

# Improving how Emergency Room in Haiti handle patient's information

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**Abstract**—Haiti is not usually considered as using advanced technology or secure data and information. But this study attempts to move Haiti forward with applied science in healthcare, education, and overall living, and describes possibilities for implementation in the near future. This research explores the best factors that should be included in the software engineering and programming of systems using Artificial Intelligence and Information Security.

**Index Terms**—Information Security, Health Insurance Portability and Accountability Act, Haiti, Internet of Things, Identity Assurance, User Role, Java Enterprise Edition

## I. INTRODUCTION

It is time for a reboot. It is time for Haiti to move forward and we will start with applied science delivered by computer science that is trustworthy because of great security [1]. The 2010 earthquake that affected 3 million people and killed 230K of them in Haiti brought in a rush of assistance to the country from international aid sources, but they found that they had to bring with them their own communications infrastructure, as the existing resources were damaged.



Fig. 1. Cap Haitien

Trust issues quickly became apparent, as the different governmental and non-governmental activities did not have methods in place for inter-

operability of diverse systems because of needing to protect their systems with information assurance. The recovery from the disaster was slow, in part because of continuing trust issues, and in part for other reasons.



Fig. 2. Earthquake 2010

Today, ten years on, we have more effective and less expensive computer science information security hardware, software, artificial intelligence, and these technological advancements can greatly increase the trustworthiness and integrity of the communications systems of Haiti, as well as supporting resilience and recovery capabilities of the economy of Haiti to adapt to and bounce back from threats to its strength and positive growth.

## II. LITERATURE REVIEW

In our search for a publication related to our topic, we came across an article title, "Supporting Clinical Practice at the Bedside Using Wireless Technology" by Bullard, Meurer and others [2]. In summary, they studied and tested the productivity of physicians using wireless network mobile computer versus standard desktop computer. Their results found that wireless technology allowed doctors to access information at the bedside and increased the use of clinical guidelines and decision

support tools and patients accepted this use of information technology.

“Systems that are designed to simplify or automate tasks, especially using computer technologies, hold tremendous promise in guiding clinicians with patient care and increasing the safety of this care in the frenetic emergency department (ED) setting”. Developed IT systems addresses the major limitation of wireless technology portability. In addition to that, it increases security, improves performance and efficiency. Haiti does not have an officially recognized national or sector specific cyber security strategy. We intend on changing that so that all parts of the country are safe.

### III. APPROACH

The primary goal of this project is to help a future ER to use the power of technology to improve efficiency of medical staff. The secondary goal for this project is The propose solution needs to be simple, cost efficient, and be easy to maintain. The secondary requirement is to provide a method to increase security to the site and improve security in communities in Haiti to explore ideas about integrating Artificial intelligence to improve physical security.

The application needs to be either a desktop application and/or web application and use Java as the programming language. The solution's purpose should allow these two departments to perform their duties as efficient as possible without the replication of data. AS such, the database where the existing consultation application was storing the patient's records will also be used for the Emergency Room. The propose solution for the primary goal is as follow: Create a new desktop application using JavaFX and use the existing MySQL database.

As for the secondary goal in our case a community will be regarded as an enclosed area that is controlled and requires some sort of identification to gain access. For now, we will limit our communities to business, hospitals, and schools. Each of the three scenarios have different requirements but they are similar in certain ways. Access to the public, usage of gates at entry points, enclosed areas in either a wall or fence, and having security guards are some of the basic functional needs that are assumed to have existed prior to this project. Other

requirements are as follow. All entries need to have at least one security guard and there will be a central security office where the camera stream can be viewed, In addition to that, there should be enough storage available to store events up to a period of time.

All entry points will be equipped with security cameras that are connected to a server for image processing. This will assist in regulating vehicles going in and out of the community. Using the information available to the system, it will determine whether entry is permitted or not. Based on the results from the verification process, an alert will be sent to the security office and from there they will operate the gate. There will be additional cameras that have a clear view of the perimeter as well as others throughout the area.

After preliminary assessments, it is assumed that the hardware requirements are as follow: IP cameras (Wired preferably), multiple servers responsible for image processing, a file server to store security footage, or a fully working security system equipped with facial recognition. There will be a need for a database to store profiles, switches (depending on the number of cameras used, distances, types of camera, etc..), High speed router, motorized gates (where it applies)

### IV. METHODOLOGY

This study's primary focus was to design and create a prototype application that will allow two units in a hospital to perform their duties as efficiently as possible without the having too much redundant information. The solution should be reliable and cost efficient. As the hospital is under construction some requirements are subject to change. Therefore, a dynamic design was needed to accommodate future features. Based on project requirements, Web application and Desktop Application was the two types of application that was deemed acceptable. A web application is a type of application that is deployed on a webserver. This type of application can be accessed by using a web browser. A Desktop Application is a type of application that need to be installed on every machine that will be using the application. It can only run on the platform(s) it was designed for. In general Desktop Application are harder to maintain however they provide certain security

perks such as limited access to a service. To benefit from the perks that each type provides a dual application approach is adopted. As such the solution will be divided into three modules. The first module will consist of the creation and the implementation of the database. The focus will be the design for the ER. The second module was to design and create a prototype application written in java. The code should be written in a way that facilitate the implementation of a Servlet. The third module included the setup a local network, server installation.

The user interface was created using Scene Builder an FXML editor by Gluon and is saved as a FXML document. FXML is a variant of XML that is created by oracle to aid in the creation of JavaFX application. To link the GUI with the rest of the application, a JAVAFX controller must be used (MainController.java in this project.)

The package containing the GUI contain the Following classes: ER, TableContent, Main.fxml, mainController. ER is the entry point of the application, TableContent which is a class that define the structure of the search table Fig. 4, Main.fxml contain the informations about the different nodes on the form, and mainController which is responsible for the manipulating the UI. Some Fields in the application are validated on insertion as shown in Fig. 5.

The business logic is written in Java and is composed of the following classes: Allergies, DBConnect, Pair, PairList, Patient, Admission\_entry and Util. Allergies Class holds the information about a patient's allergies ( including allergies to medications.) PairList<E, E1> is a collection of Pair <E, E1>. A patient object hold the patient information such as name, identification number, date of birth, contacts, emergency contacts, etc. Per requirements, this package should be implemented in both the Desktop and the Web application and should require little to no changes. All information retrievals and manipulation will go through the Main class.

Fig. 3. Patient's Information

Fig. 4. Searching a record by using the Last Name

MYSQL database which is supported by oracle was the database of choice due to its popularity and because it was the database of choice for the existing consultation application. For simplicity, this paper will only focus on the tables (personnelle\_medicale, contact, Patient, admission, admission\_entry) to be used for this application. For starters we used the 4 GB ram

variant of the Raspberry Pi 4 to the Pi the server will run.

Upon reviewing the existing database certain flaws became obvious. The database was not normalized, there were redundant information stored, contact information were limited, etc. To remedy some the issues the table allergies, *personnelle\_medicale* were redesigned to provide the result shown in Fig. 5 and Fig. 6. By adopting this design in allergies it remove the restriction for putting an undefined amount of allergies for a patient.

Field	Type	Null	Key	Default	Extra
id	varchar(25)	NO	PRI	HULL	
Date_De_Naissance	date	YES		HULL	
Nom	varchar(50)	NO	PRI	HULL	
Prenom	varchar(50)	NO	PRI	HULL	
sexe	enum('M', 'F')	YES			
adresse	varchar(255)	YES		HULL	
Ville	varchar(255)	YES		HULL	

Fig. 5 Personnelle\_Medicale Table

Field	Type	Null	Key	Default	Extra
patient_id	varchar(20)	NO	PRI	HULL	
type	enum('autre', 'medicament')	NO	PRI	HULL	
allergie	varchar(45)	NO	PRI	HULL	

Fig. 6 Allergies Table

Other change such as adding primary keys to tell records apart and ensure uniqueness. Foreign keys were also added to link related record from multiple tables. Strict foreign rules were used to prevent broken links and orphan record. An orphan record that do not related to any record in a reference table.

Although the database and the application are completed, they need a network to link them to one another. Ethernet cable connected the servers to switches and routers. The database will be available only on the local network to add a layer of protection against unwanted access while decreasing retrieval time. To use the application, a user must be either connected via an ethernet cable or via Wi-fi (use will be limited.) To prevent unwanted access to the database user will be authenticated and cross referenced with video stream.

Full DDL script for the table creation

```
CREATE TABLE `personnelle_medicale` (
  `id` VARCHAR(25) NOT NULL,
  `Date_De_Naissance` DATE DEFAULT NULL,
  `Nom` VARCHAR(50) NOT NULL,
  `Prenom` VARCHAR(50) NOT NULL,
  `sexe` ENUM('M', 'F') DEFAULT '',
  `adresse` VARCHAR(255) DEFAULT NULL,
  `Ville` VARCHAR(255) DEFAULT NULL,
  PRIMARY KEY (`id`, `Nom`, `Prenom`),
  KEY `fk_admission_update_32` (`Nom`, `Prenom`)
) ENGINE=INNODB;
```

```
CREATE TABLE `contact` (
  `med_personnel_id` VARCHAR(25) NOT NULL,
  `contact_key` VARCHAR(45) NOT NULL,
  `contact_value` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`contact_key`, `contact_value`,
    `med_personnel_id`),
  KEY `fk_contact_1_idx` (`med_personnel_id`),
  CONSTRAINT `fk_contact_1` FOREIGN KEY
    (`med_personnel_id`)
    REFERENCES `personnelle_medicale` (`id`)
    ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=INNODB;
```

```
CREATE TABLE `patient` (
  `patient_id` VARCHAR(20) NOT NULL,
  `birthdate` DATE DEFAULT NULL,
  `Nom` VARCHAR(100) NOT NULL,
  `Prenom` VARCHAR(100) NOT NULL,
  `Sexe` ENUM('M', 'F') DEFAULT '',
  `picture` LONGBLOB,
  `picture_ext` VARCHAR(7) DEFAULT NULL,
  `Rue` VARCHAR(255) DEFAULT '',
  `Ville` VARCHAR(50) DEFAULT '',
  `Department` VARCHAR(30) DEFAULT '',
  `Pays` VARCHAR(30) DEFAULT '',
  `groupe_sanguin` ENUM('O+', 'O-', 'A+', 'A-', 'B+',
    'B-', 'AB+', 'AB-') DEFAULT '',
  `Nif` VARCHAR(45) DEFAULT '',
  `Tel1` VARCHAR(45) DEFAULT '',
  `Tel2` VARCHAR(45) DEFAULT '',
  `Email` VARCHAR(45) DEFAULT '',
  `Urgence_Nom` VARCHAR(45) DEFAULT '',
  `Urgence_Prenom` VARCHAR(45) DEFAULT '',
  `Urgence_Ville` VARCHAR(45) DEFAULT '',
  `Urgence_Email` VARCHAR(45) DEFAULT '',
```

```

`Urgence_Departement` VARCHAR(30) DEFAULT "",
`Urgence_Pays` VARCHAR(30) DEFAULT "",
`Urgence_Rue` VARCHAR(50) DEFAULT "",
`Urgence_Tel1` VARCHAR(20) DEFAULT "",
`Urgence_tel2` VARCHAR(20) DEFAULT "",
`Urgence_Relation` VARCHAR(45) DEFAULT NULL,
PRIMARY KEY (`patient_id`)
) ENGINE=INNODB;

```

```

CREATE TABLE `admission` (
  `date` DATE NOT NULL,
  `patient_id` VARCHAR(20) NOT NULL,
  PRIMARY KEY (`date`, `patient_id`),
  KEY `fk_admission_1_idx` (`patient_id`),
  CONSTRAINT `fk_admission_1` FOREIGN KEY
  (`patient_id`)
  REFERENCES `patient` (`patient_id`)
  ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=INNODB;

```

```

CREATE TABLE `allergie` (
  `patient_id` VARCHAR(20) NOT NULL,
  `type` ENUM('autre', 'medicament') NOT NULL,
  `allergie` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`patient_id`, `type`, `allergie`),
  CONSTRAINT `fk_allergie_1` FOREIGN KEY
  (`patient_id`)
  REFERENCES `patient` (`patient_id`)
  ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=INNODB;

```

```

CREATE TABLE `admission_entry` (
  `id` VARCHAR(25) NOT NULL,
  `patientid` VARCHAR(20) NOT NULL,
  `admission_Date` DATE NOT NULL,
  `medecin` VARCHAR(30) DEFAULT NULL,
  `date` DATE DEFAULT NULL,
  `heure` TIME DEFAULT NULL,
  `plainte` VARCHAR(2000) DEFAULT NULL,
  `histoire` VARCHAR(2000) DEFAULT NULL,
  `etat` VARCHAR(600) DEFAULT NULL,
  `poids` DOUBLE(6, 2) DEFAULT NULL,
  `pression_arterielle` VARCHAR(100) DEFAULT
  NULL,
  `temperature` DOUBLE(6, 2) DEFAULT NULL,
  `frequence_respiratoire` DOUBLE(6, 2) DEFAULT
  NULL,
  `pulse` DOUBLE(6, 2) DEFAULT NULL,

```

```

`hauteur` DOUBLE(6, 2) DEFAULT NULL,
`tete` VARCHAR(600) DEFAULT NULL,
`thorax` VARCHAR(600) DEFAULT NULL,
`abdomen` VARCHAR(600) DEFAULT NULL,
`respiratoire` VARCHAR(500) DEFAULT NULL,
`impression_clinique` VARCHAR(600) DEFAULT
NULL,
`genital` VARCHAR(600) DEFAULT NULL,
`extremite` VARCHAR(600) DEFAULT NULL,
`autre` VARCHAR(1000) DEFAULT NULL,
`doctor_Nom` VARCHAR(50) DEFAULT "",
`dotor_Prenom` VARCHAR(50) DEFAULT NULL,
PRIMARY KEY (`id`),
KEY `fk_admission_update_1_idx` (`patientid`),
KEY `fk_admission_update_32_idx` (`doctor_Nom`,
`dotor_Prenom`),
CONSTRAINT `fk_admission_update_1` FOREIGN
KEY (`patientid`)
REFERENCES `patient` (`patient_id`),
CONSTRAINT `fk_admission_update_32` FOREIGN
KEY (`doctor_Nom`, `dotor_Prenom`)
REFERENCES `personnelle_medicale` (`Nom`,
`Prenom`)
) ENGINE=INNODB;
;

```

## V. ARTIFICIAL INTELLIGENCE

Artificial Intelligence is intelligence demonstrated by machines that can perform tasks that typical required human intelligence. Artificial Intelligence is a collection

of many technologies in one. A large portion of these advances have quick importance to the medicinal services field, however the procedures and assignments they support shift generally. [3]

Machine Learning is a factual procedure for fitting models to information and to 'learn' via preparing models with information. Machine learning is one of the most well-known types of AI; In 2018, Deloitte survey of 1,100 US managers whose organizations were already using artificial intelligence, 63 percent of companies surveyed were employing machine learning in their business. It shows there are

various techniques to artificial intelligence. [4] Another 79 percent say that AI technologies empower people to make better decisions. This is entirely too important to overlook. Better decision making in the healthcare field leads to saving more lives, quicker.

In the healthcare field, the most widely recognized utilization of customary AI is precision medication – foreseeing what treatment are probably going to succeed on a patient dependent on different patient properties and the treatment context. [5] The mass majority of machine learning and precision medication applications require a preparation dataset for which the result variable is known; this is called supervised learning.

Another form of AI technology is natural language processing. NLP is the ability of a computer to understand, analyze, manipulate, and potentially generate human language. Using NLP, machines can make sense of unstructured online data so that we can gain valuable insights. [6] This includes, speech recognition and translation. In healthcare, the prevailing uses of NLP include the creation, comprehension and characterization of clinical documentation and distributed research. NLP frameworks can investigate unstructured clinical notes on patients, plan reports (e.g. on radiology exams), translate understanding communications and direct conversational AI.

Artificial intelligence appears to have as of now quickly embedded itself everywhere into patient healthcare. For example, the journal Nature published an article in 2017 in which machine learning was able to diagnose skin cancer as efficiently as dermatologists. [7]. In 2018, another scientific article claimed that AI was even able to do it better than dermatologists. [8]. In addition, the FDA (Food and Drug Administration) in the USA authorized the first AI device to diagnose diabetic retinopathy without a physician's help in April 2018. [9] Many countries across the world such as the United States, France, China have implemented the use of Artificial Intelligence in their everyday lives. Leaving smaller countries, such as Haiti behind.

#### VI. PRELIMINARY FINDINGS/RESULTS.

Due to the materials used in the construction, there is a performance issue with wireless signal. Therefore, we will wire all or most terminals to reduce latency and increase connectivity. In addition to that, we are in the process of created a database and a web application to propose and promote to the hospital in Haiti.

#### VII. CONTRIBUTIONS.

There are many changes taking place in the healthcare sector. One may therefore ask why are databases important? Simple, it is essential that proper systems are in place to manage the health data. Healthcare databases are an important part of running the entire operations. Such systems include labs, finances, patient identification, tracking, billing, payments, among others. The reality is that almost everything runs on a database system and we cannot underscore the importance of technology in healthcare. With technological innovations, medical facilities are leaning towards online transaction processing, thus doing away with paper. Anything that a medical practitioner collects from a patient forms part of the database. These include encounter forms, discharge forms, or any other registries. The whole purpose then of having a database is to ensure that the information is safe, updatable when necessary, and is easily accessible to anyone who may require them.

Technology makes it easier for professionals to send information to their colleagues and it also means documentation is much easier to store within networks, and thus, more room for more equipment and patient beds is available with less storage required.

Preventing cyber-attacks in this instance is especially important because without being able to use technical data stored within databases and networks, it means healthcare professionals cannot be as efficient. It is especially important today when the population is growing so fast that even an efficient industry cannot keep up with it.

#### VIII. CONCLUSION

Healthcare is heavily reliant on technology these days, not just for hardware that can help cure illnesses but also when it comes to sending,

retrieving, and storing data. Healthcare has been an extremely important field for millennia. Optimizing processes is almost as significant as new discoveries and inventions in this industry. As everything goes e- and mobile nowadays so does the healthcare domain.

Our research is a project that will surpass the end of this current semester. The hospital we chose to implement our systems and procedures have yet to complete their infrastructure, making this the ideal location to start. Team member, Luc, is in communication with a physician working in/on the hospital and they will continue reporting to each other in the upcoming months. Through our findings and research, we believe our project will have great success and will turn out to be the start of technology advancement in a technology-deficiency country.

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