Smart Intravenous Infusion Monitoring and Detection System In Healthcare Institutions Using IoT Technology: A Qualitative Study

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Abstract- In recent days, traditional methods used in monitoring intravenous fluid in healthcare institutions, especially in Nigeria are becoming obsolete due to heavy workload, more patients, negligence, and inattentiveness as a result it becomes more harmful to patients' health. When saline is consumed without immediate attention or when there are irregularities in the fluid droplet the consequences are always fatal: complications include blood rushing back to the saline bottle, and air bubble occurrence which prompts air embolism and stroke. More so, when there is regularity in the fluid droplet that is intravenous fluid restriction: the flow rate could be high or low. When it's high, it leads to fluid overload, and when its low it results in fluid under load as a result causes heart failure, tissue breakdown, pulmonary edema, and bowel malfunction. The system made use of four sensors to troubleshoot the above-mentioned problem effectively. The load cell sensor was used to monitor and detect liquid level, capacitive sensors function as a droplet sensor to detect intravenous fluid and the air bubble sensor detects the air in the drip set. Through these techniques, patients can be monitored from the control room.

Index Terms*:* The Internet of Things (IoT); IV Therapy; Intramuscular route of administration; IV fluids;

I. INTRODUCTION

IV therapy is a medical treatment in which fluids, nutrients, and medications are delivered directly into a patient's vein, usually using a needle or cannula. This technique is described in more detail in 2018 study by Anderson and colleagues, which found that IV therapy has many benefits, including faster absorption of medications and reduced risk of gastrointestinal side effects, Anderson *etal*, (2018), The process of administering IV chemotherapy is complex and requires constant supervision from medical staff to ensure that IV bottles are changed on time and any potential problems are quickly addressed. One such problem is blood reflux, which occurs when blood flows back into the infusion tube and blocks the cannula. This can have serious consequences for the patient, so it's important to take immediate action if it occurs. This could lead to a significant loss of medication, or even worse, damage to the patient's tissues. Blood flux also occurs as a result of the wrong positioning of the arm. In addition, when the cannula is not properly fixed, air could have its way into the infusion pipe thereby causing bubbles in the pipe which lead to blockage in the blood vessels and consequently causes air embolism. An air embolism is a trapped bubble in a blood vessel. Air embolism can lead to stroke or cause death if not fixed immediately when the patient is in a critical state. Moreover regulation of the rate of flow in IV is paramount to avoid fluid overload and under load. Hospitals are faced with the challenge of blockages hence, this research. Blockage can lead to so many critical problems, and that includes complications such as backflow of blood, death, and stroke, in the case of bubble formation. Some of the causes of blockage are as follows: (1) Covering of the blood vessels (2) Wrong positioning (3) Low pressure (4) Press

The literature and experience show that gaseous micro emboli during cardiac surgery can contribute to inflammation, postoperative delirium, coagulopathies, reduced neurocognition, stroke, and mortality. This is why per fusionists, surgeons, anesthetists, and nurses go to great lengths to use a variety of filters and devices to avoid and prevent this micro emboli source in cardiac surgery cases. By indication, there is physiology, hazards, and morbidity associated with intravenous air.

Several studies reveal that most patients die because of the carelessness of some healthcare givers. Many reports claim the number to be as high as 440,000 However, patients in the intensive care unit (ICU) especially, are mostly victims. However, there are many routes to administer drugs to the body to obtain a maximum therapeutic effect. These include the parenteral, oral, and topical routes of administration (Kasinathan, 2017). In research by Shargel *et al*, (2012), examples of parenteral means of administration are the intramuscular, intravenous, and subcutaneous administration methods. In this paper, we are concentrating on the intravenous method of administration.). Rose and colleagues (2015) expand on the concept of the Internet of Things (IoT), defining it as the extension of network connectivity and computing capabilities to objects and sensors that are not typically considered computers. Essentially, it's about making everyday items "smart" and connected to the internet. (Rose et al., 2015)

A. Statement of the problem

1) There are some significant risks associated with IV therapy, including the possibility of over- or under-hydration. Too much fluid can cause complications like pneumonia or heart failure, while too little fluid can lead to kidney failure. As such, it's important for medical staff to carefully monitor the patient and make sure that the IV therapy is administered correctly. Hence the importance of fluid mismanagement incidents to avoid fluid overload or under load.

2) Keeping very close monitoring keeps the life of nurses and doctors at risk and this led to the loss of many doctors and nurses during this pandemic.

3) Healthcare professionals find it difficult and stressed out to move from one bed to another, and as a result, it becomes impossible for frontline workers to monitor and tend to every patient personally

B. Aim and objectives of the study

This paper aims to develop a smart IoT-based intravenous fluid monitoring and detection system in healthcare institutions that helps to monitor intravenous delivery, enhance patients' recovery, and control abnormalities in intravenous therapy across healthcare institutions in Nigeria. The objectives are to design a system that monitors, detects, and creates database and signal alarms through the application of sensors and IoT technology. This study will be beneficial to the following people: Patients, health workers and health institutions

C. Limitation of the Study: This system is not designed to be used on mentally ill patients or mad patients because they could get violent and injure themselves with the device.

D. Definition of Terms

(1)**The Internet of Things (IoT):** The Internet of Things (IoT) is a network of physical objects that are connected to the internet. These objects, known as "smart devices," can collect and share data, and can be controlled or monitored remotely. Examples of IoT devices include fitness trackers, smart thermostats, and even smart refrigerators. (2)**Intravenous Therapy (IV):** This is a medical technique that administers fluid, nutrients, or medication through a needle or tube inserted into a vein. (3) **Intravenous (IV) stand or poles:** An IV stand or pole is a medical device that's used to hold and deliver IV fluids and medication to patients. These stands are typically made of metal and have adjustable height, so they can be positioned at the appropriate height for the patient. They also usually have wheels, so they can be moved around easily. Sometimes, IV stands have hooks or other attachments for holding bags of fluid or other supplies. (4)**Catheter:** A catheter is a thin tube that's used to deliver fluids, medications, or other substances into the body. There are many different types of catheters, but the most common type is an IV catheter, which is used to deliver fluids directly into a vein. Catheters can also be used to drain fluid or collect samples from the body. The tip of a catheter is usually soft and flexible, so it can be inserted into the body without causing damage. Some catheters are disposable, while others are reusable. (5)**Blood flux:** Blood flux occurs when there is blood flow back to the saline line or intravenous line.

II. LITERATURE REVIEW

In this section, we will be looking at the review of related work written by other researchers. This review will throw light on the methodology and concept used in their work, on the other hand, exposing the gaps that the proposed system intends to fill.

Intravenous therapy is majorly used for dehydration and to supply nutrients that aid in the speedy recovery of an individual. This practice has been around ever since the 1600s. Regardless, due to inadequate knowledge and inadequate modern science of the human body, initial attempts to administer drugs and intravenous fluid were unsuccessful. While IV therapy has been around for a long time, there have been some major advancements in this field over the past 25 years. For example, the development of smart pumps has made it possible to more accurately deliver IV medication and fluids. There have also been advancements in the types of IV drugs available, with new treatments being developed all the time. And finally, the way that IV therapy is administered has also evolved, with more focus on infection control and patient comfort. Warren (2021).

III. ANALYSIS OF THE EXISTING SYSTEM

The researchers took a close look at the current system to identify its advantages and disadvantages. the new system would build upon the strengths of the old system while addressing its weaknesses. In the current healthcare system, nurses play a critical role in providing care for patients. When setting up an IV drip, the nurse or doctor in charge must manually monitor the saline level, adjust the flow rate using a roller clamp, and check for any abnormalities on a regular basis. To adjust the flow rate of the saline, the roller clamp is used to compress or release the tubing. Rolling the clamp up will compress the tubing and slow or stop the flow of saline. Conversely, rolling the clamp down will release the tubing and increase the fluid rate. This allows the healthcare professional to finely control the flow of saline as needed. Because of frequency of monitoring, nurses are stressed out at the cause of this procedure, also, lives are lost in this process because of the lack of immediate action during emergencies. Likewise, the healthcare giver might be infected with a highly infectious disease as a result of too much closeness to patients, especially during pandemics.

After thorough research, the survey carried out showed that 85% of admitted patients in Nigeria receive intravenous therapy and they have different experiences and opinions as concerns to the administration. Unfortunately, almost all the patients stated their challenges and ugly experiences with health attendants. More so, the health attendance explained how tedious their work has been seeing that everything is still manual

Based on the interviews conducted, there is currently no functional IoT-based system for monitoring intravenous fluid levels. Without such a system, nurses must rely on manual monitoring and intervention, which can be a challenge for both the nurses and the patients. This highlights the need for a more automated system that can take some of the burden off of the healthcare professionals

A. *Materials and Method*

Research Methodology: For this research, we adopted the Triangulation method (quantitative and qualitative methodologies) to analyze the existing system and gather user requirements to build a better system. Primary and secondary data were used, the sources of primary data are as follows; observation, questionnaire, personal interview, and survey whereas secondary data sources encompass the following: books, journal articles, website sources, and conferences. This researcher used a combination of probability and non-probability sampling techniques to select participants for the study. We also used a semi-structured questionnaire, as well as conceptual analysis and a review of existing research, to collect and analyze data. This mix of methods provides a well-rounded approach to the study and helps to ensure that the results are accurate and reliable.

Three groups of respondents were used which include the resident doctors, the nurses, and the patients. The study areas covered are the Pediatrics department, Obstetrics & Gynecology department, and Surgery department. The population of the study comprised a total number of 502 participants, which included 103 resident doctors, 252 nurses, and 147 patients from 4 different hospitals. Using the Taro Yamane formula, the we determined that a sample size of 227 was needed to achieve a 95% confidence level and a 5% margin of error. This is a statistically significant sample size that will provide an accurate representation of the population..

B. Methodology

Furthermore, before the analysis of quantitative methods, questionnaire responses were analyzed using SPSS hypotheses were tested using the Chi-Squared test and t-test analysis, and the dataset was checked for missing data and outliers.

A qualitative method was used to gather in-depth knowledge from selected experts on the techniques and approaches that would be perfect fits in addressing the research problems, answering the research questions, and testing the hypotheses. Both primary and secondary data were used in this exploration. The interview method was used as an instrument for gathering information for the qualitative research methodology. C++ was used for the analysis of the qualitative data in the study. C++ is a popular programming language that allows for more complex data structures and algorithms, as well as a higher level of abstraction. This makes it well-suited for the analysis of large datasets. Object-oriented programming paradigm was used to organize the software for the study into manageable pieces of code. This makes the code easier to understand and maintain, and also allows for code reuse.

C.. Information Gathering

information gathering is the process of collecting and organizing data and information from various sources in a structured way. This process helps researchers gain insights, create new knowledge, and make informed decisions. both primary and secondary data, and they used a combination of methods to collect that data. They used questionnaires, observations, and online research to gather information

D. Components/Materials

In the modeling of the system, several components were assembled and embedded together for the functionality of the system.

The components/materials that were used incorporate an Atmega microcontroller, weight/load sensor, Infrared sensors, AREF, inbuilt LED, EEPROM, ATmega328, Arduino Mega, Wi-Fi module, IV pole, LCD screen, IC and IC base, resistors, capacitors, transistors, diodes, adapter, ESP 32, SIM800L, battery, 7805 regulators, load cell

IV. DISCUSSION AND DATA ANALYSIS

Table 1: Medication Preferences

S/N	Items	Responses	Percentage
1	Oral	50	22
2	Intravenous	177	78
	Total	**227**	**100**

Preferred Medication Response

Table 1 shows the responses of the respondents on their preferred medication method. It was indicated that 50(22%) of the total respondents preferred oral medication while 177(78%) of the total respondents preferred intravenous medication.

A. Research Analysis for health care workers

Q1. What could make a drip stop flowing?

Responsee

Covering of the blood vessels: Broken capillaries or

Broken blood vessels are caused due to physical truma to the skin, low pressure, wrong positioning and press

Q2. What is your opinion on the development of a smart intravenous administration System for health institutions**?**

Responses

It's a welcome idea, if the IV infusion can be digitalized, It will ease a lot of stress and enable multitasking

Q3 In your opinion, is there a relationship between IV infusion occlusions and death,

Responses

Negligence in taking care of patients can lead to so many complications even death in most cases

Q4 What is the nature of abnormalities and affect patients undertaking this therapy?

Responses

It cn cause fluid overload and under load, there could be blood flow back, air bubble formation and more.

Table 2: Demographic Data of the Respondents via Questionnaire

S/NO	Category1	Category 2	Responses	Percentage
1	Gender	Male	161	70.9
		Female	66	29.1
		Total	227	100
2	Designation	Doctors	47	20.7
		Nurses	114	50.2
		Caregiver	66	29.1
		Total	**227**	100
3	Experience	1-5 years	164	72.7
		6-10 years	41	18.1
		11 and above	22	9.7
		Total	**227**	**100**
4	Qualification	FLSC	16	7.0
		NCE/OND/RN	98	43.2
		MBBS/B.Sc	67	29.5
		M.Ed/M.Sc	41	18.1
		PhD	5	2.2
		Total	**227**	**100**
5	Marital status	Single	80	35.2
		Married	98	43.2
		Divorce	23	10.1
		Widow	26	11.5
		Total	**227**	**100**

Data representation of the respondents

Table 2 shows the demographic data of the respondents. Results from the table indicated that 161(70.9%) of the respondents were male while 66(29.1%) of the total respondents were females. The result from the table also indicated that 47(20.7%) of the total respondents were doctors, 114(50.2%) of the total respondents were nurses and 66(29.1%) of the total respondents were patients. The result from Table 14 further showed that 164(72.7%) of the total respondents have spent 1-5years in their place of work, 41(18.1%) of the total respondents have spent 6-10 years in their working place, while 22(9.7%) of the total

respondents have spent 11 years and above on the qualifications of the respondents, 16(7.0%) of the total the total respondents were with First School living certificate, 98(43.2%) of the total respondents were with either ordinary national diploma (OND), National Certificate of Education(NCE) or Registered Nurse certificate. The table further showed that 67(29.5%) of the total respondents had a first-degree certificate (MBBS/B.Sc), 41(18.1%) of total respondents were with Master's degree and 5(2.2%) of the total respondents had with Ph.D. certificate On the marital status, 80(35.2%) of the total respondents were single, 98(43.2%) of the total respondents were married, 23(10.1%) of the total respondents were divorcees while 26(11.5%) of the total respondents were widows.

Table 3. Choices of Treatment

Item	Choices	Responses	Percentage
Have you received treatment?	Yes	217	95.6
through drip infusion before	No	10	4.4
	Total	**227**	**100**

Treatment evaluation (Researcher's Field Work)

Table 3 shows the responses of the respondents on whether they had received drip the Table shows that 217(95.6) of the total respondents agreed that they had received drip infusion while 10(4.4%) of the total respondents have not received drip infusion.

Table 4: Intravenous (Drip) Monitory Stage

S/N	Question	Item	Responses	Percentage
1	Who administered the drip to you	Doctors	40	17.6
		Nurse	187	82.4
		Total	**227**	**100**
2	Do you feel pain during the process	Yes	182	80.2
		No	26	11.5
		Slightly	19	8.4
		Total	**227**	**100**
3	Where the nurses come regularly to check on you and the status of the drip	Yes	24	10.6
		No	203	89.4
		Total	**227**	**100**
4	If yes how often	10 minutes	18	7.9
		20 minutes	62	27.4
		1hr	147	64.8
		Total	**227**	**100**
5	Have you ever observed a blockage while taking a drip	Yes	186	81.9
		No	41	18.1
		Total	**227**	**100**
6	Have you noticed air bubbles on the drip line before	Yes	182	80.2
		No	45	19.8
		Total	**227**	**100**
7	Have you noticed blood flowing back through the IV line	Yes	189	83.3
		No	38	16.7
		Total	**227**	**100**
8	Have you noticed irregularity in the flow rate (either being too fast or being too slow)	Yes	168	74
		No	40	30.4
		Undecided	19	8.4
		Total	**227**	**100**
9	Have you had an absence before	Yes	129	56.8
		No	68	30
		Undecided	30	13.2
		Total	**227**	**100**
10	Are there effects of IV infusion set occlusion (blockages) during IV therapy	Yes	164	72.2
		No	51	22.5
		Undecided	12	5.3
		Total	227	100
11	Had there been a time any of these stated above happened	Yes	167	73.6
		No	33	14.5
		Undecided	27	11.9
		Total	**227**	**100**

	without the presence of a nurse or doctor			
12	What experience do you have when any of the above happened	Very painful	30	13.2
		Swollen	50	22.1
		Blood flowing back	72	31.7
		Air bubbles	75	33
		Total	**227**	**100**

Intravenous (Drip) Monitory Stage

The responses of the respondents on the intravenous (drip) monitory stage are shown in Table 4. The result from the study showed that 40(17.6%) stated doctors administered drip to them, and 187(82.4%) of the total respondents stated that nurses administered drip to them.

Item 2 showed the responses of the respondents on whether they feel pain when they receive drip. The result showed that 182(80.2%) of the total respondents agreed that they feel pain when they are receiving drip while 26(11.5) said no while 19(8.4%) of the total respondents strongly disagreed.

Item 3 showed the responses of the respondents on whether the nurses are coming regularly to check on the status of the drip. From the table. 24 of the respondents said that nurses regularly checked on the status of the drip, while 203 said they did not. That's a pretty big difference! Let's see if I can rephrase this information to make it easier to understand. It seems like the majority of respondents felt that nurses were not checking on the drip status regularly.

Item 3 indicated that 18(7.9%) of the respondents agreed that nurses were coming to check on the status of the drip every 10 minutes, 62(27.4%) of the total respondents agreed that nurses were coming to check on the status of the drip every 20 minutes while 147(64.8%) of the total respondents agreed that nurses are coming to check on the status of the drip.

Item 5 showed the responses of the respondents on whether they have observed blockages while taking drip. The result from the table indicated that 186(81.9%) of the total respondents agreed that they had observed blockages while taking drip. While 41(18.2%) of the total respondents disagreed that they had observed blockages while taking drip.

Item 6 showed the responses of the respondents on whether they had noticed the air bubble on the drip line before. From the table, it was indicated that 182(80.2%) of the total respondents agreed that they had noticed the air bubble on the drip line in the drip infusion process. While 45(19.8) of the total respondents agreed that they had noticed the air bubble on the drip line in the drip infusion process.

Item 7 showed the responses of the respondents on whether they had noticed blood flowing back through the IV line. The result from the table showed that 189(83.4%) of the total respondents agreed that they had noticed blood flowing back through the IV line while 38(16.7%) of the total respondents stated that they had noticed blood flowing back through the IV line during the drip administration process

Item 8 showed the responses of the respondents on whether they have noticed irregularity in the flow rate (either being too fast or being too slow). The table shows that168(74%) of the total respondents agreed that they have noticed an irregularity in the flow rate (either being too fast or being too slow), 40(30.4%) said no while 19(8.4%) of the total respondents were indecisive

Item 9 showed the responses of the respondents on whether they have had absences before. The result from the table showed that 129(56.8%) of the total respondents had had an absence before, 68(30%) of the total respondents disagreed that they had had an absence before, while 30(13.2%) of the total respondents were indecisive.

Item 10 showed that 167(73.6%) of the total respondents agreed that they have had complications in the drip infusion process, and 33(14.4%) of the total respondents said that they have not had complications in the drip infusion process. While 27(11.9%) were unable to decide. Item 11 showed the responses of the respondents when they had drip infusion. The table showed that 30(13.2%) of the total respondents on their experience when having drip infusion. The table showed that 30(13.2%) of the total respondents stated that it was very painful, 50(22.1%) of the respondents stated that they had swollen bodies, 72(31.7%) of the total respondents had blood flowing back while

75(33%) of the total respondents stated they have had air bubbles.

Table 5: Technology use assessment

S/N	Question	Item	Responses	Percentage
13	Do you have a hospital phone to communicate with the nurses during such emergencies	Yes	40	17.6
		No	187	82.4
		Total	**227**	**100**
14	If NO, state the kind of device used for communication	Phone calls	19	8.4
		Text message	26	11.5
		None	182	80.2
		Total	**227**	**100**

Technology use assessment

Table 5 illustrates the technology use assessment in drip infusion. It revealed that 40(17.6%) of the total agreed that they have hospital phones to communicate with the nurses at such emergencies while 187(82.4%) of the respondents disagreed that they have hospital phones to communicate with the nurses at such emergencies.

Item 14 showed the kind of device they use to communicate with the medical personnel in the case of an emergency. 19(8.4%) of the total respondents agreed that it was phone calls, 26(11.5%) of the total respondents stated that it was text messages and 182(80.2%) of the total respondents stated that they did nothing.

Answers to the above questions guided us during the input specification section. With this, validations were made so the right data would be input, user- typed -input was minimized by using selection boxes in most of the fields.

V. SYSTEM REQUIREMENT

A specification is a precise and detailed description of something, including its design and the materials used to make it.

A. Hardware Requirement

The hardware requirements are the specific components and features that are required for the system to function.

1) Android or iOS: mobile smart phones with the latest operating systems

2) Drip Stand / Pole: Drip Stand for about 5.5ft high with two drip holder

3) IV Bag: Any intravenous fluid

4) Sensors: The sensors used include a load sensor, capacitive, and air bubble sensor.

5) Microcontroller and Arduino: The Arduino Mega is a microcontroller board based on the ATmega328 (datasheet) with several connectors.

For optimal functionality and delivery of the system, the following software requirements must be in place for sustainability.

B. Software requirement

1) Uninterrupted internet connection
2) IoT Web Server
3) Cloud Storage
4) Flash Memory
5) Static Random Access Memory (SRAM)
6) Electrically erasable programmable read-only memory (EEPROM)
7) Arduino IDE
8) C++
9) C language
10) Thing Speak

VI. SYSTEM DESIGN

The major goal of this phase is to develop software architecture/design based on the approved functional and non-functional requirements. It detects who is involved - i.e. project roles and responsibilities, the process, and deliverables. The deliverables are the database design, integrations/endpoint design, application design, infrastructure design, review, and approved design. The Architectural design of the system is shown in Figure 1. Also, the Main Menu Interface Design is illustrated in Figure 2.

A. Architectural Design

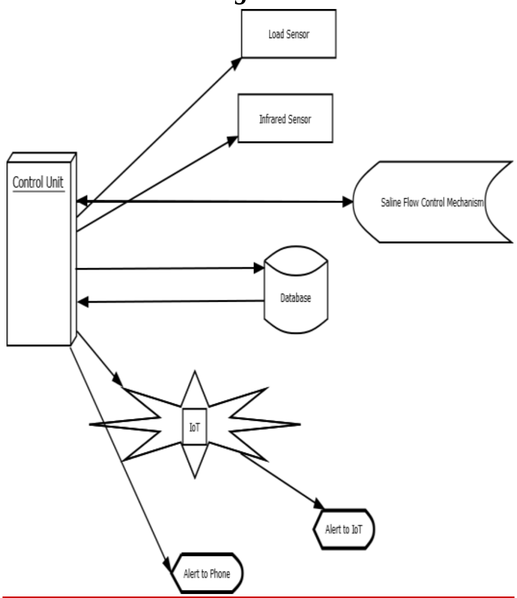


Fig 1: Architectural Design of the New System(Researcher's fieldwork)

B. Main Menu interface structural design

Figure 2 shows the interface structure of the system and how the sub-systems relate

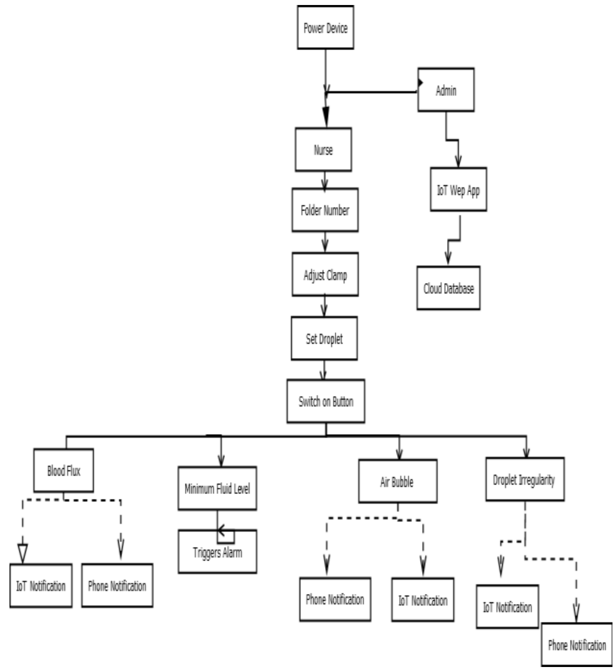


Figure 2: Main Menu Interface Design

VII. SYSTEM IMPLEMENTATION

This project has two modules. The Admin module and Nurse module. Development tools required to achieve the system design are as follows: Audino Mega, C++, Python, Thing Speak database engine

A nurse was trained and assigned to the technical aspect of the new system to administer the drip. Firstly, she hung the drip, to get the weight of the drip, and adjusted the clamp to set the droplet rate, after 15 seconds of the flow the actual droplet was saved and stored in the cloud database. Once all is set she starts monitoring the progress from her office via SMS notification.

This system is made up of two phases: the mobile phone interface and the IoT interface. The IoT interface is the cloud interface/ back end made up of the database and the administrator panel. The mobile interface is accessible to nurses and doctors, where they will be setting the drop rate, and receive messages on the patient's intravenous performance for responses. The database interface is the platform for system administrators. This is where the patient's and nurse's details are stored, such as the performance of the intravenous therapy and notifications for management use.

VIII. RESULT

Figure 3: Thing Speak Intravenous Monitoring System (IMS) Channel

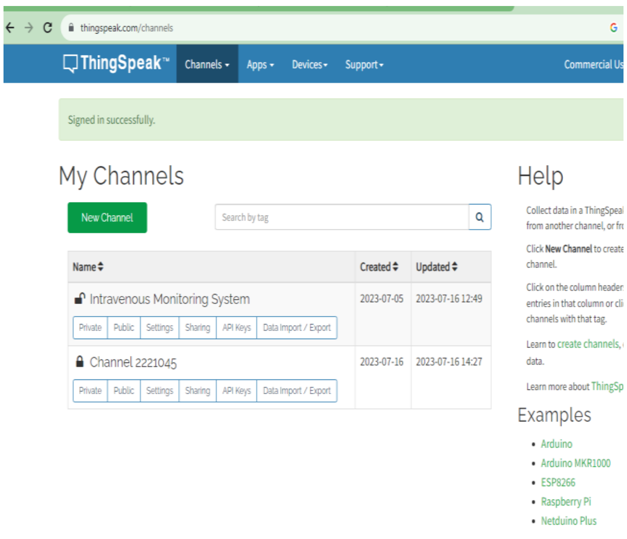


Figure 3: Private and Public View Channel

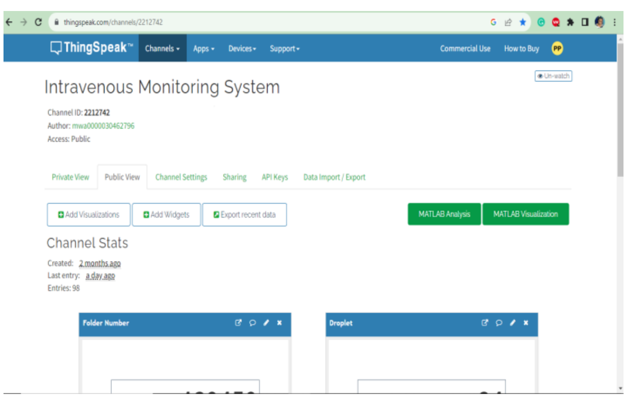


Figure 4: Private and Public View Channel

Import and Export Page

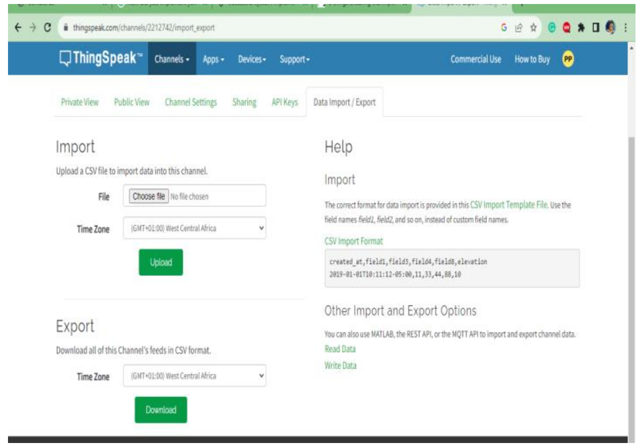


Figure 5: Import and Export Channel

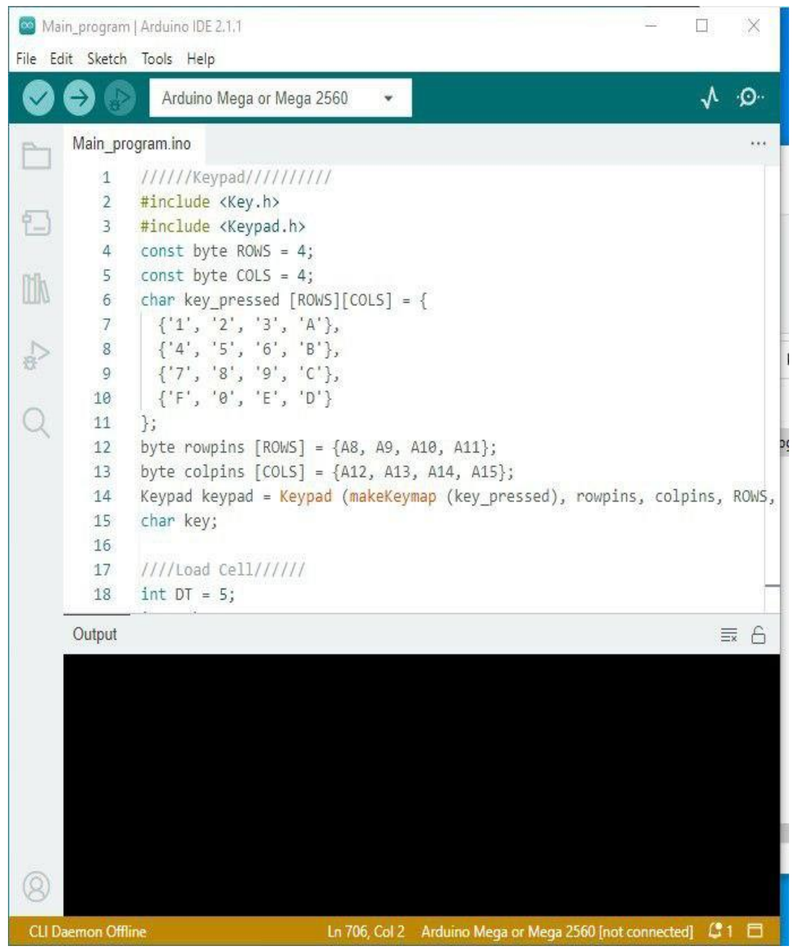
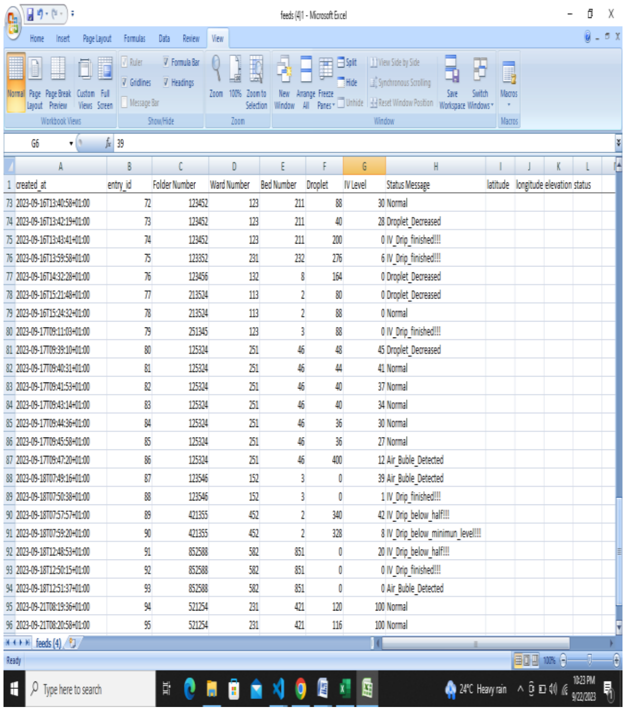


Figure 5: Arduino interface

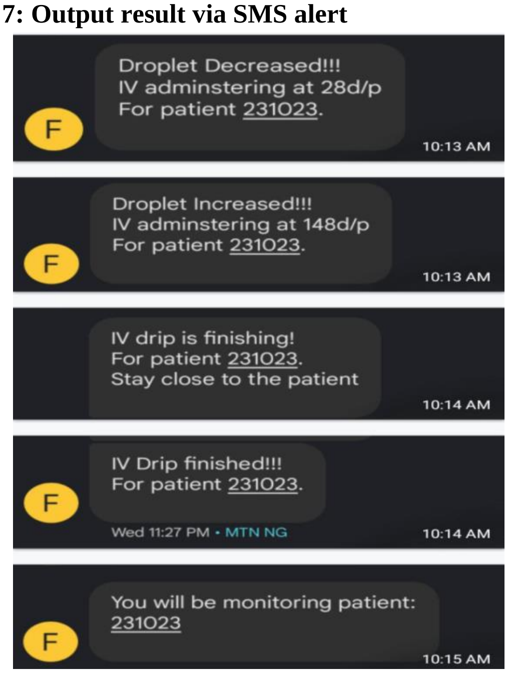
Figure 6: Database Implementation



	created_at	entry_id	Folder Number	Ward Number	Bed Number	Droplet	IV Level	Status Message	latitude	longitude	elevation	status
73	2023-09-16T13:40:58+01:00	72	123452	123	211	88	30	Normal				
74	2023-09-16T13:42:19+01:00	73	123452	123	211	40	28	Droplet_Decreased				
75	2023-09-16T13:43:41+01:00	74	123452	123	211	200	0	IV_Drip_finished!!!				
76	2023-09-16T13:59:58+01:00	75	123352	231	232	276	6	IV_Drip_finished!!!				
77	2023-09-16T14:32:28+01:00	76	123456	132	8	164	0	Droplet_Decreased				
78	2023-09-16T15:21:48+01:00	77	213524	113	2	80	0	Droplet_Decreased				
79	2023-09-16T15:24:32+01:00	78	213524	113	2	88	0	Normal				
80	2023-09-17T09:11:03+01:00	79	251345	123	3	88	0	IV_Drip_finished!!!				
81	2023-09-17T09:39:10+01:00	80	125324	251	46	48	45	Droplet_Decreased				
82	2023-09-17T09:40:31+01:00	81	125324	251	46	44	41	Normal				
83	2023-09-17T09:41:53+01:00	82	125324	251	46	40	37	Normal				
84	2023-09-17T09:43:14+01:00	83	125324	251	46	40	34	Normal				
85	2023-09-17T09:44:36+01:00	84	125324	251	46	36	30	Normal				
86	2023-09-17T09:45:58+01:00	85	125324	251	46	36	27	Normal				
87	2023-09-17T09:47:20+01:00	86	125324	251	46	400	12	Air_Buble_Detected				
88	2023-09-18T07:49:16+01:00	87	123546	152	3	0	39	Air_Buble_Detected				
89	2023-09-18T07:50:38+01:00	88	123546	152	3	0	1	IV_Drip_finished!!!				
90	2023-09-18T07:57:57+01:00	89	421355	452	2	340	42	IV_Drip_below_half!!!				
91	2023-09-18T07:59:20+01:00	90	421355	452	2	328	8	IV_Drip_below_minimun_level!!!				
92	2023-09-18T12:48:53+01:00	91	852588	582	851	0	20	IV_Drip_below_half!!!				
93	2023-09-18T12:50:15+01:00	92	852588	582	851	0	0	IV_Drip_finished!!!				
94	2023-09-18T12:51:37+01:00	93	852588	582	851	0	0	Air_Buble_Detected				
95	2023-09-21T08:19:36+01:00	94	521254	231	421	120	100	Normal				
96	2023-09-21T08:20:58+01:00	95	521254	231	421	116	100	Normal				

Figure 6: Database implementation

Figure 7: Output result via SMS alert



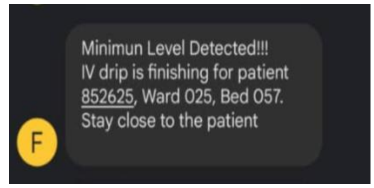


Figure 8: Development Of IoT Fluid Monitoring And Alert Systems in Healthcare Institutions

IoT Fluid Monitoring and Alert Systems

IX. CONCLUSION

A. Summary of Achievements

The development of an IoT-based fluid monitoring and alert system for intravenous patient administration in healthcare institutions across Nigeria is a vital step in achieving quality healthcare delivery. Medical errors can be either commission errors (taking an action you didn't mean to take) or omission errors (failing to take an action you should have taken). Beginning from the problem statement of this work, issues were mentioned as factors militating against the smooth running of the existing system. Furthermore, pertinent issues were also observed. This observation is the basis of our research gap. The research shows that there is no comprehensive model that solves the problem of IV monitors; unfortunately, the existing systems solve these problems in parts. The lack of a comprehensive development-based intravenous system in Nigeria poses a great challenge for healthcare institutions.

A standardized IV monitoring system ranges from IV droplet monitor, minimum level indicator technique, air bubble indicator, and blood flow back. With a development-based intravenous monitoring system, caregivers can save time, and lessen stress as a result of frequent monitoring since the system monitors the patients and sends messages in real-time to the caregiver on the status of the drip.

X. CONTRIBUTION TO KNOWLEDGE

Based on the research goals, the findings of the study added to the existing knowledge in the following ways:

1) uncovers the factors causing IV blockages during IV administration. This is a significant contribution because these factors have led to so many complicated health issues and loss of lives.
2) This research also develops a system that could monitor these blockages and notify the health care giver in charge in real time to enhance patients' recovery rate and hospital management
3) The research was able to establish that there are relationship between blockages and the leading cause of death via hypothesis testing
4) The study also models a system that can monitor Saline droplet detects Saline level and sends SMS in real-time in healthcare institutions
5) The study also provides a valuable contribution to academic research in drip monitoring and models Development based Intravenous Drip Monitoring Systems providing a theoretical understanding of IoT and monitoring systems to implement the findings made on the cause of the study and integrate the gaps the research was made to cover.

XI. REFERENCES

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