the line simply over the cannula and beneath the Y connector

- Attach the syringe

- Begin the imbuement and draw liquid into the syringe until the point that the air bubble is caught.

- Remove syringe, clasp and recommence mixture

2.3 Types of infusion pump

1.Continous infusion pump: has small pulses of infusion between (20 nl -100ML) the pulses rate depending on the programmed infusion speed

2.Discontinous infusion: has high infusion rate, low programmed infusion ate to keep the channel open, time is programable

3.Total parenteral nutrition: can pump nutrient solution large enough to feed a patient

4.Patient controlled infusion: it is the type for patient controlled analgesia, it must be programmed to avoid toxicities.

2.4 Bubble detection systems

1.Non-invasive Air Bubble Detector

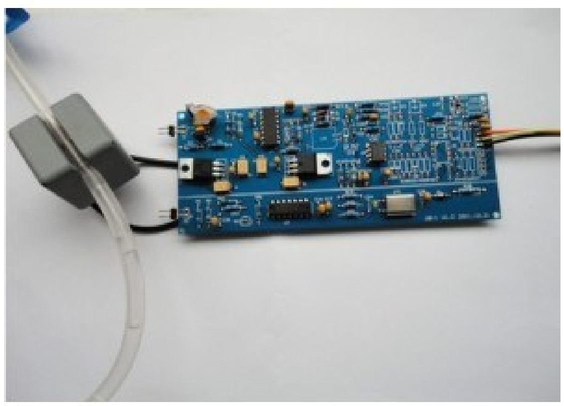

Figure2.4.1: non-invasive air bubble detector

Air bubble identifier is created on ultrasonic brace on innovation and give air bubble recognition in fluid streams of shut pipe, cinch on working way can highlight no weight misfortune, no moving parts, sanitation. Non-intrusive introducing way implies no compelling reason to cut the pipe and can check the rise from outside of tubes and don't contact fluid so it won't contaminate the fluid medium. the rule of air bubble locator is made as ultrasound will have diverse attributes in various proliferation medium and after that by uncommon electric circuit to process and investigation, the air pocket sensors can wisely judge the liquid medium circumstance in the tubes and afterward give related outcome. A normal non-intrusive ultrasonic air-in-line sensor uses a dynamic piezoelectric component as a transmitter to create a high recurrence acoustic wave. This acoustic wave goes through the sensor divider and is coupled to the tubing that is in contact with that divider. The wave at that point goes through the liquid filled tubing to the contrary sensor divider and is gotten by a detached piezoelectric component on the opposite side. The capacity to detect when air is available is because of the extensive acoustic impedance distinction that exists between the tubing divider or liquid and air. This extensive impedance crisscross makes an acoustic mirror which mirrors the ultrasonic wave back toward the transmitter. Since vitality does not come to the get side, the sensor will demonstrate the nearness of air.

2.Air-in-line sensors

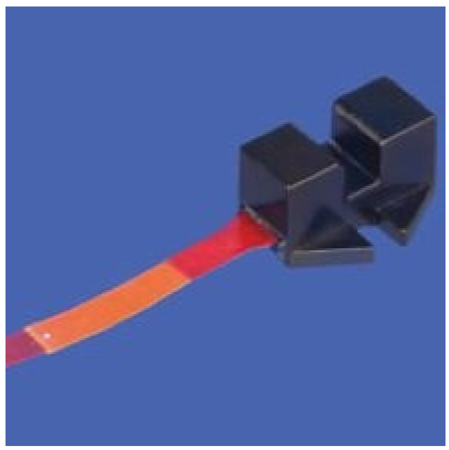

Figure2.4.2: Air-inline-sensor

It supplies a sensor and systems for applications including volumetric infusion pumps, hemodialysis machine, blood collection and component separation instruments. We have a range of air bubble sensors to suit a variety of applications. These sensors will detect the presence of air bubble in flexible tubing for example in infusion lines. All the sensors can be mounted in any orientation and are designed to be dry coupled to flexible tubing. It's a strain measurement device offers air line sensor however it use a proprietary digital ultrasonic bubble detection system to offer superior repeatability, reliability, and customizability for a wide variety of air-line applications.

2.5 RESULT

As they are bubble detection systems using an ultrasonic sensor, it may make measurement mistakes for close distance, So I decided to make an infusion pump system with infrared sensor for accurately close distance sense measurement.

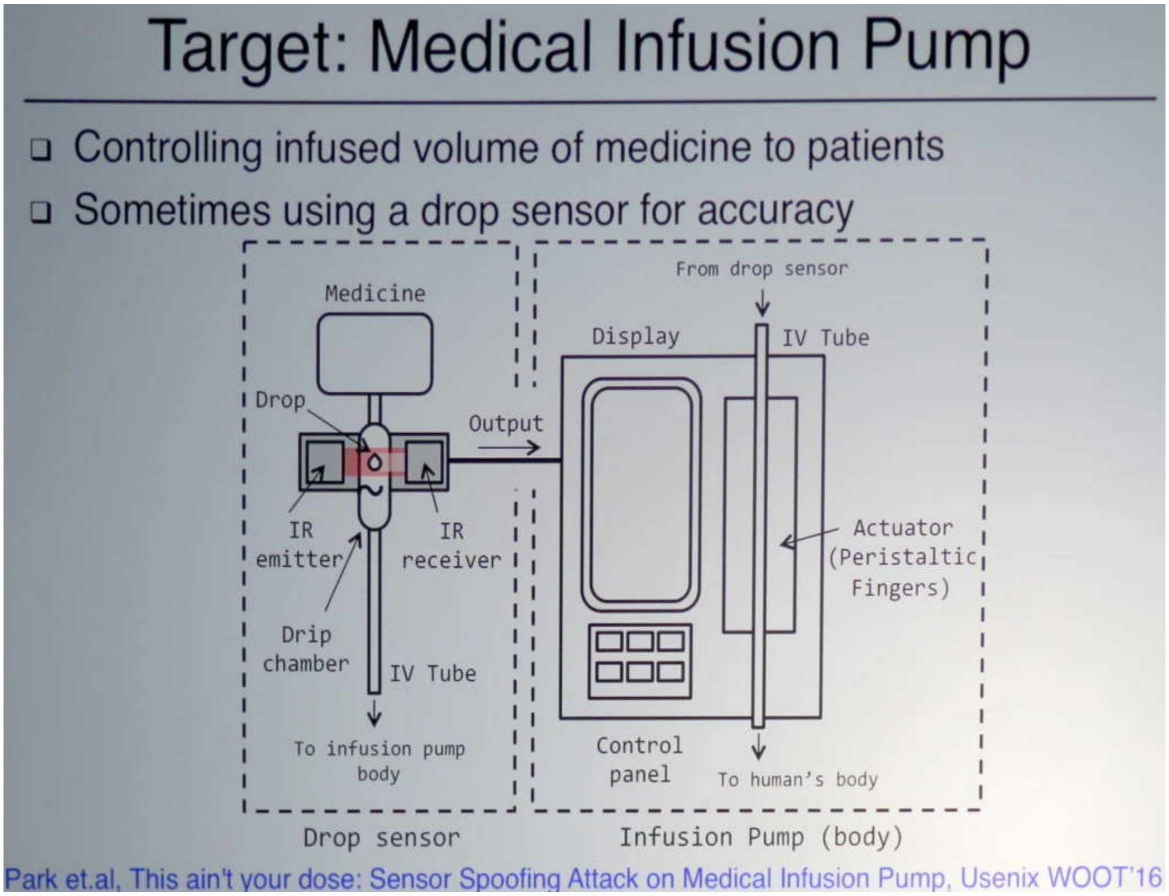

Figure2.5: IR sensor for accuracy

Chapter 3: material and methods

3.1 Aim of project:

the aim of this project is to make a system that can detect any air bubble occur during applying an infusion pump to the patient, as we mentioned before about how fatal can any air bubble be so we made a system including microcontroller, IR sensor, LCD to display the output.

We also wrote some commands in the software section that can be used easily be the user of an infusion pump,

so, if any air occlusion occur the nurses can rapidly before any risk of patient life happen.

3.2 Component:

1.Power supply: which provide the required voltage for the other component of the device so it give the power to operate the system

2.LCD:

Figure3.2.1: LCD screen

known as an electronic display module is a screen used to display programmed output messages. LCDs are preferred over multi-segment display LEDs, because of its cost-effectiveness and lack of barriers towards displaying special or custom characters and animations, that other display modules are incapable of presenting.

Our LCD screen will display speed of fluid flow through the pipe which can be controlled through the LCD screen, also it is display the pressure, Load directly the last infusion rate and volume limit it can adjustable buzzer volume. And it could have night mode to ensure good rest of patients. Real time display, Soft key design, easy to operate.

3.Buzzer:

Figure3.2.2: buzzer

provide the sound when the patient at risk to alarm the nurse or the family at home that there is a bubble could be dangerous to patient life.

4.Infrered sensor:

Figure3.2.3: IR sensor

An infrared sensor is an electronic gadget that emanates as well as recognizes infrared radiation with a specific end goal to detect some part of its environment. Infrared sensors can gauge the optical and warmth of a protest, and additionally identify movement. A large number of these sorts of sensors just measure infrared radiation, instead of emanating it,

All items emanate some type of warm radiation, for the most part in the infrared range. This radiation is undetectable to our eyes, yet can be recognized by an infrared sensor that acknowledges and translates it.

In a run of the mill infrared sensor like a movement identifier, radiation enters the front and achieves the sensor itself at the focal point of the gadget.

This part might be made out of in excess of one individual sensor, every one of them being produced using

pyroelectric materials, regardless of whether common or simulated. These are materials that produce an electrical voltage when warmed or cooled.

5.Emitter:

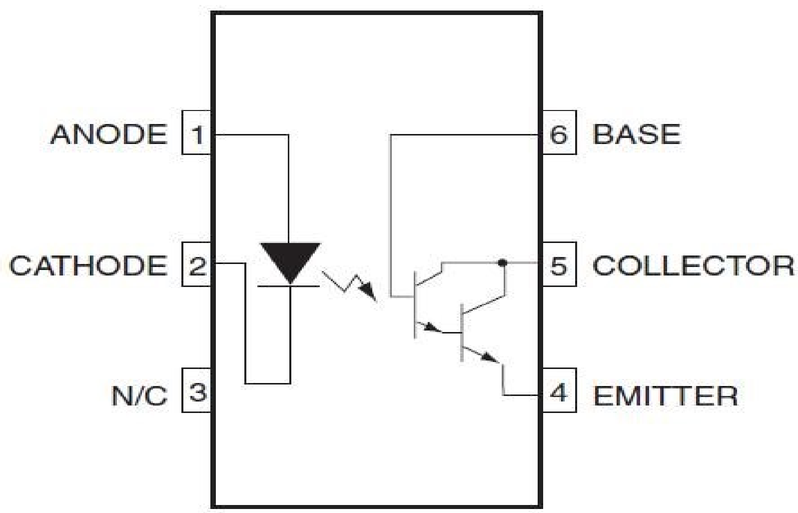

Figure 3.2.4: emitter

To give or send out a person or thing that emit, however as a nuclear physics a radioactive substance that emits radiation, but as electronics, the region in a transistor in which the charge-carrying holes or electronics originate.

6. Arduino:

Figure3.2.5: Arduino

Arduino is an open-source electronics prototyping microcontroller platform based on flexible, easy to use hardware and software.

The board is powered by connecting it to a computer via the USB connection or by connecting it an AC-to-DC adapter via power jack, or even by connecting it to a battery via its ground (GND) and voltage input (Vin) pin-outs in the ‘power’ section. The board operates with a 5V power supply that is provided to it when connected by the USB connection. However when supplied externally by a battery or an adapter it can withstand a supply voltage of 6-20V, yet it’s recommended to limit the voltage supplied between 7-12V. The GND and Vin pins can also be used to access the power supplied to the board as to distribute it to other adjacent components.

The Arduino UNO microcontroller board was employed in this project due to the great properties it provided. Whereas the USB connection provides the required interface with the computer as to upload programs into the chip which then as we mention will control the system to detect the bubbles.

8.Software implementation:

We have programed the Arduino to communicate with the touch screen, and included while loops in its sketch, one for each program. Each loop selects a particular Arduino pin, and loops into repeated 1 second pulse and 5 seconds rest. The Nextion library is included to access the touch screen. Here is the full sketch of the Ardunio :

```
#include "Nextion.h"

NexPicture start = NexPicture(0, 1, "start");
NexPicture stop = NexPicture(1, 1, "stop");
NexPicture up = NexPicture(0, 2, "up");
NexPicture down = NexPicture(0, 3, "down");

int plus = 8;
int minus = 7;
int Buzzer = 5;
boolean working = false;
String pumping = "Pumping";
String bubble = "Bubble Detected !!";

NexTouch *nex_listen_list[] =
{

  &start,
  &stop,
  &up,
  &down,
  NULL
};

void startPopCallback(void *ptr)
{ digitalWrite(plus, HIGH);;
```

```
  digitalWrite(minus, LOW);;
  working = true;
  String command = "t0.txt=\"" + pumping + "\"";
  Serial.print(command);
  endNextionCommand();
}

void stopPopCallback(void *ptr)
{ digitalWrite(plus, LOW);;
  digitalWrite(minus, LOW);;
  digitalWrite(Buzzer, LOW);;
  working = false;
}

void upPushCallback(void *ptr)
{
  digitalWrite(plus, LOW);;
  digitalWrite(minus, HIGH);;
}

void downPushCallback(void *ptr)
{
  digitalWrite(plus, HIGH);;
  digitalWrite(minus, LOW);;
}

void upPopCallback(void *ptr)
{
  digitalWrite(plus, LOW);;
  digitalWrite(minus, LOW);;
}
```

```
void downPopCallback(void *ptr)
{
  digitalWrite(plus, LOW);;
  digitalWrite(minus, LOW);;
}

void setup(void)
{
  pinMode(plus, OUTPUT);
  pinMode(minus, OUTPUT);
  pinMode(Buzzer, OUTPUT);
  digitalWrite(plus, LOW);
  digitalWrite(minus, LOW);
  nexInit();

  start.attachPop(startPopCallback, &start);
  stop.attachPop(stopPopCallback, &stop);
  up.attachPop(upPopCallback, &up);
  down.attachPop(downPopCallback, &down);
  up.attachPush(upPushCallback, &up);
  down.attachPush(downPushCallback, &down);
}
void loop(void)
{
  nexLoop(nex_listen_list);

  if ((analogRead(A0) < 230) && (working == true)) {
  digitalWrite(plus, LOW);;
  digitalWrite(minus, LOW);;
  digitalWrite(Buzzer, HIGH);;
  String command = "t0.txt=\"" + bubble + "\"";
```

```
  Serial.print(command);


  endNextionCommand();


  }
}

void endNextionCommand()
{
  Serial.write(0xff);
  Serial.write(0xff);
  Serial.write(0xff);
}
```

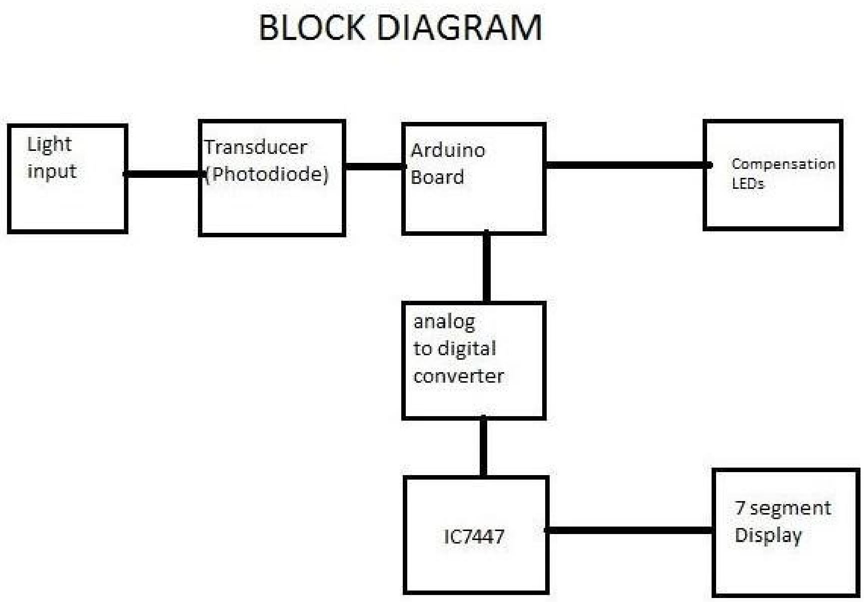

Figure 3.2.6: block diagram

3.3 Working principle

The power supply feeds the microcontroller and feeds the LCD screen as well.

We are using an IR optical sensor that has an infrared emitted diode with an infrared phototransistor to detect the reflected infrared signal, the emitter generated an infrared signal, that signal is stably reflected into the phototransistor as long as the infusion procedure is working well; but whenever an air bubble occur that reflected signal is going to change, so the microcontroller detect that changing signal value, as we already programmed the microcollector to send a command to stop the infusion pump motor and send an alarm to the infusion pump motor to fix the problem.

chapter 4: Discussion

4.1Discussion

Improvement our device that we have made a system for bubble detection that uses infrared sensor, all the other systems for bubble detection are using ultrasonic sensor which can be not very accurate because we need a very tiny one and it might be expensive but for our project we are using the infrared however its cheap, small and accurate specially for close distances, but ultrasonic sensor may make mistakes for close distance.

4.2: Advantages and disadvantages.

Advantages of our device

1.The device is able to save the patient life

2. Can be used in the hospital or the patient home

3. Inexpensive

4. Easy to run

5. Accurate because its using infrared sensor

Disadvantages

May slow down drug delivery process

4.3: Future

the next step we are going to design and build the whole infusion pump system to do the basic operation of it, which it drug delivery and we are going to connect the motor of the infusion pump to our system, so when the sensor detects a bubble the motor will stop then the device will warn the nurses and the family to save the patient life and remove the bubble finally operate the device again. We also going to add a touch screen (LCD) with programmable to control the device and display some important things for accurate working as displaying speed of fluid flow and many other helpful things that we mention before.

Chapter 5:

CONCLUSION:

Fluid therapy is a very important treatment procedure, due to its reliability, controllability and easy to use.

This project concentrates on a very important problem which occur during an intravenous fluid therapy, it’s a very serious problem can lead to death, so we made a smart bubble detector for infusion pump with infrared sensor and audible alarm.

The pre-programmed system helps the nurse and the patients to understand the device well, the electric circuit is also designed well, which can give the user the output accurately and it’s the best way to detect the bubbles and save life’s.

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