Newer Generation of Robotics Used in Hospital

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Abstract

The report has proposed a method whose goals are to reduce the pressure in the hospital and to help medical staff to combat COVID-19. At the same time, it provides an opportunity for long-term socially isolated people to participate in social exchanges. Through the combination of medical robots and service robots, users can enjoy humanized artificial intelligence services while receiving treatment. The robot can replace medical staff who always direct contact with patients and it can also provide remote communication when people visit the patient. The project is facing medical staff and patients in the hospital. We focus on analyzing the functionalities of the robot, which is characterized by different responses and expressions to patients. The multi-functional robot can deliver supplies to the sickroom, take the temperature for patients, and provide a remote video call. Moreover, the robot can display seven emotions and respond to users with voice. The report contains images of robot emotions and some program code about script dialogues. In addition, the work method snapshot and workflow are provided in the report that can provide readers with a clear concept. This research also aims at human-robot interaction and it determines the user's satisfaction with the robot's response to investigate the necessary functions that have not been developed.

Keywords: Medical Robots, Service Robots, Multi-functional, COVID-19, Human-Robot Interaction etc.

1. Introduction

According to COVID-19 [1] is getting more serious with the increasing number of infections. Instead of using a large number of medical staff and medical equipment to take care of the patients, robots can help patients to get clinical care and more timely treatment. With the deployment of medical robots, the pressure to fight with COVID-19 in the hospital is greatly reduced. Our goal is mainly to focus on the logical design of a medical

robot, such as emotions, functions, etc.. Section 2 reviews a number of related works and scholarly articles about the social robot in the medical field. Section 3 will discuss the novel design of the new generation robot. Section 4 will describe the scripted dialogue of the robot and the emotions that can be displayed on the face of the robot. Section 5 will give a conclusion about the project and present our future works.

2. Related Works/Literature Review

What divers to make a medical innovation on artificial intelligence that is medical staff are facing a severe pandemic and their work environment is at risk of infection. There are some related works that can support our project to work properly and ensure our robot can really help medical staff to fight with the disease.

1) Robots can play an important role in fighting with a pandemic. A science journal points out the role of the robot in fighting with COVID-19 [1]. The robot can manage public health and decrease infection. This article can relate to our project, our robot aims to play the same role in combating the disease.

2) In the meanwhile, a piece of news on the website gives us inspiration, a robot called 'ninja' has been deployed in a Thai hospital [2]. Their robot can provide a video call between medical staff and patients. At the same time, the robot can bring supplies to a high-risk area. Therefore, our project can design a medical robot with some useful functions, for example, delivering medicine and remote communication.

3) Based on an article that discusses the expression in different colours [3], we would design different colours on the wheel. It is better to express the feeling of the robot with its facial emotions.

4) For the actions of the robot that we are considering, we can refer to a scholarly article that talks about two experiments on robot-human interaction with nonverbal expression. The robot can express the emotion through the tactile reaction and show its behaviours to express its emotions [4]. Therefore, our robot can express its emotions and reply with actions when the user touches it or speaks to him.

5) To consider the risk of direct contact between medical staff and patients, it is necessary for doctors to use a robot to make a video call with patients. According to a research paper, the research group uses robots as social mediators to test a remote communication system on ten pairs of users under two different game modes. Their findings state that remote communication is accepted by users and most users prefer one of the modes [5]. Our project considers implementing remote communication through the touchscreen, camera, speaker, and microphone of the robot. The paper would give our project help to make the robot design more interactive.

6) In order to reduce the risk of infection, doctors have to take the temperature for patients without direct contacting. The robot with the temperature monitor can be competent for this job.

According to a research paper, a research group implements a patient's temperature measurement system to take the temperature for patients. They also refer to the details about how hardware and software architecture can be implemented [6]. Their research can provide us with ideas about the implementation of the temperature monitor on the robot. It is feasible for a robot to take the temperature for patients with the temperature sensor.
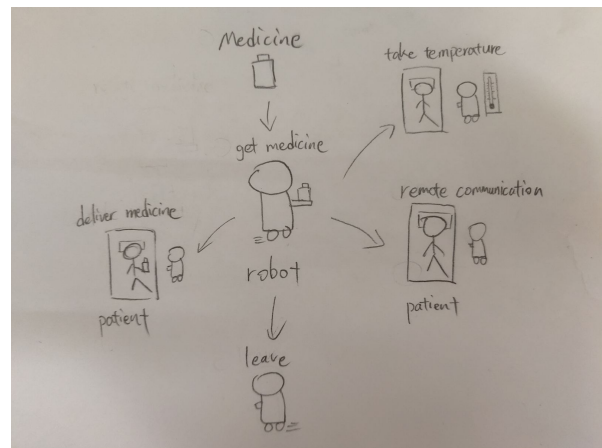
7) For how to implement real-time collision avoidance, a research paper can provide a reference. Based on the content of the research, the research provides a description of multi-robot collision avoidance. An algorithm that they research presents there are no errors in localization while combining the computation of collision avoidance [7]. When a robot is delivering supplies, collision avoidance ensures the robot can deliver supplies to the destination safely.

8) Our project focuses on remote treatment for patients. According to the news that can relate to our project, a dynamics' Spot robot is deploying to treat remotely for coronavirus patients in Boston's hospital [8]. Our project considers developing the same kind of service function on the robot that can remotely treat patients in the hospital.

9) While the disease is spreading, more hospitals are considering deploying the medical robot. A piece of news said that a Belgian hospital has deployed a patrol robot. It describes a use case of a robot to detect if people are wearing face masks properly [9]. The most important part is the function of face recognition, which we can consider in our current project. The function can help our robot become more multi-functional because the robot can keep detecting around while it is delivering supplies.
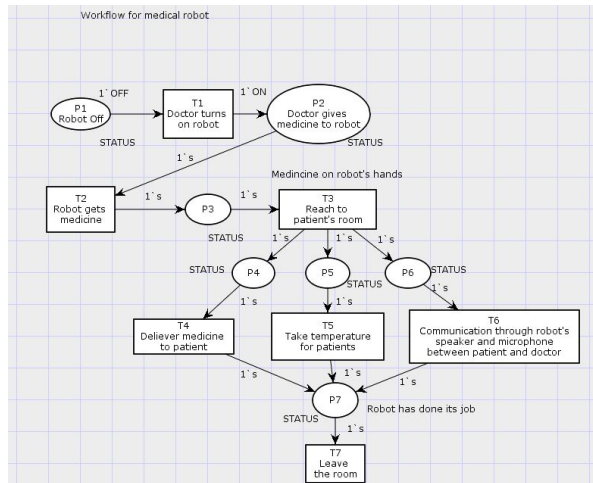
10) Moreover, designing an interactive robot needs to consider cultural differences. Different cultures may influence the communication model of the robot. A research paper studies the differences between Japanese and Chinese cultures. Word expressions and facial expressions are contained in the comparison of the research [10]. Therefore, our project needs to refer to the research and pay attention to the differences in expressions. To avoid misunderstandings caused by the robot's expressions.

3. Design

There are some images of the design shown below:

a) Layout for medical robot

Workflow for medical robot

P1 Robot Off — 1` OFF — T1 Doctor turns on robot — 1` ON — P2 Doctor gives medicine to robot

STATUS — 1` s — STATUS — 1` s

Medincine on robot's hands

T2 Robot gets medicine — 1` s — P3 — 1` s — T3 Reach to patient's room

STATUS — 1` s — 1` s — 1` s

STATUS — P4 — P5 — P6 — STATUS

STATUS — 1` s — 1` s

T4 Deliever medicine to patient — T5 Take temperature for patients — T6 Communication through robot's speaker and microphone between patient and doctor

1` s — 1` s — 1` s

P7 — Robot has done its job

STATUS — 1` s

T7 Leave the room

b) Workflow for medical robot

Description: the basic introduction about the work system of the medical robot	
Customers	**Products & Services**
- Medical staff - Patients	- Deliver supplies to sickrooms - Take temperature for patients - Provide remotely video call

Work Practices (Major Activities or Processes)		
- Turn on the robot - Put medicine on the hand of the robot - Robot delivers medicine to patients - Robot takes temperature for patients - Doctors can have a video call with patients - Robot leaves the sickroom		
Participants	**Information**	**Technologies**
- Robot maintainer - Medical staff - Patients	- Indoor map - Patient information - Temperature information	- Indoor positioning system - Collision avoidance - Temperature monitor - Remote communication system

c) Work method snapshot

The a) Layout and b) Workflow can give the audience a clear concept of the running process. c) The work method snapshot can provide brief information about the project.

In order to allow robots to accept human's increasingly busy work. The robot must be defined to have a certain workflow. The robot will be set to a certain patrol route, and react after detecting or hearing special sentences and move to the designated bed. At the same time, the robot can detect the patient's physical condition through a body temperature monitor while serving the patient, which can help the hospital to know the patient's condition quickly.

It is important to use a robot to communicate with the patient. This needs to be achieved by setting a pre-sentence response.

In terms of hardware, the robot needs the following:

1. A temperature sensor - the robot can detect body temperature in real-time for patients.

2. A microphone and call system - the robot can move quickly after receiving a command.

3. A remote communication system - can have communication between medical staff and patients.

The way to realize the language logic is by using the Zenbo lab with DDE. Back to the specific design, the first is the patrol of the robot. The robot needs to be designed to keep walking on the designated route and observe the nearby situation in real-time. At the same time, once the robot gets instructions or hears specific commands, it will go to the designated location and take corresponding actions. The above can be achieved by realizing a set database and a number of corresponding trigger conditions.

The second is hardware. The temperature sensor will convert the temperature into an infrared image and the robot will analyze it. Once the temperature and colour distribution are abnormal, the robot will move accordingly. In addition, the voice system will recognize the patient's sentence and match it with its command database. Once the match is successful, the robot will perform the action according to the command. Statements will be executed in order, and the administrator can modify the priority at any time.

Lastly, the interactive system is needed to be considered. The aforementioned is the premise of the interactive system. What really realizes this system is the language logic designed in the Zenbo lab. For example, if the

robot receives the command from the patient, the robot can show different postures, like nodding and shaking its head. The important point of interaction is to make the patient feel the intimacy of concern rather than being left out. Therefore, the robot's performance machine is important.

4. Prototype Scenario

Robot emotions [11]:

a)   Happy

b)   Waiting

c)   Doubting

d)   Blink

e)   Except

f)   Calling

g)   Sleeping
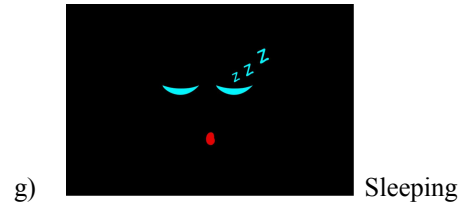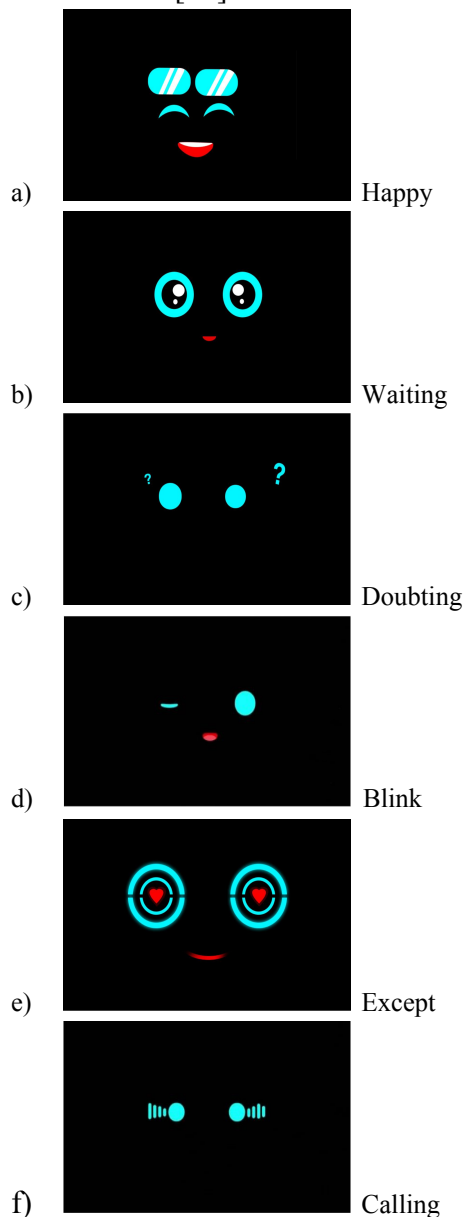
The robot has seven emotions that can be displayed on its face. Each emotion has its own meaning and expresses its feeling based on different situations. In addition, different colours will be displayed on the wheel of the robot. The robot can nod and shake its head when the user touches it or give an unrealized command.

    a. When the user touches the head of the robot to turn on it, the robot will display a happy face and yellow wheel. It will node and greet the user with:

```
speak.Speak("Hello, what can I help you?
You have four commands: deliver, testing, video, and goodbye.")
```

    b. The robot is listening and waiting for the user to speak a command. The orange colour will be displayed on the wheel.

    c. The robot will be doubted if the user speaks a command that it does not include in the list of commands, such as deliver, testing, video, goodbye. The wheel will display white colour. At the same time, the robot will shake its head and respond with:

```
speak.Speak("I do not understand what you said,
please give me a command")
```

    d. If the user speaks a command "deliver", the robot will blink and the colour of the wheel will turn green.

The robot will respond to the user with:

```
speak.Speak("Medicine is delivering, please wait.")
```

e. If the robot receives the command "testing", the robot will display its orange wheel and reply with

```
speak.Speak("Please wait, I am taking your temperature.")
```

f. If the user gives a command "video", the robot will display the calling emotion. The wheel will display the colour of blue and respond with:

```
speak.Speak("Connecting, video call is progressing...")
```

g. If the user says "goodbye" to the robot or touches the robot's head again, the robot will display the sleeping emotion and the yellow colour on its wheels. Then replying to the user with:

```
speak.Speak("Happy to help you, see you.")
```

Finally, the command will end the program and the robot will be shut down. Users have to reopen the robot if they want to have an interaction with the robot again.

5. Conclusions

The ultimate reason why we need robots is to save labour costs and reduce the sacrifice of resistance to COVID-19. There are three points that the robot really needs to achieve:
1. Robots need to efficiently complete the characters that humans can accomplish.
2. Robots can provide faster and better reactions to reality and special situations.
3. Robots can communicate with humans naturally and can be recognized by most people.

For our future plan of the robot, we could try to consider more functions on the medical robot. Creating a more powerful database containing a large number of commands. The robot will not be limited to several functions. More actions and emotions can be performed on the robot. The robot will be more interactive and vivid.

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