Analysis of voice control of a collaborative robot

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Abstract. Using the voice control to interact with things around us can always be one of the most interesting things. Voice control is becoming more and more used in everyday life, whether it is a smart home, voice control of a mobile phone or voice control of comfort equipment in a car. Whether, voice control gets into the production industry line is the right question. Reliability is still insufficient. The paper is focused on analysis of voice control of a collaborative robot. Analysis is focused on various voice commands, their repeatability and reliability in robot-human cooperation. The research determines the most problematic voice commands and ideal voice commands for voice control of a collaborative robot.

1. Introduction
Research and development of technology is still irreversibly ahead. Every day we can meet something new that makes our work easier, increases our living comfort or increases the safety of us and our family. Progress is unstoppable in any industry, as is voice control. This research focuses on the analysis of voice commands of a collaborative robot. Otherday, we could not imagine that we could control a certain thing without physical contact. Today, we take remote control as a completely normal thing that we encounter every day. The same goes for voice control. We never even dreamed that we could control things with our voice. In today's rapid development, this thing is becoming a reality. Voice commands work in our cars, in our houses, voice commands in them and our smartphones.

Research into voice control in the past has yielded a lot of new information, such as knowledge about a voice controlled robotic arm vehicle [1-3], Li-Fi based voice control robot [4], [5], a voice controlled robot using arduino [6], [7], speech recognition system for a voice controlled robot [8] voice-controlled autonomous vehicle using IoT [9], [10]. The question still is, what is the reliability of voice control? Can voice control match the reliability of control with physical contact? The answer to these questions seeks to clarify this research.

2. Objectives and methods
The aim of this research is to analyze the voice commands to control a collaborative robot. For this purpose, the collaborative robot DOBOT Magician and its accessories for voice control, the Arduino kit, Figure 1, were used. DOBOT Magician is a multifunctional desktop robotic arm for practical training. Arduino kit is an additional equipment for voice control of DOBOT Magician.
Figure 1. Collaborative robot DOBOT Magician and Arduino kit

DOBOT Magician has 22 original fully programmable voice commands, for example Turn on the light, Play music, Pause. Figure 2 shows all voice commands for DOBOT Magician.

Figure 2. Voice commands
In order to check the success of the voice command, each voice command had to be reprogrammed to move the arm of the collaborative robot. For example, the first command moves DOBOT Magician for 30 points upward, the second one moves for 30 point downward. The reprogramming of commands is shown in Figure 3.

```c
if(SmartKit_VoiceENGVoiceCheck(7) == TRUE)
{
    Dobot_SetPTPCmd(MOVL_INC,0,0,30,0);   //magician moves upward
    Serial.println(voiceBuffer[6]);
}
else if(SmartKit_VoiceENGVoiceCheck(8) == TRUE)
{
    Dobot_SetPTPCmd(MOVL_INC,0,0,-30,0);  //magician moves downward
    Serial.println(voiceBuffer[7]);
}
```

**Figure 3.** Example of reprogramming commands

In this way, all voice commands were reprogrammed in order to verify their success. That is, if I say a voice command and the DOBOT Magician moves, the simulation was successful. If I say a voice command and DOBOT Magician does not move, the simulation was not successful. A 100 simulations was performed for each original command. Each simulation was recorded and evaluated at the same time. For this research was also necessary headset microphone and computer with audio software. AUDACITY software was chosen as the most suitable audio software for the given simulations. It is a free, easy-to-use, multi-track audio editor and recorder for computer. Interface of AUDACITY is shown on Figure 4.

**Figure 4.** Interface of AUDACITY
This is a simulation procedure, at first, it was necessary pronounce the voice command, record a voice command at the same time, after that verify the realization of the voice command and finally evaluate and analyse of the voice command. 22 commands were verified and 100 simulations were performed for each command, a total of 2200 simulations were performed. Simulation procedure is shown on Figure 5.

Figure 5. Simulation procedure

3. Results
After completing 2200 simulations, all data was analysed. A table of success of voice commands was prepared, then the simulations were analyzed in the AUDACITY program. The analysis looked for a connection between successful voice commands and less successful voice commands. The main problems of less successful voice commands have been successfully located. The results are shown in Table 1.

Table 1. Success of voice commands

| Voice command      | Success [%] | Average time [s] | Number of words |
|--------------------|-------------|------------------|-----------------|
| Open the door       | 98          | 0,887            | 3               |
| What’s the time     | 96          | 1,104            | 3               |
| Play music          | 93          | 0,958            | 2               |
| Decrease temperature| 93          | 1,329            | 2               |
| Increase temperature| 92          | 1,419            | 2               |
| Close the door      | 92          | 0,994            | 3               |
| Turn on the TV      | 89          | 1,382            | 4               |
| Turn off the TV     | 88          | 1,457            | 4               |
| Mode 2              | 88          | 1,109            | 2               |
| Previous            | 87          | 0,803            | 1               |
| Turn on the light   | 86          | 1,22             | 4               |
| Mode 1              | 86          | 1,138            | 2               |
| Turn off the light  | 78          | 1,28             | 4               |
| Right               | 78          | 0,511            | 1               |
| Next                | 76          | 0,615            | 1               |
| Stop                | 76          | 0,534            | 1               |
| Start               | 73          | 0,71             | 1               |
| Left                | 72          | 0,567            | 1               |
| Pause               | 71          | 0,56             | 1               |
| Down                | 71          | 0,56             | 1               |
| Go                  | 70          | 0,412            | 1               |
| Up                  | 68          | 0,335            | 1               |
In the first half of the Table 1 are the commands with longer average time and with more than one word. In the end of the Table 1 are short and quick commands with only one word. This is the main problem of the voice control of this collaborative robot. Ideal voice commands are phrases with more than one word and not too much short. Short voice commands consisting of only one word clearly had a problem executing the command in simulations. The collaborative robot DOBOT Magician could not perceive these short voice commands as well as it could perceive long voice commands composed of several words. Less successful voice commands include Turn on the lights and Turn of the lights. These voice commands were not so successful because DOBOT Magician often replaced commands one after the other and vice versa, because of the similarity of voice commands. It is very interesting that such a case did not occur with similar voice commands Turn on the TV and Turn off the TV. It is definitely worth mentioning that none of the 22 commands had a 100% success rate of voice commands.

4. Conclusion
This research was to analyze the voice control of a collaborative robot. The collaborative robot DOBOT Magician has 22 voice commands that have been reprogrammed to move, so that the success of the voice command can be easily verified. From each voice command, 100 simulations were performed, a total of 2200 simulations, which were analyzed. The achieved results show that the collaborative robot DOBOT Magician implements voice commands composed of several words very well. Voice commands consisting of only one word, which were short, were less successful. Therefore, in the future, when dealing with voice commands and voice control, the fact that voice control works with more success for longer commands and phrases than for short commands should certainly be taken into account. It is certainly worth mentioning the fact that none of the 22 voice commands achieved a 100% success rate. Voice control can make our work easier and the comfort of using various devices. However, its reliability is still not 100%. The authors of the scientific article still see great scope for improving the voice control of collaborative robots, which can be of great help to us in the future.

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