CHALMERS
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SSY235 - Decision Making for Autonomous System

Planning report (BarIAGo)

Assignment - 5

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1 Motivation and Introduction

The world of 2020 has changed for everyone. Because of Covid 19, the act of leaving your house to have a fun night out with your friends is no longer save. The risk of contracting and spreading Covid has forced people stay at home. A big reason why people used to go out with friends was going to a bar. But having staff at the bar, talking and interacting with the customer is not a good Covid safety practice. A way to make bars safer is to replace the bartender with and an autonomous cocktail mixing robot. So the customer would order a drink, perhaps with their phone, and the robot would combine the ingredients and mix the cocktail. This would not only increase the customers safety but could also safe the owner some money, not having to a bartender a salary. This robot can also be adapted to a home bar. So people can have their personal at home bartender.

2 Purpose and goals

Would it not be nice to have a personal bartender, someone who is always ready to take your order, someone who might know your preferences and make suggestions of drinks you might like depending on your mood or the inventory of your bar. The goal is to create that bartender (autonomous robot), that can remember your drinks and extrapolate new and exciting drinks tailored to your tastes or at least cut down on the waiting time. So from start to finish, no humans need apply (no interaction with a human is needed).
Picture this:

> You have just found your seats, you look around to make sure that you are at least 1,5 m away form the next table. The bar looks too crowed for your taste. So you pick up your phone, scan the QR code of your table and order your Cuba Libre, with white Bacardi rum. But some just ordered a round of daiquiris for all their friends and finished the Bacardi rum. So as soon as you place your order a massage pops up to ask you if a substitute rum is satisfactory or maybe a similar and equally tasty drink is something you want. You pick the substitute rum and before long you see a BarIAGo robot rolling with your drink in hand.

3 Problem description and tasks

The process of preparing a drink can be broken down in to several steps. The BarIAGo must take the order of the customer first and then decide which cocktail he needs to prepare. In the next step he needs to communicate with the inventory to see if all ingredients are available and find suitable substitutes if necessary. Then he needs to pick up the ingredients and prepare the cocktail. Finally he can serve it to the customer by serving the drink at the customers table and avoiding all collision on his way.
In order to become a successful bartender, the robot has to be able to do all the sub steps mentioned above. In the following parts we talk in detail how we want to realize those actions with our robot.

4 Boundaries and limitations

The final goal of the project is a bit to ambitious, but we found it important to show the possibilities of this project first and then set some realistic boundaries to prove the concept. All the actions mentioned above in the task description are complex tasks on their own. Since

the time of our project is limited we need to apply some simplification for realization.
The first limitation is the ordering process for the customer. While communication of the bartender with its customer is an important part, we want to substitute it with a general menu, where a cocktail of choice can be selected from the terminal input. This input will be send directly to our BarTIAGo. The usage of speech recognition to order a cocktail is an option we consider, if we are able to solve all the other sub-tasks before and have time left to implement a speech module.
In addition the movement of the robot and the location of the ingredients need to be limited, by positioning the robot in an known environment, where all ingredients have their set space and the robot can serve its drink at the counter directly. The process of the cocktail preparation will also be simplified for the robot, by using an universal shaking action to prepare all the cocktails.

5 Method and implementation

5.1 General Ideas and Workflow

For the realization of the BarIAGo our robot needs to be able to do all the sub-tasks mentioned in the problem description part. Therefore we have planned a general software structure for our project in ros in the figure 1.

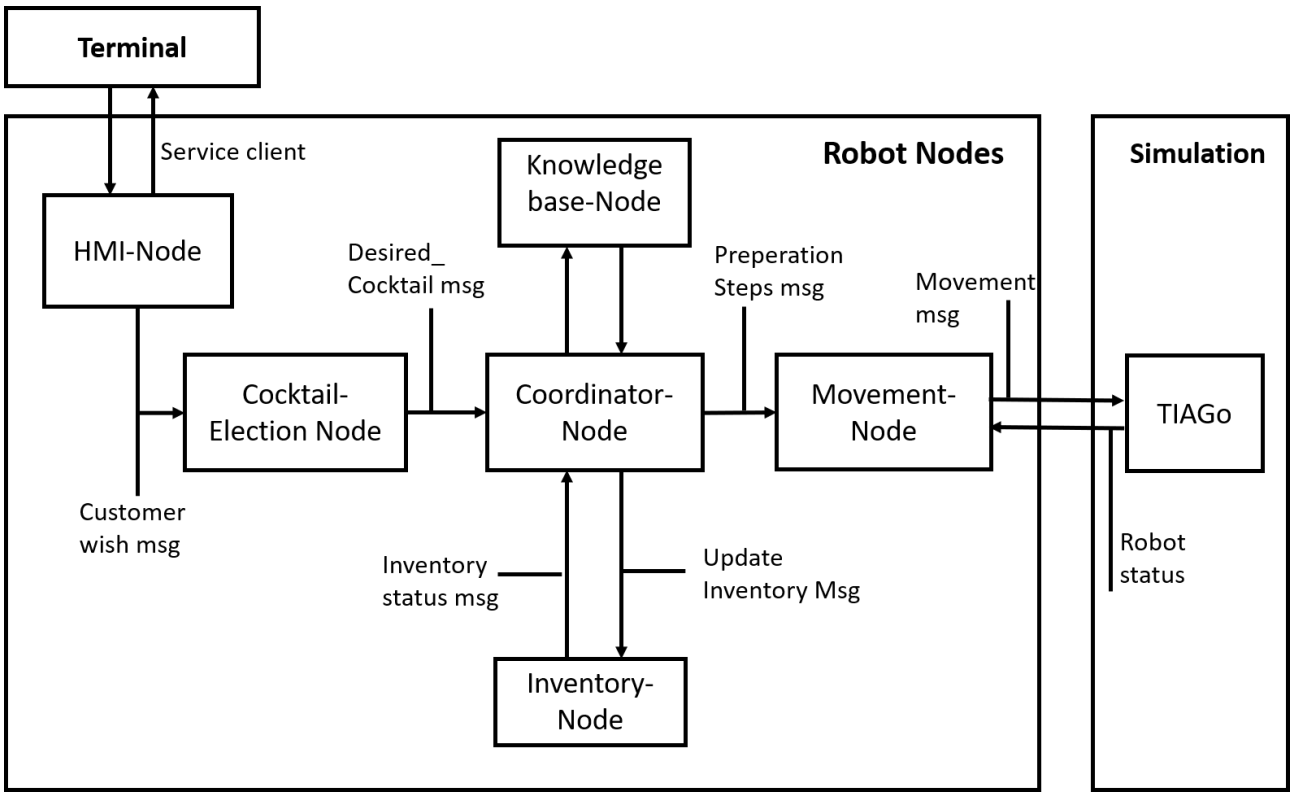

Figure 1: Ros software implementation overview. All nodes are listed in the rectangles, while the messages of a topic are indicated with an arrow between the nodes. The arrow head indicates the nodes, that listens to the message, while the other end is the publisher node.

The general software structure can be seen above. The BarIAGo uses several different nodes

to achieve all the needed sub-tasks. Each node has exactly one task. The different nodes will be further explained in detail in the next section.

5.2 Nodes Implementation

In order to serve a cocktail of choice we want to implement the following nodes and topics in ros:

1. **Human-Machine-Interface-Node**: Basic idea of this node is to communicate with the customers, so one can order a cocktail. This will be implemented through a terminal shell. In this node, we will implement cocktail menu. This node will have Service-Client type of relationship to communicate with the other node. This node will publish **customer_wish msg** message to the Cocktail-Election Node.

2. **Cocktail-Election Node** : In this node, we will use the decision tree algorithm to choose the perfect cocktail for customers preferences. The basic function of this node is to listen to the customer wish message and subsequently publish desired cocktail to the coordinator node.

3. **Knowledge Node** : This node is connected to the knowledge base ontology defined in protege. It has service-client relationship with the coordinator node. If there are ingredients missing the robot can start a query to find a suitable substitute ingredient and ensure the success of the cocktail.

4. **Coordinator-Node**: This node will initially listen to the **Desired_Cocktail msg** published by the Cocktail-Election node and then using that message to plan the motion of the robot TiAGO to prepare for the cocktail. Before planning the motion, the node will check the knowledge base node and **Inventory-Node** whether the desired cocktail ingredients are all available. The **Inventory-Node** will send inventory status message to **Coordinator-Node** in certain reasonable frequency. If any of the ingredients are unavailable in the inventory, then the ontology in the Knowledge-Base node will suggest some other disjoint ingredient which is subclass of the same class. Afer deciding on the cocktail and the ingredients the node will plan the actions to prepare the cocktail. The planned motion is then published to the **Movement-Node**. In addition, every time a certain combination of ingredients were used, the node will publishes **Update Inventory msg** to the **Inventory-Node**.

5. **Inventory-node**: This node publishes the current inventory-status through **Inventory status msg**. This node will communicate with the Coordinator node over two topics. It will publish the current status of the available ingredients with the **inventory_status msg** to the Coordinator node. This message consists of a list with all the ingredients. If the cocktail decides on his cocktail and the needed ingredients he will publish an update with the **update_inventory msg** to the Inventory node. Therefore we ensure, that all the available ingredients are updated every time.

6. **Movement-Node** The movement node listens to the **update_inventory msg** and is responsible for translating all the steps of the cocktail preparation into the movements needed for the cocktail mixing. Therefore the nodes publishes messages to the TIAGo robot in the Gazebo simulation and coordinates it's movements.

7. **TIAGo-Node** This Node is the default TIAGo node, which will create all the movements in the simulation, by receiving the message from our movement node.

5.3 Tools for Implementation

For the realization of the different nodes we will need additional packages and tools to realize the different tasks. All the packages we want to use with our robot are listed here:

1. Control and Moving → MoveIT
2. Decision Tree Algorithm → Python
3. Marker Creation → ArUco
4. Mapping and Navigation → Octomap and Rviz
5. Knowledge Base and Query → Protege

If we finish all the subtasks explained before, we have planned to extend the capabilities of our robot by the following tools to further improve it's abilities;

1. Speech recognition → CMUSphinx
2. Object recognition → Darknet ROS

5.4 Data Collection and Evaluation

The robots needs to learn, when to prepare which cocktail and adapt to the wishes of our customers. Therefore we want to use an Decision Tree algorithm to learn the right cocktail depending on the customer preferences. In order to create a more exciting user experience we decided to surprise the customer with a cocktail depending on the properties they decide on in their order. In a first implementation we want to use the following properties for deciding on a specific cocktail:

1. Flavour Preferences
   (a) sweet
   (b) sour
   (c) bitter
   (d) spicy
2. Type of liquor
   (a) Rum
   (b) Vodka
   (c) Non-alcoholics (e.g. Soft Drinks)
   (d) Gin
   (e) Tequila
   (f) Baijiu
3. Current customer mood
   (a) sad
   (b) happy
   (c) excited

(d) nervous

4. Nationality Origin

   (a) Northern European
   (b) Central European
   (c) Southern European
   (d) Eastern Asian
   (e) Southern Asian

Based on this properties we plan to make a small survey with around 10 people to let them check their personal preferences. This dataset is then used to train the decision tree algorithm. After the training the BarIAGo is able to surprise the customer with a suitable cocktail for each preference and enhance the customer experience.

6 Schedule

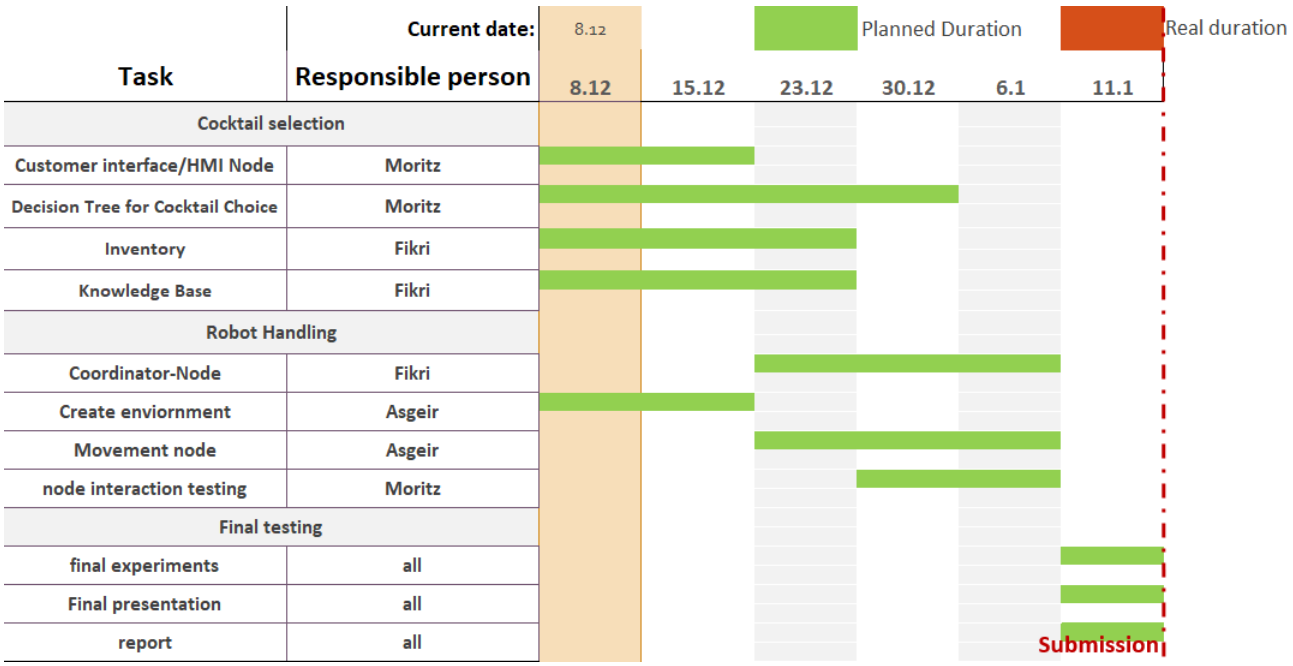

Figure 2: Gantt diagram for the project

Our plan for the project can be seen in figure 2. We divided the project in three parts. Each student has its own responsibility for a task of the cocktail serving. Moritz will cover the cocktail ordering through the terminal and be responsible for the training of the decision trees. Fikri is coordinating the inventory and knowledge base nodes. He will also create the coordinator node, which is communicating with those two nodes. Asgeir is realizing the environment for the simulation and will be responsible for the movement of the robot. We planned to finish all sub-tasks until the 6th of January. So we have one week left to fix possible issues and write the report and the final presentation. We predict the amount of work for each person will be roughly equal.