Lebanese American University

MCE550 – Robotics & Intelligent Systems

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Project Proposal

VENBOT: **V**oice-controlled **E**nvironment-aware **N**LP-based **M**anipulator

Ro**BOT**

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Group Members

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Project Description

The aim of this project is to experiment with natural language processing (NLP) to control a manipulator in a Gazebo environment. To elaborate, we would convert NLP input into robot commands, mainly pick-and-place instructions, to be executed by a manipulator robot simulated inside Gazebo. ROS would be the main framework behind the software pipeline of the manipulator robot including but not limited to robot simulation, motion planning, computer vision core, and natural language processing core. The applications of this type of project span across a multitude of fields. Most often than not, voice-controlled intelligent robots are deemed to be useful in industrial environments where manual labor work can become overwhelming, repetitive, and time consuming. Voice-controlled manipulator robots can also help increase efficiency and productivity in other lines of work such as garbage sorting and recycling, agriculture, and so on and so forth. Most importantly, one of this robot's critical use cases appears in dangerous manual work that needs to be controlled by a human operator. This robot allows such work to be possible without the need of manual human intervention. The potential behind this project goes on further, as we plan on increasing a level of complexity by adding an additional manipulator robot and training the two agents to collaborate together to complete tasks that a single robot might struggle with.

Objectives

In a nutshell, please find the following objectives and requirements of our project proposal.

- Design and simulate a minimal Gazebo world that VENBOT would interact with
- Implement one of the world's currently available state-of-the-art manipulator robots with a suitable gripper for the pick-and-place commands
- Develop an interface for processing NLP inputs and translating them into robot commands
- Implement computer vision for object recognition, pose estimation, grasping point calculation
- [Optional] Extend the project to include an agent that can understand more convoluted statements and commands
- [Optional] Extend the project to include an additional manipulator robot that collaborates with the existing one in order to complete more challenging tasks

Block Diagram

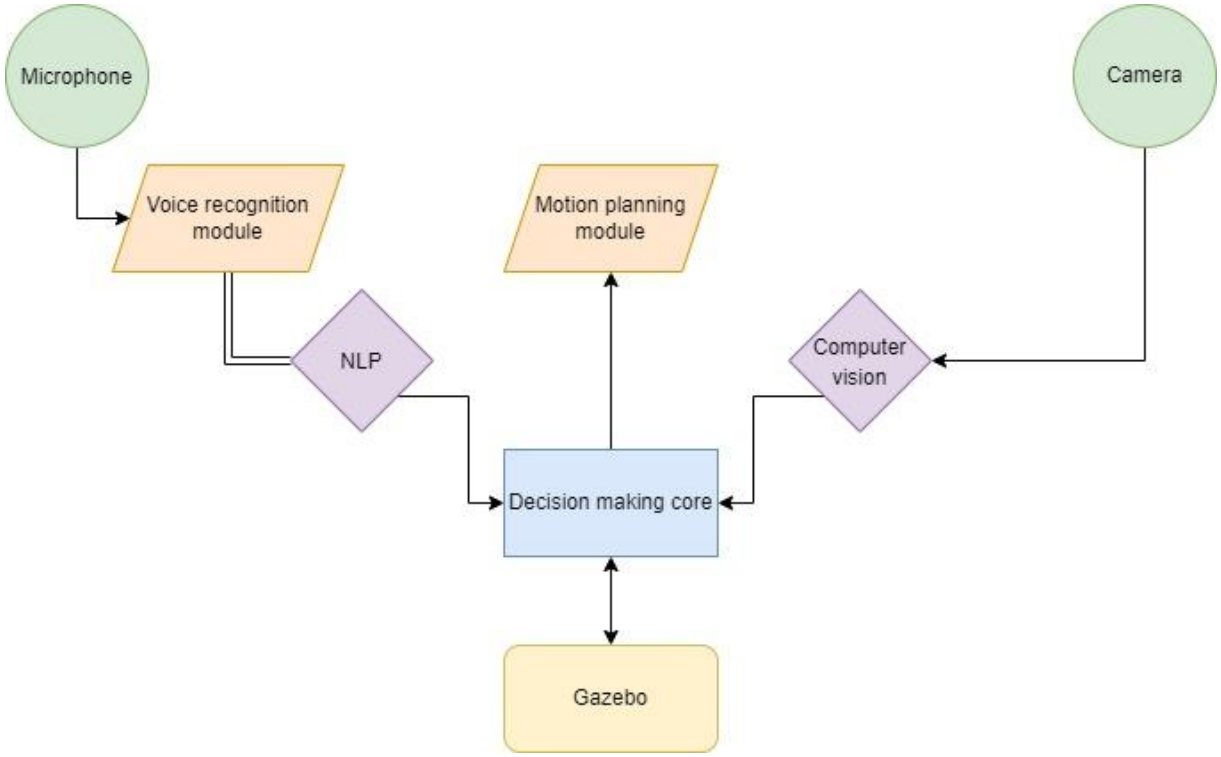

Figure 1: Block Diagram

Projected Plan and Next Steps

Although we did not yet develop a Gantt chart concerning our plan for the project, we did assemble the following list of steps we would like to go through for developing and delivering our project. Please find the following list below.

1. Briefly review state of the art
2. Familiarize with off the shelf machine learning voice-recognition and NLP techniques
3. Design a minimal Gazebo simulation world
4. Implement a SOTA manipulator robot into Gazebo
5. Develop the motion planning pipeline for the manipulator robot
6. Design an overall structure of the NLP architecture as well as define a list of limited useful commands
7. Develop a voice recognition module that can accurately detect robot commands
8. Develop a computer vision script that recognizes different basic objects, calculates their pose, and returns their grasping point
9. Connect the motion planning pipeline, the NLP pipeline, and the computer vision core using ROS
10. Test VENBOT with multiple objects through all of its available commands