Using Amazon's Echo Dot for Outreach Robots and to Interface with Robot Operating System(ROS) for Voice Recognition on Robots

Eric J. Santillana

Software Engineering, UPR Mayagüez

Mayagüez, Puerto Rico, 00681

Email: eric.santillana@upr.edu

Abstract

Voice enabled devices are a convenient way to interact with technology even more so if it is used on a robot. Having a robot respond to the user's voice commands is a great way to keep the user engaged and interested. Most speech processing software has many accent, background noise and communication disorder complications, with Amazon's Echo Dot those complications are greatly reduced. In this project, this device was used to answer the users outreach questions about Southwestern Indian Polytechnic Institute and to control robot movements. This is an excellent recruitment tool because it makes the user interested in the College and in the field of embedded programming and robotics.

Introduction

As society moves towards a technological era, more and more people are interested in getting a STEM related degree. This means having Open Houses and doing Outreach so the people can become interested and choose what educational institution fits their needs. The methods of doing outreach are all very similar for all educational institutes, hand out brochures with information, give tours, websites and many other tools to get the people engaged and interested in the institution. But, what if you had a robot that can answer all those questions people ask on these events? Or even better, what if the user could make this robot move with his or her voice? That would make open houses and outreach a different and more engaging experience for the people attending these events.

Approach

The approach for this project has two parts: Outreach and Integration to ROS. Both approaches use the Amazon Echo Dot as the voice recognition tool.

A. Outreach

This part uses Amazon's serverless compute system AWS Lambda and Amazon Developer Portal to create the skills necessary to answer the users outreach questions (Figure 1). This compute system runs the code in response to events and automatically manages the underlying compute resources. The code for this AWS Lambda function is written in Node.js. AWS has support for the following programming languages: C#, Java 8, Node.js and Python. Amazon refers to the functions in the Echo Dot as "skills", these are created in the Amazon Developer

Portal. Here you specify the skill's invocation name, interaction (utterances, intents) and configuration (Service Endpoint Type) in this case the created AWS Lambda function for the skill (Figure 1). In this console, you can also test the skill without having to use the actual Echo Dot. This is very convenient because you can quickly test your skill.

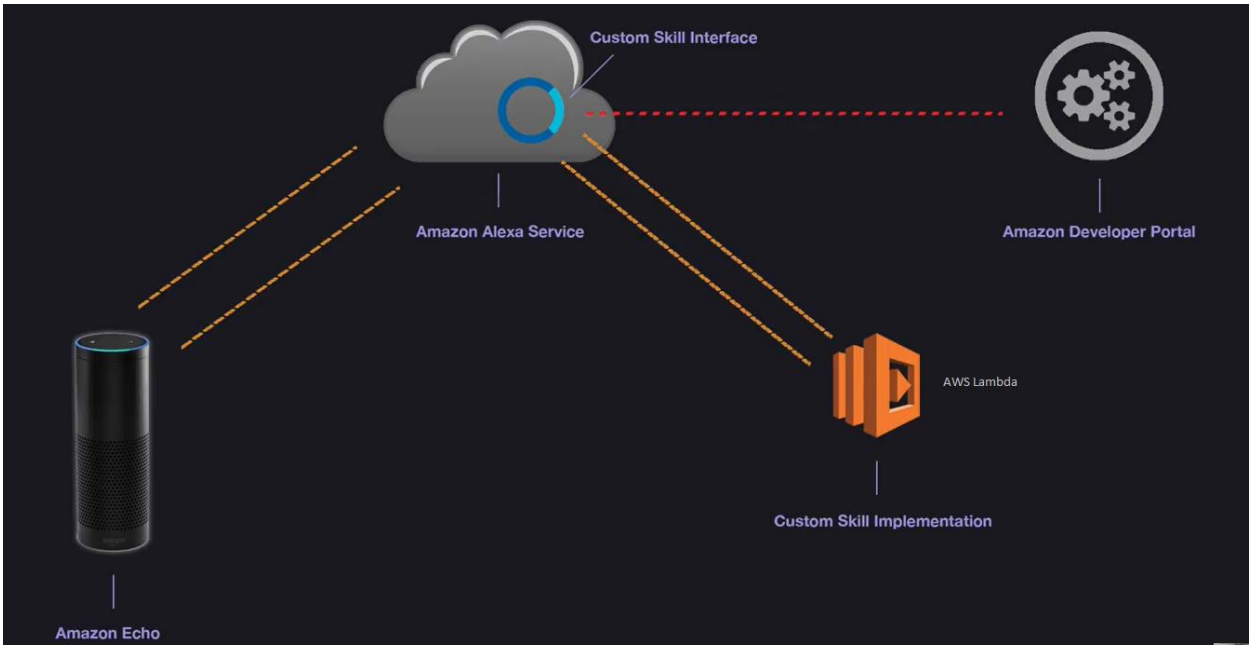


Figure 1. Model of how the Amazon Skill Service works

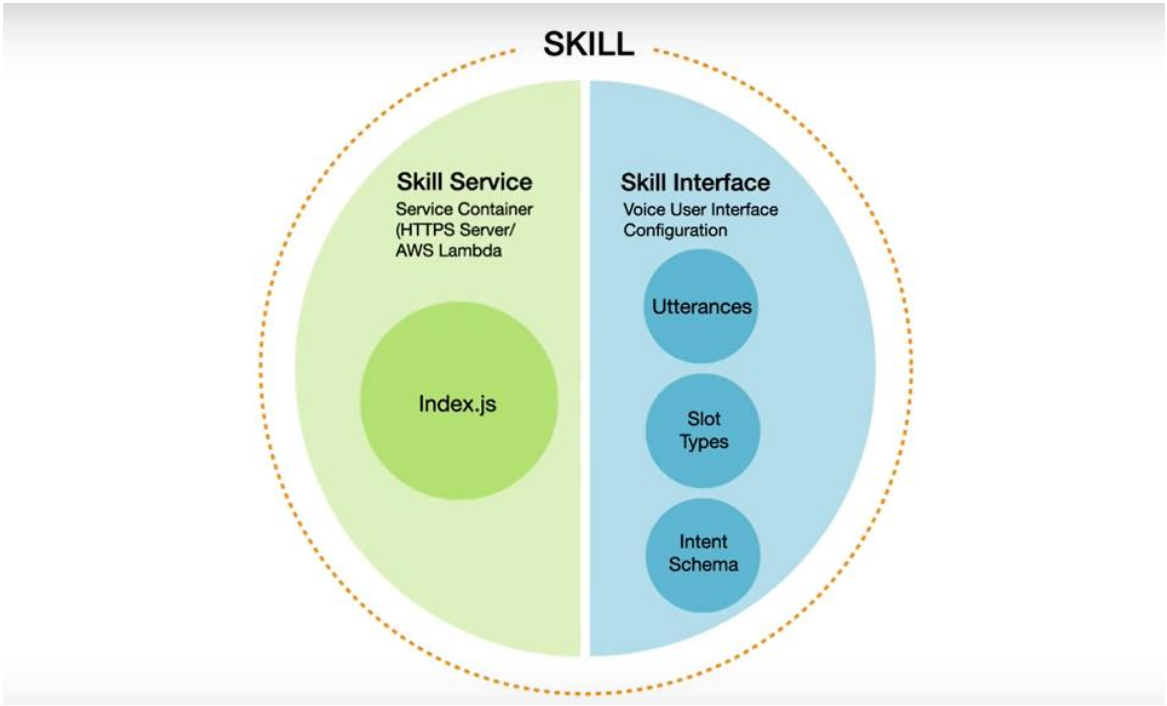


Figure 2. Amazon Echo Skill Setup.

B. Interfacing Amazon Alexa with ROS

This part requires to have a computer with Ubuntu installed (14.04 and up). You must install the following software on your system: Robot Operating System ROS(Kinetic or Indigo recommended) with rosbridge-server, npm, node.js and bespoken tools. For this Alexa skill AWS Lambda is not necessary, since the bespoken tools proxy lambda command allows you to run a Lambda as a local service your machine(Figure 1). More info on the installation and the code can be found on my GitHub: https://github.com/ericsantii/alexa-turtlesim-ros.

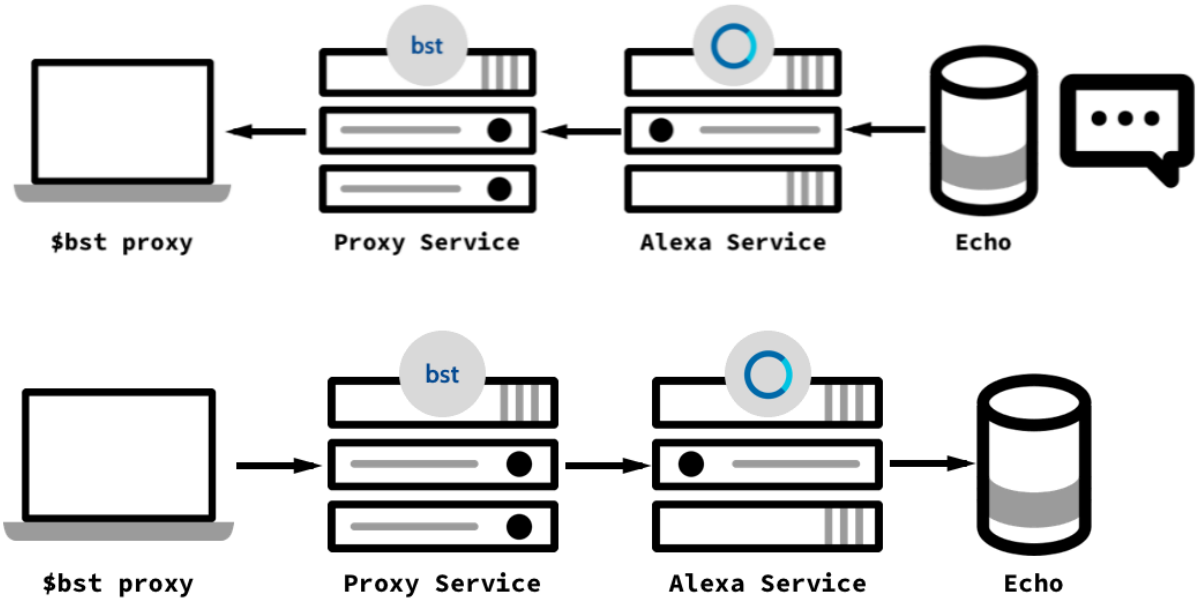


Figure 1. Model showing how the Amazon Echo interacts with the bst proxy service.

Experiment

A. Interfacing Alexa with ROS

I collected data for a total of 4 weeks taking in account the utterances of the skill. The people that used the skill are predominantly from the Southern parts of the United States. These utterances are used to control the movement of the robot by sending messages from the Proxy Service and ROS running on the robot. The utterances were:

- Move forward
- Forward
- Move backward
- Backward
- Turn left
- Turn right

These phrases are used to test the total number of utterances which ended during a session, which includes sessions ending due to an error.

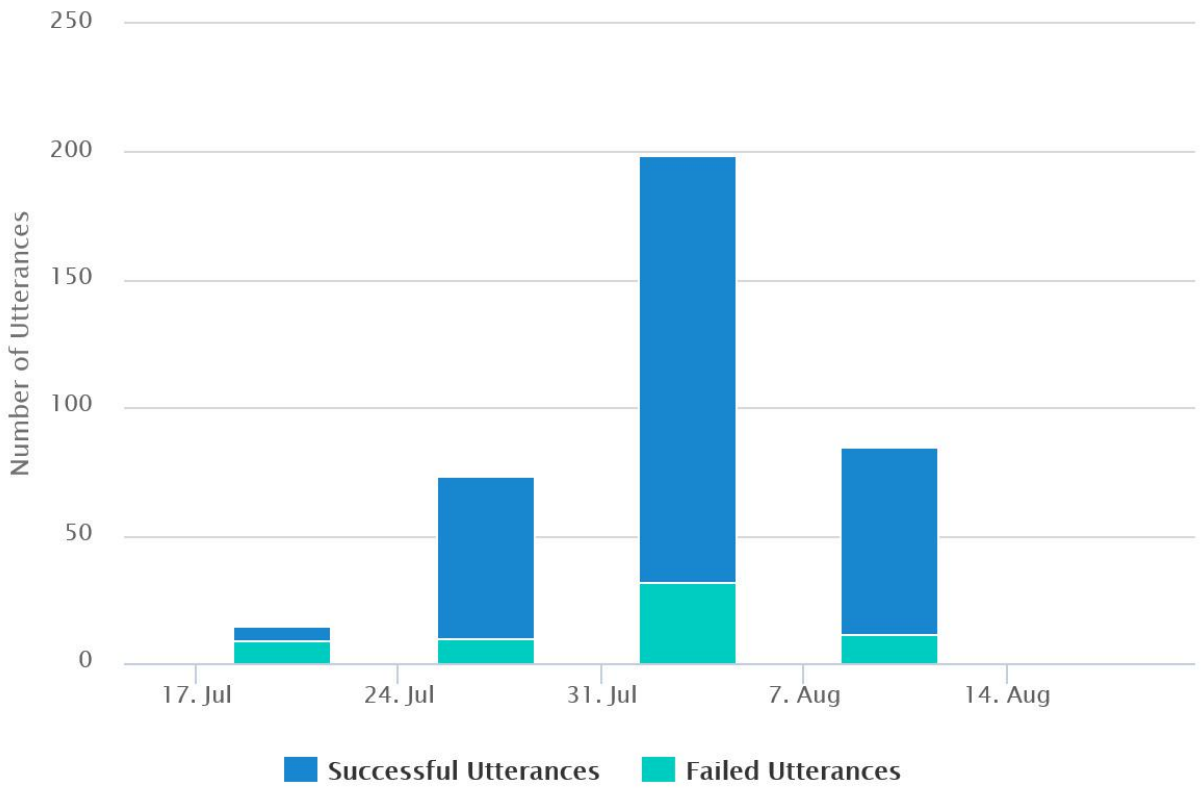
The calculations done are:

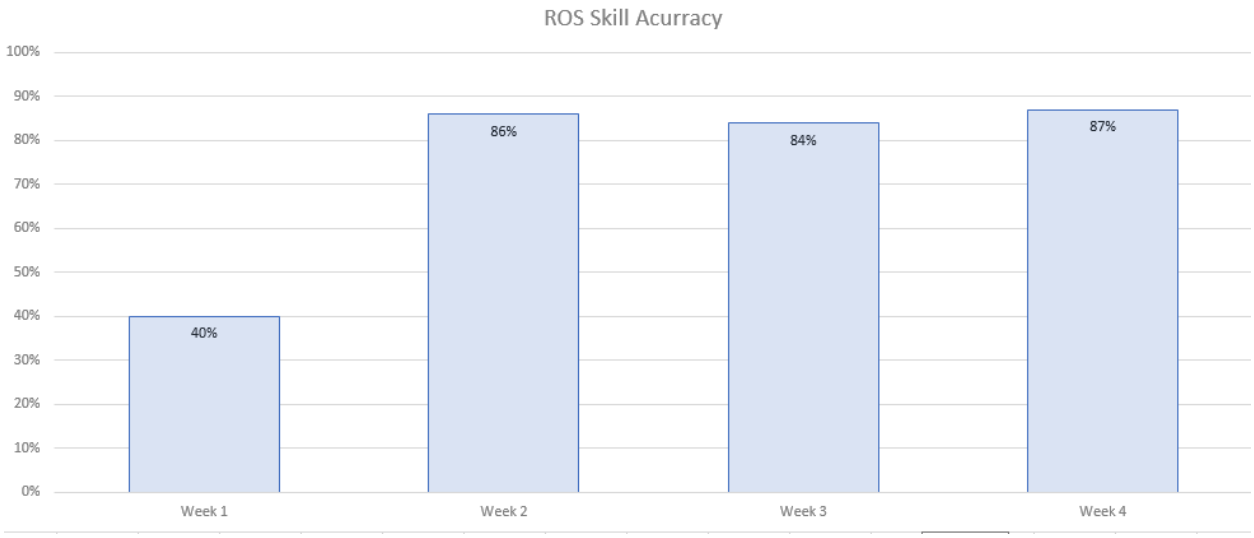
- The total successful utterances per week
- The total failed utterances per week
- The accuracy of the skill per week

Total Utterances

Date/Time	Successful Utterances	Failed Utterances
2017-07-20 00:00	6	9
2017-07-27 00:00	63	10
2017-08-03 00:00	167	32
2017-08-10 00:00	74	11

Total Utterances (Successful and failed)





B. Outreach

I collected data for a total of 4 weeks taking in account the utterances of the skill. The people that used the skill are predominantly from the Southern parts of the United States. The utterances were:

- Can I apply for admissions on-line?
- Is there a SIPI store to buy SIPI t shirts?
- Do you offer a Nursing program?
- Do I really have to take Math?
- Will courses transfer to other colleges?
- Is SIPI Accredited?
- How long does it take to complete a Certificate?
- Is there a health clinic on campus?
- How long does it take to complete an Associates Degree?
- Is there a curfew at the dorm?
- Do you have family housing?
- Can I bring my own vehicle?
- What items do I bring if I'm staying in the dorm?
- Does SIPI offer child care?
- How much is tuition?
- Do I have to pay for textbooks?
- How many students attend SIPI?
- What tribes are represented at SIPI?
- Can non-Natives attend SIPI?
- Does SIPI offer scholarships?
- What clubs are on campus?
- Does SIPI have sports teams?

- May students work and go to school?
- Who are you?
- Who designed you?
- How were you made?
- What are your capabilities?

These questions are used to test the total number of utterances which ended during a session, which includes sessions ending due to an error.

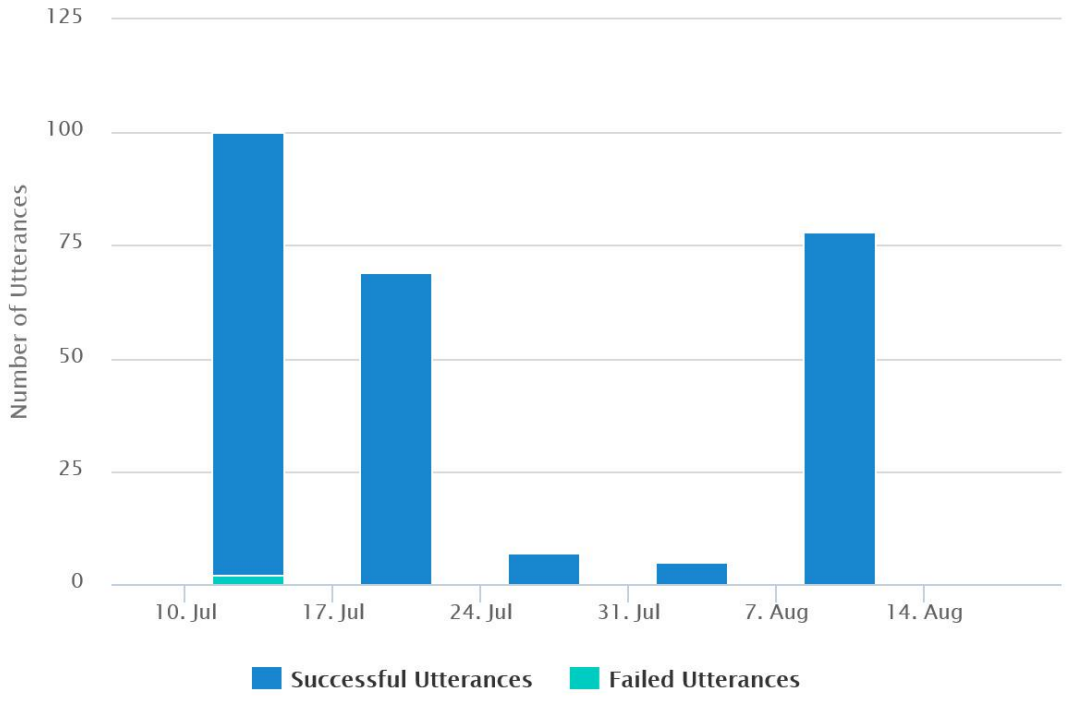
The calculations done are:

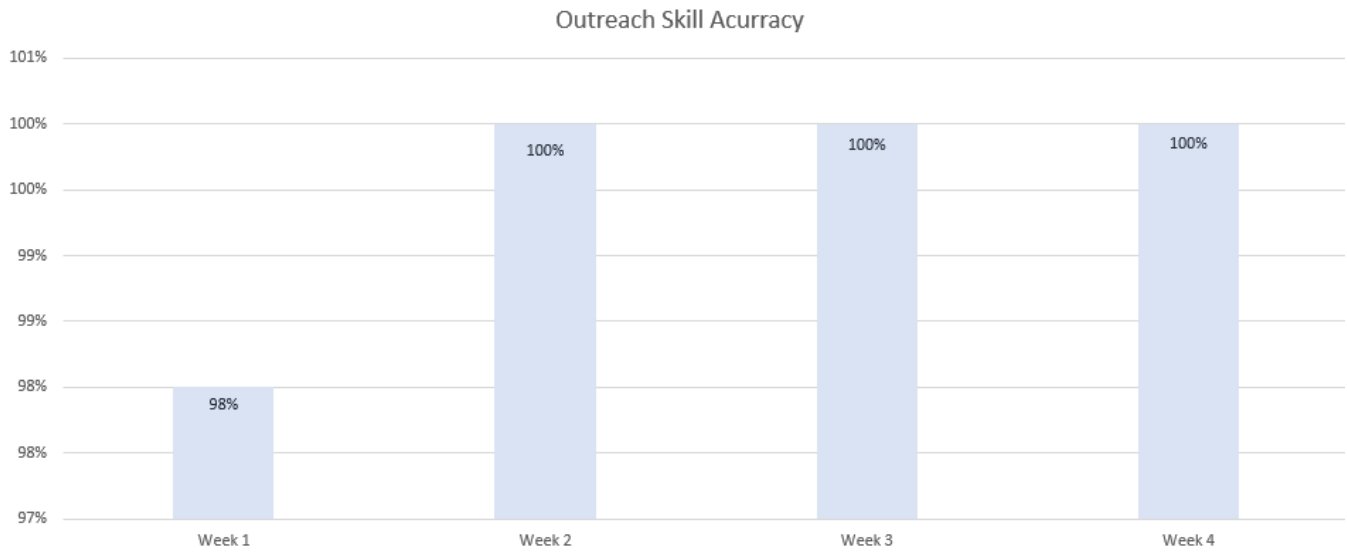
- The total successful utterances per week
- The total failed utterances per week
- The accuracy of the skill per week

Total Utterances

Date/Time	Successful Utterances	Failed Utterances
2017-07-13 00:00	98	2
2017-07-20 00:00	69	0
2017-07-27 00:00	7	0
2017-08-03 00:00	5	0
2017-08-10 00:00	78	0

Total Utterances (Successful and failed)





Analysis

Between the ROS skill and the Outreach skill comparing the accuracies in Figure and Figure it is shown that the Outreach skill is more accurate. The reason for this high accuracy is because the Outreach skill does not to be interfaced with ROS. Interfacing Alexa to ROS meant not using AWS Lambda and using the bst proxy service, which is a great tool but not as effective at computing as AWS Lambda. Also looking at Figure the first week the accuracy was 40% this is because there was a problem with the code that made the skill fail after a utterance was spoken. This was fixed and in week two the accuracy was greatly improved. Also a bug was found that when you spoke a utterance to the ROS Skill and did not follow up with any more utterances then the skill would actually communicate an error message, that is why the following weeks the accuracy ranged from 84% to 87%. The Outreach Skill was successful with its accuracy ranging from 98% to 100%. This skill did not require any interfacing to ROS and would use AWS Lambda as its compute system.

Conclusion

The goal of this project was to create an outreach robot that could understand questions related to Southwestern Indian Polytechnic Institute and basic movement commands. The project focused on using Amazon Alexa as the device to handle all the voice recognition. By making two Amazon Alexa Skills, ROS Skill for the robot movements and Outreach Skill for the questions, the project requirements were met. Future extensions of this project include making the robot understands other languages and to move to certain locations given some coordinates.

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