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EMA: Electronic Medical Assistant

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Abstract. Diseases such as asthma attacks, stomach infections, common colds, and throat and ear infections are common diseases presented by pediatric patients in public and private primary care doctor's office. The initial examination protocol of the physicians who attend these patients consists of a review of organs such as eyes, nose, throat, heart rhythm, lung and intestinal sounds and temperature. This review should provide the physician with sufficient information to determine if it is a case that requires urgent medical care or not. This document presents the design of EMA, an Electronical Medical Assistant who, based on sensors and an Arduino, obtains data directly from the patient. EMA could be used in two main scenarios; the first one is when the patient is at home and the data is sent to the doctor in order to receive a medical advice. The second one is when the patient is waiting at the hospital; a nurse read his/her data using EMA and sends it to the doctor who will decide the kind and order of the attention. The methodology consists of dividing the project into work packages, assigning to each one the activities corresponding to each of the project modules.

Keywords: Common diseases, pediatric patients, primary health care, Arduino, electronical assistant.

1 Introduction

Much of the care provided in health centers in the area of family medicine is given to pediatric patients, children between the first days of birth and 12 or 13 years of age. In the case of adults, this is a bit different since many of them avoid going to medical care for minor situations, for example common diseases such as flu, fever, and stomach conditions, among others. This is because, in most cases, the adults themselves resort to some other solution, which sometimes includes self-medication so as not to suspend their daily activities. In the case of pediatric patients, health problems require more attention, since something that might not be serious, such as dehydration or respiratory diseases, due to lack of timely care may be aggravated and have fatal consequences.

In addition, unlike in adults, in children self-medication is usually a much more delicate subject. When it comes to patients in the first few months of birth, the situation is even more complicated, first because of the fragility of their health due to their early age, and secondly because of their inability to communicate. In addition, this is complicated by the lack of experience of the parents, who also in many cases are young.

When a health problem occurs in pediatric patients, for example, a common cold, taking the child away from home could complicate the situation due to climatic changes and even pollution, and on the other hand, it involves long hours of waiting to be attended at a health center. In a situation like this, the transfer could be considered as unnecessary. Given this situation, what this document proposes, is to have a medical assistant for pediatric patients. This problem is addressed from two important points of view. The first is to try to solve the problem of unnecessary transfers, for which it is necessary to carry out the examination of the child at home and send to the doctor the results of such exploration.

The second is to allow parents to perform the osculation in a simple way. That is, it is known that the exploration in children is sometimes complicated, especially in children between 3 and 9 years of age, since in the doctor's office is performed by a strange person who is unfamiliar for the patient. To try to counter this problem, it is intended that the medical assistant has a friendly way in order to facilitate interaction with the child. The rest of the document is divided as follows: Firstly, the background and the origin of the problem of this proposal are presented in detail. Subsequently, the general objective and the specific objectives are presented.

Next, the theoretical framework section is presented, which presents the current situation of the technologies needed to develop the project, and studies and research that have been carried out and revolving around similar problems. Subsequently we present the impact or benefit that the development of this project will have, followed by the section of methodology that shows the description of the development phases realized for the achievement of the objectives.

2 Related Work

Use of an electronic medical record improves the quality of urban pediatric primary care was presented in [1]. This initiative allows to evaluate the quality of pediatric primary care, including preventive services, before and after the introduction of an electronic medical record (EMR) developed for use in an urban pediatric primary care center. Similarly, a study about physician assistant management of pediatric patients in a general community emergency department was presented in [2]. A pilot study, in order to enhance a pediatric CDSS (Clinical Decision Support System) with an electronic tablet based user interface and evaluate it for usability as well as for changes in patient questionnaire completion rates was presented in [3]. A system, called the Electronic Medical Record Search Engine (EMERSE) was presented in [4]. It functions similar to Google but is equipped with special functionalities for handling challenges unique to retrieving information from medical text.

The use of Electronic Health Record (EHR) documentation by healthcare workers in an acute care hospital system was presented in [5]. In this work, authors examined what information is used by clinicians, how this information is used for patient care, and the amount of time clinicians perceive they review and document information in the EHR. In [6], a general architecture of a health care system for monitoring of patients at risk in smart Intensive Care Units was presented. The system advice and alerts in real time the doctors/medical assistants about the changing of vital parameters or the movement of the patients and also about important changes in environmental parameters, in order to take preventive measures.

A novel IoT-based mobile gateway solution for mobile health (m-Health) scenarios was proposed in [7]. This gateway autonomously collects information about the user/patient location, heart rate, and possible fall detection. Moreover, it forwards the collected information to a caretaker IPA, in real time, that will manage a set of actions and alarms appropriately. The algorithms used for each mobile gateway service, and the scenarios where the mobile gateway acts as a communication channel or a smart object are also addressed by the authors initiative.

Unlike to analyzed works our initiative presents an Electronical Medical Assistant, named EMA. EMA, that it could integrating to works [1, 5, 6 and 5] and it could be used when the patient is at home and the data is sent to the doctor in order to receive a medical assistance and if the patient is waiting at the hospital, and nurse analyzes the data through EMA System and sends it to the doctor who will decide the kind and order of the attention.

3 EMA Architecture Description

We have decided to call this EMA (Electronic Medical Assistant) assistant. This medical assistant is presented as a robotic electronic device equipped with sensors focused on the measurement of vital signs that are commonly read in pediatric patients in a general medical practice. That is, a set of sensors that capture the temperature, the sounds emitted by heart and lungs, and images of eyes, nose, and throat, and, through a digital platform, send them to the family doctor for analysis and determine the actions to be taken, without implying the transfer of the patient.

Although EMA is geared towards the care of pediatric patients, because somehow, moving from home to a health center is complicated, sometimes unnecessary, or sometimes not recommended, it can also be used by other types of patients. Patients with different ages. This project has the additional advantage of being able to monitor the patient’s health status in a constant way, since thanks to it; the patient’s data can be collected at any time, which allow analyzing its evolution in shorter periods. An additional problem that this project also tries to attack is the auscultation of pediatric patients, since the review is often complicated due to children’s fear of doctors.

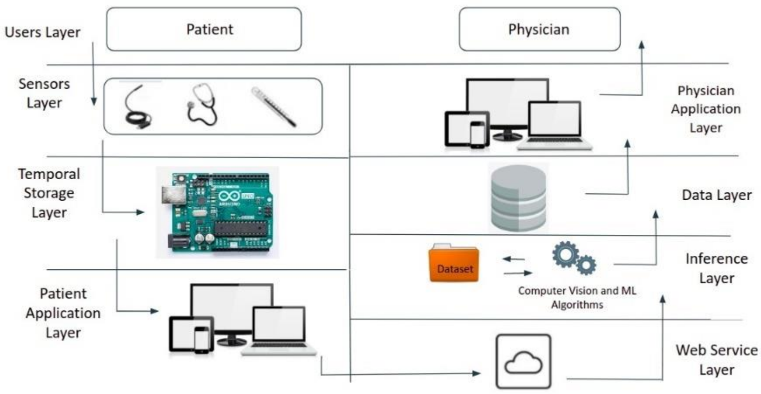

Fig. 1. EMA Architecture Patient to Physician.

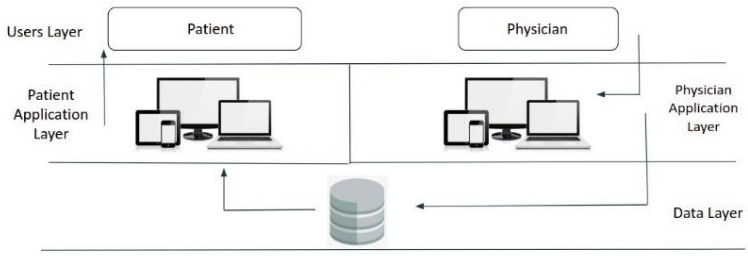

Fig. 2. EMA Architecture Physician to Patient.

Therefore, it is thought that if an electronic device in the form of a robot that simulates a toy performs this activity, the child will feel more confident and will facilitate their review. The architecture of this device will be conformed by an Arduino device that will have connected the different sensors that capture the information on the health of the patient.

This device should have the ability to connect to the Internet to send this information to your family doctor, who will receive it through the digital platform Medic-Us presented in [8]. Additionally, we plan to develop a module that is added to the social network and serves for the interpretation of sounds emitted by patients and captured by sensors using signal processing techniques, and thereby provide a clearer idea to the physician about the normality or anomaly of the sounds, and that this information is useful to the doctor to determine the actions to be taken.

Finally, in case the device can not send the data over the Internet, it will be provided with the capacity to store the data collected in an external storage device, for example, a USB memory for later sending using another device. The EMA architecture is presented below and is shown in Fig. 1 (Data flow patient to physician) and Fig. 2. (Data flow physician to patient)

The EMA architecture starts with the patient which is sensed by three kinds of sensors; the first one is a camera to take pictures of the patient's eyes, nose, throat, or any other sign that can be captures in a picture, for example, something in the skin. The

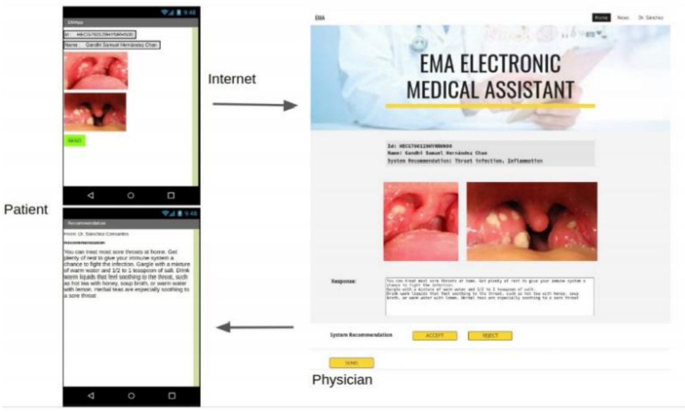

Fig 3. EMA use case.

second one is a sound sensor that captures different kind of sounds, for example lung, stomach, and bowel sounds. Finally, the third sensor is a temperature sensor that captures the temperature of the patient. All the data captured by the sensors layer is send to an Arduino device.

The Arduino device must send the data to the Patient Application Layer that can be a mobile device or a PC device. This can be done in three different ways, using a Bluetooth module, using a Wi-Fi module, or storing the data in a USB and then connect it to the PC. The Patient Application Layer send the data to the Inference Layer though the Web Service Layer.

The Inference Layer is composed by a Dataset which contains images to compare with, and an inference engine supported by computer vision a Machine Learning algorithm in order to make classification tasks. Then, the patient data and the result of the inference engine are stored in the Database (Data Layer) and presented in the Physician Application Layer.

Once the physician has analyzed the patient data he can communicate with the patient and send the result using the Physician Application Layer. The response will be stored in the Database (Data Layer) to allow the patient access it though the Patient Application Layer.

4 EMA Use Case

The mobile application is divided in two parts as it is shown in the left side of the picture. In the first part the patient takes pictures and load into the mobile application. The pictures can be taken from an external camera as it was shown in the architecture figure or from the mobile camera. Once the pictures are loaded, the patient can send it by Internet to the physician. As shown in the architecture, the images go through the image analysis engine for classification. Based on the result of the classification, the system generates a recommendation. The physician receives the patient information, images, and system recommendation in the web application, as shown on the right side of the figure.

The doctor accepts or rejects the recommendation of the system. Based on this answer, the images will be stored in the repository with the corresponding classification. The doctor writes his recommendation to the patient and sends it to him. The patient receives the doctor's recommendation in the mobile application. For each of the interactions between patient and doctor, a record is stored in the database in order to generate the patient's history and to be able to observe the evolution of the case.

5 Conclusions

The impact of the development and application of this technology has several aspects. On the one hand, the direct benefit to the parents of patients by allowing them not to transfer the patient unnecessarily but still, to be able to receive the health service and medical advice. On the other hand, the benefit to the patients, regardless of their age since they can be monitored from their home continuously or at least in shorter intervals of time.

In the same way, doctors obtain the benefit of knowing the health status of their patients and storing this information, which will allow them to know better their evolution, and to have information that serves as part of the medical history. In addition, having systems that compare the data obtained from a patient and the parameters considered as normal, for example, in the case of pulmonary sounds or heart rate, will enable physicians to offer a better diagnosis and for therefore a better treatment. Hospitals, clinics, and other health centers will benefit from having fewer people in their waiting rooms and thus be able to offer a better service.

6 Future Work

As a future work we intend to add to EMA artificial intelligence capabilities to perform two main activities. The first is image recognition using computational vision techniques such as those presented in [9] and [10] using OpenCV libraries, for the purpose of identifying abnormalities related to redness of the eyes, inflammation of the throat, etc. For this, an image repository and a system training process should be provided. The second activity is the treatment of signals.

The signals will be obtained from the sounds of the heartbeat, lungs and stomach and intestinal noises. As in the previous case it is intended to develop a system that, based on a repository of sounds and training process, be able to recognize abnormalities in the signals generated by the sounds. Also, we are interested in build computational models that can classify diseases based on patient symptoms and use these models in a space-time context in order to address epidemiology issues.

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