Poster: Edge-IoT Framework for Speech and Mobile-Based Human-Robot Interaction

Harish Ram Nambiappan, Enamul Karim, Md Jillur Rahman Saurav, Anushka Srivastav
University of Texas at Arlington
Arlington, Texas, USA
{harishram.nambiappan,enamul.karim,mxs2361,axs0985}@mavs.uta.edu

Fillia Makedon
University of Texas at Arlington
Arlington, Texas, USA
makedon@uta.edu

ABSTRACT

In this paper, a novel Edge-IoT framework is proposed which interconnects the user's smartphones with the robotic system for human-robot interaction. The user sends speech commands using mobile application which is processed by the framework and sent to the robotic system. The robotic system executes the task and sends a completion message to the user through the framework. Preliminary experiments conducted by sending multiple requests to the framework to perform a robotic task showed that the framework is able to handle multiple requests, send commands to the robotic system to perform the robotic task and send completion messages to the user efficiently.

CCS CONCEPTS

• **Human-centered computing** → **Smartphones**; • **Computing methodologies** → **Speech recognition**; • **Computer systems organization** → **Robotics**.

KEYWORDS

Internet-of-Things, Edge Computing, Human Robot Interaction

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1 INTRODUCTION

There is a need for human-robot interactive systems where smartphones are integrated with robotics, using Internet-of-Things, to assist humans in various scenarios. Previous works like [4, 5] focus on using smartphones with robots but they use smartphones as a controller to control robotic movement. Works like [1, 3] focus on using speech-based IoT in human-robot interaction, but the implementation is limited to verbal communication between human and robot. There is a need to work on human-robot interactive scenarios in which people can use their smartphones to transmit commands to a robot to accomplish a certain task while they can work on another task. In addition, an efficient framework is required so that several users can issue commands via smartphones and the robotic system can handle the workload created by multiple commands through the framework. In this paper, a novel Edge-IoT framework is proposed for speech and mobile-based human-robot interaction where users can send speech commands, through smartphones, which are processed and sent to the robot through the framework. In this way, the Edge-IoT framework interconnects user smartphones with the robotic system for human-robot interaction. A basic proof-of-concept version of the framework is implemented in this paper, where multiple users can interact with the robotic system through smartphones. The MINA Robot [2], consisting of Franka Emika Panda Arm mounted on a Summit-XL Steel Mobile Base, is used to implement this framework.

Figure 1: *Left:* User giving speech commands through the mobile application. *Right:* Robot performing the task based on the speech command

2 PROPOSED SYSTEM

Figure 2 shows the System Architecture of the Edge-IoT Framework which interconnects the user's smartphones with the robotic system. The mobile application uses the smartphone's microphone sensor to record the user's speech and sends it to the user edge node (Raspberry Pi). The user edge node performs speech recognition, using Google Speech Recognition, and retrieves the object details. The control command is generated by the user edge node using the object details and sent to the server, which stores commands in a database in the order of message arrival. The server retrieves the recently arrived commands from the database and sends them to the robotic edge node (Intel NUC). The robotic edge node stores the commands in its database and sends each command to the robotic system. The robotic system executes the task and sends the completion message to the robotic edge node. The robotic edge node repeats the process of sending the next command in its database to the robotic system. The received completion message is transmitted from the robotic edge node to the server, then to the user edge node

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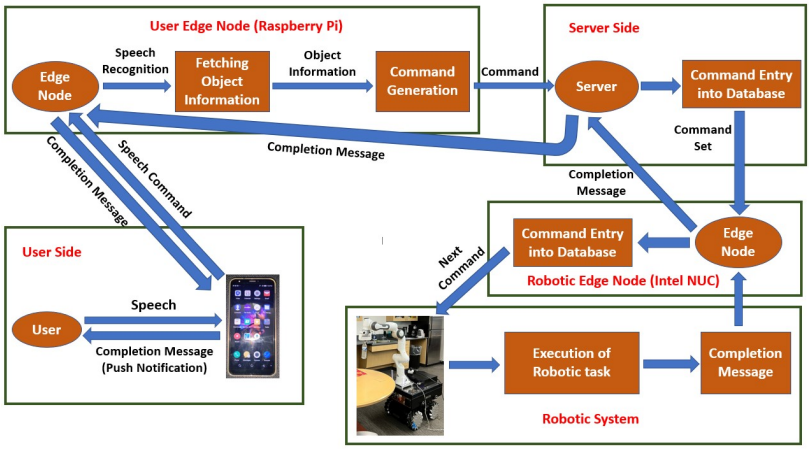

Figure 2: System Architecture of the Edge-IoT Framework

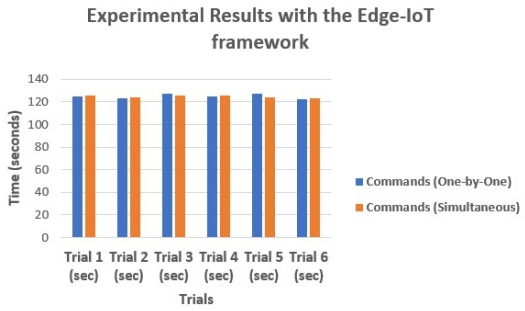

Figure 3: Chart showing the time taken to complete the task in each trial

and the user's mobile application, which sends a push notification to the user.

3 EXPERIMENTATION

The initial version of the framework was tested with the task of using the robotic arm to pick up objects from the source table to destination table. Four objects were placed in the source table. The user sends the speech command to get a particular object using the mobile application. The framework recognizes the speech command, identifies the object and sends the command to the robot to pick up the object and place it on the destination table as shown in Figure 1. The robot, edge nodes, server and the smartphones are all connected through a 2.4 GHz wireless network. The speech command was given in the following format: "Get me the x", where x is the name of the object to be picked up by the robot. Two Android smartphones were used to send speech commands to the robotic system and six trials were conducted. Each trial consisted of two scenarios - the first scenario involved sending speech commands from both the smartphones one after the other and the second scenario involved sending speech commands from both smartphones simultaneously. Therefore, in both the scenarios, two commands are sent (one from each smartphone) and the robot has to perform both the tasks. To ensure safety during experimentation, the robotic arm was set to operate at 10% of its maximum velocity. In each scenario, time was recorded starting from the moment the first request was sent till the completion of the final task and its notification to the user. The results are shown in Figure 3 which states that, in each trial, the time taken to complete both the tasks in each scenario is relatively the same. This shows that the edge-IoT framework can handle multiple requests, even if it is sent one after another or simultaneously, and can send commands to the robot to perform the robotic task and send completion messages to the user efficiently.

4 CONCLUSION AND FUTURE WORK

The paper proposes an Edge-IoT framework for speech and mobile-based human-robot interaction and was tested with the task of using the robotic arm to move objects from the source table to destination table. Future work includes adding vision-based techniques to perform tasks like character recognition and object detection so that the framework can also handle image-based requests and the robotic system can perform more efficient automated grasping of objects. Also, robotic navigation using the mobile base is to be integrated into the framework that allows it to perform a variety of user requests such as taking objects from a different place and navigating to the requested user to provide the object etc.

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