Project Proposal for Innovation Fund

An Automatic System Design to Protect Intravenous Infusion Therapy Administration for Liquid of Blood Flow in Human Body

Submitted to

Information and Communication Technology Division
Government of the People's Republic of Bangladesh

Submitted by:

Dr. Lafifa Jamal
Associate Professor and Chairperson
Department of Robotics and Mechatronics Engineering
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1. Title of the project

An Automatic System Design to Protect Intravenous Infusion Therapy Administration for Liquid or Blood Flow in Human Body.

2. Brief description of the project

Intravenous therapy is a form of treatment where essential fluids and drugs are passed into the body through the veins. Intravenous administration of fluids, drugs, and nutrition is very common in hospitals. Although insertion of peripheral and central cannula and subsequent intravenous therapy are usually well tolerated, complications that prolong hospitalization, and in some cases cause death, can arise on occasions [1]. In modern medical practice, up to 80% of hospitalized patients receive intravenous therapy at some point during their admission [2][3]. Medication, fluids, nutrition, and blood products can all be given via the intravenous route, which can be either peripheral or central. Although common, these practices are not devoid of complications, which may lead to mortality and morbidity, increased duration of hospital stay, and significant costs. Once a decision has been made to insert a cannula into a peripheral vein, it is important to obtain informed verbal consent from the patient (where possible) and to explain both the procedure and the need for cannulation. Although the risk of infection with cannulation is low [4], it is important to maintain good aseptic technique to minimize the risk of local and systemic infections. Finally, when peripheral venous access cannot be obtained and there is a need for intravenous therapy, placement of a central venous line should be considered. Although this is a last resort as a simple substitute for peripheral access, central venous access may be indicated for other reasons. In addition, the morbidity in critically ill patients is lower from centrally inserted central catheters than from peripheral intravenous catheters [5].

The majority of junior doctors do not use a local anesthetic when performing peripheral venous cannulation. The researcher reported about intravenous therapy as in a survey of 71 pre-registration house officers, local anesthesia was not used because it was too time consuming (45%), because it was felt not to be indicated (35%), because it made cannulation more difficult (21%), because of lack of availability of the local anesthetic

(13%), because of logistical difficulties (13%), because of peer pressure not to use it (4%), and because of practical difficulties (3%) [6]. The most common complication observed with central venous catheters is local and systemic sepsis. Catheter related bloodstream infection (CR-BSI) is a serious nosocomial infection with substantial and directly attributable mortality and morbidity. It has been estimated that a single episode of catheter related bacteremia costs $28 000 (£16 500) and has an attributable mortality of 10%–35% [7]. Various definitions have been used to describe sepsis related to catheters. The definitions proposed by the Centers for Disease Control [7] are among the most widely used.

As for the epidemiology, the rates of CR-BSI vary between hospitals, clinical areas, and patient groups [8]. Overall, studies from Europe and the USA suggest that the usual incidence of CR-BSI, as a percentage of catheters inserted, is between 3% and 7% [9]. For the skin asepsis, most studies have shown high levels of concordance between micro-organisms found on the skin at the insertion site and organisms subsequently found on the catheter tip [9]. A study examining catheter tips immediately after insertion demonstrated a contamination rate of 16% caused simply by passing through the skin [10].

From the above literature review and evidence, we can say that we haven't found such kind of automatic system for the riskless intravenous infusion therapy administration for liquid or blood flow in human body and the researcher had not been reported about administration, monitoring system as well as automated system; thus, we have proposed to establish this kind automatic mechanical automatic system for intravenous infusion therapy administration for liquid or blood flow in human body.

This project aims to solve these problems in following ways problem can be solved in three ways:

- ✓ When the liquid is almost finished an alarm will sound near the patient to stop it manually.
- ✓ There will be a display monitor in the nursing station to show the liquid level of each patient's saline. When the liquid level is very low, it will be indicated in the monitor so

that the nurse can immediately stop the liquid flow.

- ✓ A fully automated system will automatically stop the liquid flow without any human intervention. The speed of the liquid flow can also be adjusted.

Our goal is to develop all three systems. According to the budget and need, a user can use any of them. For third approach, our target is to design a small mechanical and intelligent structure for intravenous infusion which can work independently, patent application and commercialization for the hospital system or for the patient. From this project we want to build automatic cost effective, riskless intravenous infusion methods for patient where three main out-comes are

- ✓ A small part of mechanical system should be included in the present system for new products;
- ✓ A sensor based device will be used in the present system if we don't use the automated device; and
- ✓ A smart system development to monitor intravenous infusion flow in human body with other factors for the hospital centralization.

3. Specify existing problems (Problem Statement)

The example of the existing intravenous infusion therapy administration may be seen in Figure 1. In normal structure for intravenous infusion, once the volume of liquid in the bottle goes below a certain level, the pressure is reversed causing backflow of blood into the tube which has several adverse effects such as blockage of tube, loss of blood, swelling, infection hypothermia [11] and blood leakage [12]. Another severe effect is air embolism which is caused by emptying of the reservoir or any openings in the intravenous system [13] which causes an air lock in the pulmonary valve that restricts blood flow causing tissue hypoxia, reduced cardiac output and in extreme cases cause death.

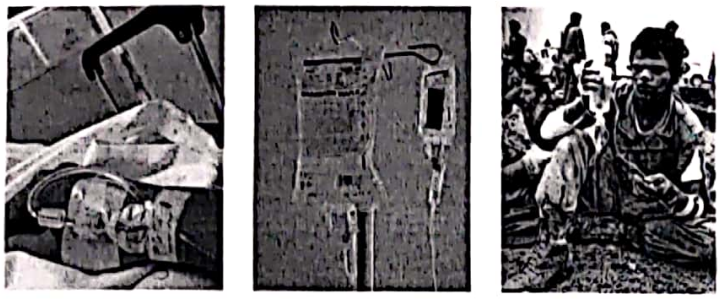

Figure 1: present situation of intravenous infusion therapy administration

To prevent backflow, a method is being adapted in hospitals wherein a blood pressure cuff is tied on the same arm as the catheter is passed beneath the cuff. In case, the length of the tube is short, an extension tube is added. The cuff is inflated when necessary, causing constriction of the lumen thus preventing backflow [14]. Although this method is quite simple and has not been proven to have any adverse effects such as disconnection of the tube or leakage of fluid at the site of injection, it requires constant monitoring by clinicians.

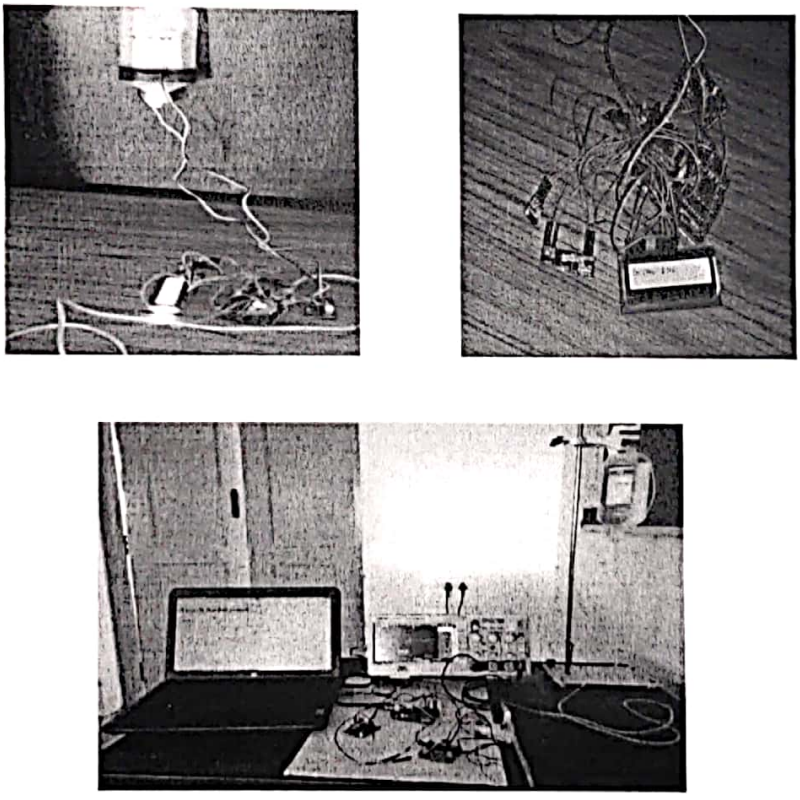

Figure 2: Some Existing Automated Intravenous Systems

In recent years, some methods have been developed to monitor intravenous infusion system. Although the overall purpose of these systems is to monitor the flow rate and raise a warning in case of any anomaly, the techniques used to develop these systems and the functionalities fulfilled by them are subject to considerable variation. None of these systems can give a complete solution to monitor and control the liquid flow. Figure 2 shows some existing solutions. From this figure, we find that the systems are not in a position to be used by general people. Till now they are in research stage. In most systems, when the liquid finishes, the attendant of the patient or nurse should come to stop the switch; thus, we say, the existing intravenous infusion system works manually. It cannot prevent blood from flowing into the needle and the pipe connected when the liquid of infusion ran out. The intravenous infusion systems are used at hospitals as well as at home for some patients. It is not always possible to monitor the level of liquids all the time. If the patient is sleeping when the liquid ran out, the blood may scare the patient when he/she wakes up. Our target is to build automatic cost effective, riskless intravenous infusion methods for patient.

4. Potential beneficiary population (Target Population)

We will develop a mechanical and intelligent intravenous infusion system. The patients in Bangladesh who require to go through intravenous infusion treatment will be benefitted during their treatment either at hospital, clinic, or at home. As the system will work automatically the illiterate people will also be able to use the system without any medical knowledge. Ultimately, this system will decrease the health issues which may occur from unattended intravenous infusion such as blockage of tube, loss of blood, swelling, infection hypothermia and blood leakage.

5. The overall purpose of the project

Our purpose of the project is to develop an automated intravenous infusion system which can work without human intervention. The human intervention is required only when the liquid is initiated. After the initiation process, it will automatically adjust the flow of the liquid and stop the flow of the liquid when needed. The system will be cost effective and can be used commercially.

6. Possible outcomes/achievements/target/output of the project

From this project we want to build automatic cost effective, riskless intravenous infusion methods for patient where three main out-comes are

- ✓ A small part of mechanical system should be included in the present system for new products;
- ✓ A sensor uses in the present system if we don't use the automated device; and
- ✓ A smart system development to monitor intravenous infusion flow in human body with other factors for the hospital centralization.

7. Duration of the project

One year.

8. Brief work plan

1. Study the existing systems.
2. Design a solution.
3. Simulate the design.
4. Purchase Equipment.
5. Setup Equipment.
6. Implement the proposed design.
7. Test the design.
8. Analyze the result.
9. If the result is satisfactory, go for the commercial product.

9. What makes the project an 'Innovation?'

In Bangladesh, there is no intelligent intravenous infusion system. This is the first attempt to design such system using ICT. It will be a milestone for the Bangladeshi people to provide this facility either at hospital, or clinic, or at home. This will be a unique solution

which will have a great impact in the health sector of Bangladesh.

10. What is the relationship between information and communication technology in the project?

Since it will be a smart automated system so it needs communication technology to use in the system. If we want to control the whole system centrally in the hospital we need to setup a central software based control system. The systems in different hospitals could be connected to a cloud-based central database which will keep record of individual patient. As a result, it will be helpful for further research to collect data from hospital to do the risk analysis of the patient. So, the application of information and communication technology will be the basis for this kind of system development in Bangladesh.

11. How the project will become sustainable? Please explain

Following a well-established service research path [15], there seem to be two essential elements of a healthcare service system; people and technology. People (health providers, patients, families, peers, etc.) represent the main source of variety, intended as a unique individual combination of quantitative and qualitative dimensions in which psychological, emotional, cognitive and cultural elements affect the processes occurring in a specific system. Technologies and, in particular, digital platforms, represent what can really boost the interactions among people, offering more effective information management. ICTs and digital platforms are able to improve the effectiveness and the quality of provided services. This makes them even more patient-centered due to the real and the ongoing active participation of empowered patients, who can now actively participate in the healthcare process through digital devices that nourishes their ability to self-manage their medical problems.

If the automated intravenous system is used by different hospitals as well as all government hospitals get support from government to install this system for the patients, general people will be acquainted with the system. They will be motivated to use it even at their home as the solution will not be costly. Bangladesh Government is promoting ICT technologies in

all sectors. People of our country are also very much enthusiastic to accept modern ICT technologies. The system will be very much user friendly to use. Thus the sustainability of the system is higher in this stage that has no doubt.

12. How will general people get benefited from this project?

As the system will work automatically, the general people will be less dependent to the medical personnel to stop the flow of intravenous system. As our target is to provide a cheap solution, the system will be affordable to general people.

13. What are the risks? How the risks will be managed?

As the system will work automatically, the system should calculate the time of stopping the liquid flow accurately. Otherwise, it will result blood flow problem which is harmful for the patient.

The sensors which will be used to detect the liquid level and the flow of the liquid will be designed so that it can calculate the time accurately.

As the system will be connected to the central database, an uninterrupted network connections will be required all the time.

14. How many percent of underprivileged women will benefit from this project?

Most of people lives in village so they don't know how to use infusion in their body they afraid when liquid is finished and specially when blood come up to the infusion bottle. Normally they call to nurse but some time difficult to find them and it is not convenient call all time. If this system is developed then they don't need to call nurse because the system will alarm the nurse when it will happen. So, 90-100% women will be benefitted from this system in future.

15. What will be the positive impact on environment from this project?

This project has no bad effect and risk for the human being, no environmental pollution to

implement this project, the power consumption is also low, it has no side effects or any radiation for the people and for the Bangladesh, and it is not high cost for the people and for the hospital so it is an excellent thinking to implement this project in perspective of Bangladeshi environment to ahead in future.

16. Proposed Budget (including breakdowns and shared cost)

Description	Cost (in BDT)
Hardware and Software Purchase	10,00,000.00
Test Cost	2,00,000.00
Electricity Consumption Cost	60,000.00
International Conference Paper and Intellectual Property / Patent Cost	3,40,000.00
Remuneration and consultation fee for the persons involved in the project	3,00,000.00
Stationeries	50,000.00
Misc.	50,000.00
Total **(Twenty Lac BDT)**	**20,00,000.00**

16. HR plan

Principal Investigator:

Dr. Lafifa Jamal, Associate Professor and Chairperson, Department of Robotics and Mechatronics Engineering, University of Dhaka.

Co-Principal Investigator:

1. Dr. SM Jahangir Alam. Assistant Professor, School of Mechanical & Automotive Engineering, South China University of Technology, China.

2. Dr. Md. Rakibul Hoque, Associate Professor, Department of Management Information Systems (MIS), University of Dhaka.

(All CV's are attached with photograph)

17. Procurement Plan

All the purchase will be done phase by phase. The project duration is two years.

In the first quarter, the Complete PC, Printer, Scanner, MCU, sensors, interfacing devices, display, necessary tools, internet devices, camera, optical wires, power supply, etc. will be purchased. High speed interconnection is essential for the research work. Server, switch, router etc. will be purchased to establish the dedicated internet connection. matlab, and some user interface software that we can buy from professional company to develop the monitoring system of automated system. Design tool will also be purchased in this quarter. Some stationeries will also be purchased.

In the second quarter, we will buy some module of MCU, sensors, interfacing devices, display, necessary tools, internet devices, camera, optical wires, power supply, etc.

In the third quarter, we will buy other necessary equipment. During this period, we will submit research papers in various reputed International Journals and prestigious top tier International (IEEE or ACM) Conferences. The registration, travel and accommodation will require a handsome amount of money. Some stationeries will also be purchased in this quarter.

In the fourth quarter, we are planning to attend some top tier International Conferences. We hope that at least two papers will be published from this research work. After successfully execution of the project, the applied process will be patented under the existing intellectual property law, provided the research team may be given royalty from the commercial income of the outcome of the research work at a rate determined by the Council.

18. Is there any research/publication on the problem statement? If yes mention briefly

In recent years, some research have been done to monitor intravenous infusion system globally. But in our country, no such research has been done yet.

We aim to publish two papers from this project. After setup the system when it will run appropriately, we can collect data and we can survey to analyze the usefulness of this system then we can publish more related publications. After successfully execution of the project, the applied process will be patented under the existing intellectual property law.

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