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Systems for Monitoring Hands Hygiene of Medical Staff in Hospitals

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***Abstract*— One of the most worrying issues that clouds the activity in Romanian hospitals and around the world is the occurrence of nosocomial infections, in many cases due to the improper hygiene of the medical staff's hands. Also in the new context of the COVID-19 pandemic, the issue of hospitals hygiene takes new dimensions. For this reason, the research in the present paper aims at identifying new methods and devices to be used in monitoring the hands hygiene of the medical staff in an efficient and simple manner, using mainly image processing and biometric analysis.**

It was noticed that by thoroughly observing the problem areas in the attempts of properly sanitizing the hands of the medical staff there arise the possibility of increasing the efficiency of doing away with infections and reduce the risk of further transmitting dangerous diseases.

Keywords*— *hands washing technique;disinfection; hygiene; monitoring systems.

I. INTRODUCTION

Hands hygiene is emerging as a primary prevention measure,which is why the World Health Organization (WHO) has developed guidelines recommending a six-step "hand rub" technique for applying alcohol-based disinfection. [2]

A study from 1996 upon the medical staff, warns that the 6 steps hand hygiene technique is not rigorously performed. 57% of the staff presented non-disinfected skin areas on the thumbs, 35% on the finger tips [5], which questions the efficiency of disinfection. In another study, a higher proportion, of 60% of the tested subjects were not able to perform an adequate technique of han rub. [1]

The importance of hands hygiene was proven to be primordial in preventing nosocomial infections, and it seems decisive to find methods for concrete support in this action, followed by identification of optimal techniques and solutions. In other words, the efficiency of hands washin depends firstly on performing and repeating this action, as many times as necessary, as often as possible and only then analyze the quality of water, soap, antiseptics or used procedures.

The shortcomings 0f frequent washing upon hand teguments (dry skin) are diminished by alcoho-based disinfectants and antiseptics, suitable emollients, equivalent or superior to antiseptic detergents. [1]

Compliance among healthcare workers regarding hand hygiene was researched in many hospitals, in many countries and Romania is only recently considering the issues with more resources. [6], [7].

Hands washing technique consists of 6 easy steps that take place over a period of 20-30 seconds depending on the complexity of future activities.

II. PROPOSALS FOR TECHNICAL SOLUTIONS OF HANDS HYGIENE MONITORING

There are systems of haands hygiene monitoring that use UV light or sensors detecting hands motions during disinfection. Studeis performed by experts showed the degree of involvement of the medical staff and also the auxiliary staff in medical facilities, be they public or private.

Based upon the analysis of speciality literature, these systems prove to be expensive enough or they do not perform with the desired efficiency as far as the monitoring process is concerned and also concerning the learning module of the 6 steps imposed by WHO.

Fig.1 Monitoring system with UV light from B-braun

In collaboration with the medical staff at the Infectious Diseases Hospital Brasov, we were able to analyzeÎ a device

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using blue UV light in order to monitor hands hygiene, while the result is visually observed by an individual or even the person performing the procedures. These devices may be used both in educational purpose and for quality control in performing hands disinfection techniques.

In figure 1 we presented an educational and monitoring device meant to properly master the hands washing techniques by rubbing, using a fluorescent testing solution. The working principle of this system is a very simple one, after applying by rubbing the fluorescent substance for 20-30 seconds, following the recommended technique, the hands are positioned under the UV lamp.

This solution is colorless, the covered skin areas appear having a certain color under the UV lamp of the device. The skin areas that did not come in contact to this solution remain dark, there being the areas where bacteria may survive and are considered areas prone to infections. The mostfrequently omitted areas during hands hygienization are presented in figure 2.

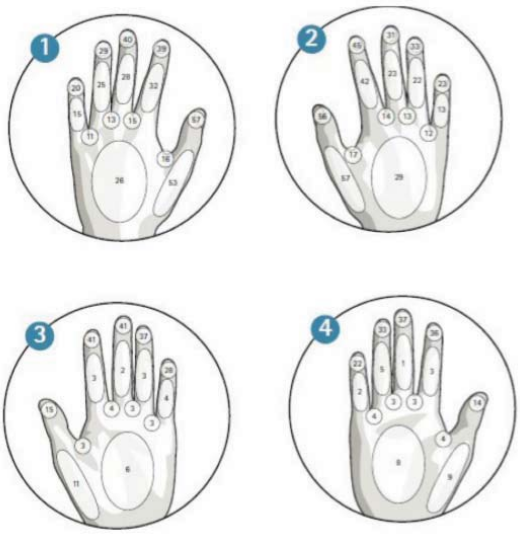

Fig.2 Omitted areas during hands washing

The explicit areas in figure 2 are the follwoing:

1. Left hand dorsal part
2. Left hand palm pat
3. Right hand dorsal part
4. Right hand palm part

Following the use of such a device, we could visually analyze the result obtained under theinfluence of a UV lamp. A fluorescent substance was used meant only for educational purpose, this being GlitterBug Gel solution produced and traded by Brevis. Another substance distributed by B-braun, under the name of Fluo-Rub can be also used as disinfectant because it has ethilic alcohol, glycerine and excipients.

The subjects were presented the 6 steps to be followed during the disinfection technique, because these do not activate in medical field. The oteined results can be seen in the following figures.

Fig.3 Palm part of first subject's hands

Fig.4 Dorsal part of the first subject's hands

Fig.5 Palm part of the second subject's hands

Fig.6 Dorsal part of the second subject's hand

As it can be observed in the above figures, the first subject was keener in following the six steeps of the hygienization technique, while the second subject omitted some of them. These statements are supported by the presence of the fluorescent substance on the skin surface of those individuals.

Following the analysis and research in the state of the art of the hands hygiene monitoring systems development we reached the idea of developing such a system.

Fig.6 shows the block diagram of the newly designed system and the manner in which new components are interconnected in order to optimize and automate the system.

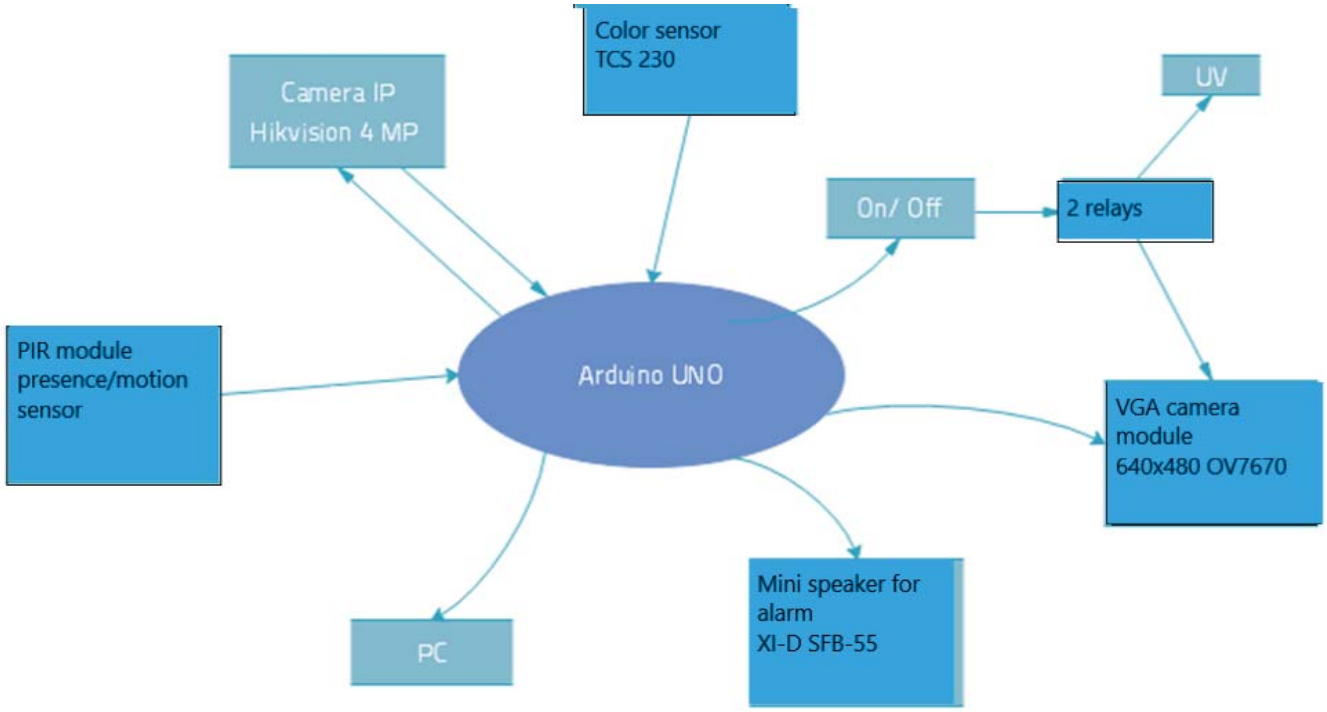

Fig.6 Block diagram of the hands hygiene monitoring system

The way the system works is a simple one, but in our opinioin it will have a good efficiency and will meet the requirements it was designed for. As presented in the above block diagram, the development board Arduino UNO will control most of the components. The moment the PIR module including the motion sensor will detect the hans presence inside the device, it will send a signal to the development board and this one will automately activate the UV lamps and camera mode.

As long as the sensor is active, the camera will be programmed to take two pictures in 5 seconds period, during which the person using the system will position the hands first with the dorsal part up, and then with the palm side up. This process will provide two pictures that will be send to the flash memory of the system and will be displayed on a monitor. If the hands analysis and image processing will provide a system error or the calculated percent is smaller than the required one, then an audio signal will be activated by help of the mini speaker also connected with the development board.

The color sensor module controbutes in obtaining a better result so that it will detect and record the wavelength of the color on the hands surface emitted by the disinfection substance. This will convert the wavelength in a square signal of a certain frequency specific to the detected colorand the results will be displayed on a monitor together with the obtained images.

As already mentioned before, perons' identification is done traditionally by help of the RFID module. In this case we will approach an identification method based on the IP camera IP Hikvision including a behavioral analysis module, and

respectively a facial recognition module, which will be connected to the monitor. In order to use such a method, the hospital should have a proper database with the medical staff from the healthcare institution. This database will be used to compare biometric values of the acquired image from the monitoring system and the image retrived from the database.

The entire system will be permanently powered by 220V and it will also dispose of an auxiliary power source to be used in case of a malfunction in the electricity network. In order to ensure a proper operation, the healthcare institution should provide a computer or a laptop to be used for data storage, display and processing of results.

III. Conclusions

By analyzing this system we found that it can be completed with new components, so that an automated hands hygiene monitoring system is obtained The camera, motion sensors, alarm sensor and color sensor were added with the purpose of transforming the system in an autnomous one.

It was propsed to perform the identification of medical staff in hospitals by help of an intrnal camera including a behavior analysis module and a facial recognition one. In order to benefit of this new method, the kealthcare unit using it will have to have a database of its staff available in order to be able to compare the biometric values of the acquired image according to the working principle of the system. Concerning the software part of the new designed system, an algorithm of image processing will be used. Following many performed trials and analysis we found that the best way of processing the acquired image is the use of the colored image by establishing certain thresholds to identify strictly the hand surface, and then the blue component will be extracted from the RGB complex. Thus, this algorithm is improving the performance of hands hydiene evaluation Further studying this problem and the spcialized literature and scientific studies we propose to develop in the future a mobile application for image processing, as such a system will provide results much faster.[3-4] By performing the economic calculus of the device and consulting a market study, the product benefits of a very efficient quality-cost ratio. According to our calculations we got a total price per product of 1471,81 lei, which is an affordable cost by comparison to the other devices existing on the market.

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