DrinkWise: An Interactive Bartending Robot

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Abstract

DrinkWise is an interactive mobile bar designated for formal events and receptions that aims to increase consumption awareness and transparency between the user and the bartender. The main difference between Drinkwise and most other bar tending robots on the market is the conveyal of information about the caloric and alcoholic content of the drinks, allowing users to make informed choices. This design report describes the high level design of the DrinkWise robot, as well as the means of evaluation that the project team will use to determine whether the robot is successful.

I. Introduction

Alcoholic beverages are a common aspect of social gatherings all over the world, but coupled with this is the problem of overconsumption of alcohol. According to the World Health Organisation, "the harmful use of alcohol is a component cause of more than 200 disease and injury conditions in individuals." [5]. Occasions where people would be especially prone to over drinking are corporate and formal events, where there are often open bars and therefore large amounts of free alcohol.

Often, people are unaware of how many units of alcohol they have actually consumed, leading them to drink more than they realise. However, it would be impracticable to simply ban alcohol from such events, as the presence of a bar and skilled bartenders play a key role in facilitating their success. Therefore, this project team proposes DrinkWise, which aims to serve as an interactive bar whilst providing transparency between the consumer and bartender.

DrinkWise aims to dispense a variety of drinks according to user's request. The user will be able to state their preferences and DrinkWise will recommend drinks. Furthermore, by facial recognition it will also be able to inform the consumer of how much alcohol they have already consumed and therefore advise them. On this, the user can make informed choices about their drink consumption whilst still being able to enjoy the event.

II. Background and Related Work

Studies have shown that labels on alcohol containers that list the percentage alcohol by volume with a means to make the consumer more drink aware are ineffective in reducing overconsumption. Then in the cases where the user has an intention for intoxication, such labels will even have a detrimental effect. [2]

Moreover, despite the fact that public establishments have started to provide calorie and alcohol unit information on restaurant and bar menus, studies have shown that this measure has been ineffective in the improvement of the consumer's drinking behaviour [3]. Therefore the evidence suggests that visual warnings are ineffective in the prevention of overconsumption of alcohol.

There are currently several bartending robots on the market, such as Somabar: an app-controlled drinks dispensing machine, and Bionic Bar: a robot that features an e-menu ordering system. The only robot that was found to be reasonably close to DrinkWise in terms of methodology is the Bionic Bar created by Makr Shakr. Makr Shakr's creation is able to estimate the user's blood alcohol level based on height and weight information supplied to an application and thus aims to promote sensible alcohol consumption. [4]

Therefore despite the growth of the market of robotic bartenders, there remains a lack of robots that aim to solve the aforementioned issues.

III. Hypotheses

The main methodology behind DrinkWise is the ability to improve the consumer's ability to make better informed decisions when ordering bar drinks. The following hypotheses allow the evaluation of this criteria:

1. Consumers are less likely to over consume when they are provided with qualitative feedback and advice from DrinkWise rather than being provided with a bar menu with calorie and alcohol unit information.

2. Consumers will find it easier to choose a drink when they are advised by DrinkWise rather than trying to choose based on information from an extensive bar menu.

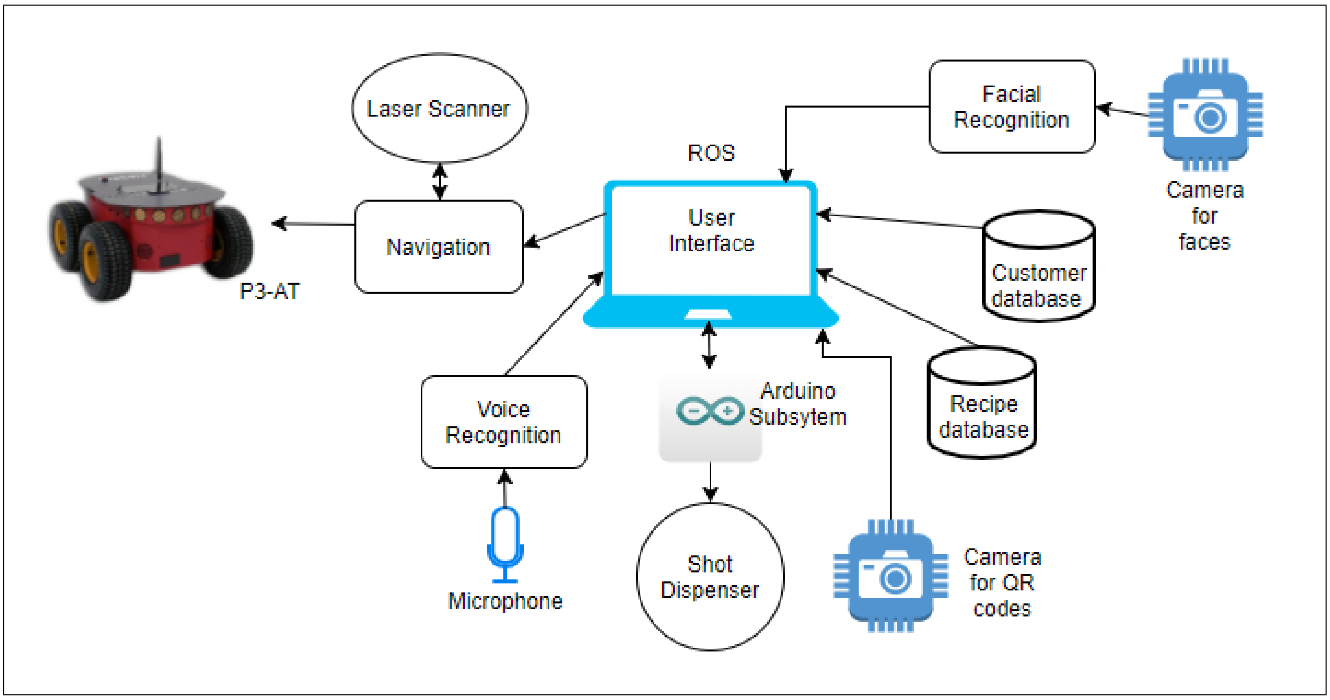

Figure 1. Overall System Design Flowchart

IV. System Design

Figure 1 describes the high level flow of the system. The key components, as detailed in the diagram, are User Interface, Voice Recognition, Facial Recognition, Navigation, and the drinks dispensing subsystem itself which is further described in Figure 3. The structure of the robot is shown in Figure 2. A supporting mount is required to be placed onto the Pioneer 3-AT (P3-AT) robot as shown and this will be designed in CAD and laser cut by the project team.

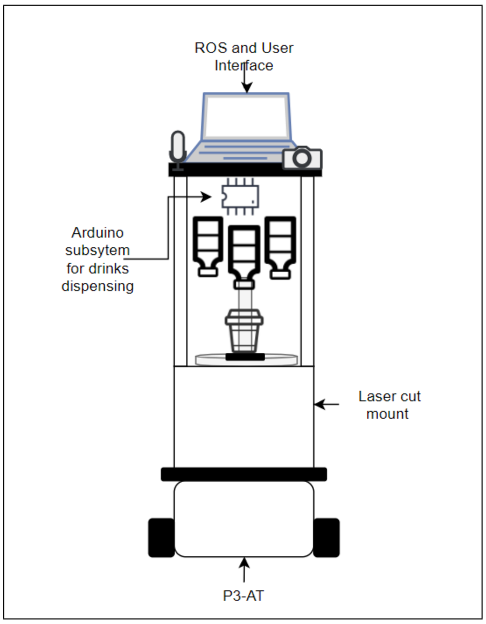

Figure 2. DrinkWise Robot Structural Design

Within these key modules, Navigation will be largely inactive, apart from when the drinks dispensing unit needs to be refilled. At this point the robot is no longer using speech recognition or facial recognition, and the only aim is to navigate towards the refuelling station. This allows the robot to be more focused on a smaller range of tasks at any time, as it would never need to navigate and dispense drinks simultaneously, reducing the required processing power.

A. Software

1 User Interface

The main inspiration of the user interface was drawn from cocktail menus from popular bars and restaurants. The user would be presented with a menu of cocktails available for order and each option would provide a visual and the calorie and ingredient information of the drink. It it's current form, a web application has been created to serve as the user interface, therefore allowing cross platform compatibility. The web application has been written in Javascript, HTML and CSS, and uses the Rosbridge library to provide a JSON interface to ROS.

A touchscreen laptop was chosen instead of incorporating a tablet device alongside the laptop. This was decided in order to increase stability of the overall structure of the robot, as the drinks dispenser and laptop would both need to be mounted to the P3-AT and the whole structure would be mobile. The touchscreen aspect allows a back up form of interaction in the case that the speech recognition is not accurate enough, which is a likely scenario in the proposed test environment.

2 Speech Recognition and Synthesis

Speech Recognition is incorporated along with the touch screen in order to more realistically emulate a bartender. The user's speech would be recorded with a microphone and then decoded using PocketSphinx and matched to an entry in a file of possible phrases. In most cases, this will be the request of a specific drink, and then this information is published onto a ROS topic which is subscribed to by the web application.

The environment for which the robot will be situated in is expected to be noisy to emulate a corporate or formal event. A suitable microphone and the noise cancelling feature of PocketSphinx will aim to mitigate the effect of this. [1]. It is expected that the speech might remain unintelligible, in which case the touch screen will serve as an alternative solution.

A key aspect to a bartender is the ability to engage verbally and interactively with the customer. According to information such as how much alcohol the user has previously consumed, the robot will advise the user on what choices to make. This will use speech synthesis and a decision tree, allowing an appropriate response depending on the user's alcohol consumption. The phrases that the robot will use will have a casual and non condescending tone, but still aim to warn the user of the consequences of overconsumption. The speech synthesis will be implemented using the ROS audio common package and the text will be sent from a decision tree system and published onto the /robotsound topic.

3 Face Detection and Recognition

As part of making the service the robot provides as seamless as possible a camera will be used to provide the robot with information. The camera feed will be used to find out about the number of people waiting to be served and the identity of the patron who is being served if they have been served before.

The number of people being served will require the robot to detect the number of faces in close proximity to it and their physical position from left to right so the patrons can be ordered in a virtual queue. To determine if a patron detected is new or not weak facial recognition may be employed to check if they are similar to the persons face that was last seen in that position. In this way, the robot will be able to determine if a person has merely turned away for a moment or if they have left and someone else has taken their place. Face detection of multiple faces at once using OpenCV has been tested on a laptop with a webcam. OpenCV has been used with python to produce a real-time face tracking script using video from the laptops integrated webcam. The detection script uses face and eye Haar cascades to look for patrons looking at the camera, and hence robot. The script will only highlight faces which are looking directly or very close to directly at the robot allowing a distinction to be made between patrons who are actively waiting to be served and patrons who are standing nearby. At present eye detection is not going to be used for any specific purpose but could be used in the future to help track the direction of gaze of the patron being served to improve the interface.

There subsequent work on face detection will involve implementing detection of gestures such as nodding or shaking of the head. This will help provide information about the patrons decisions when trying to understand them in a potentially noisy environment.

The identity of a returning patron will be predicted using OpenCV face recognition. When a patron is served their face will be used to predict their identity. If the prediction is not confident enough the patron will be asked to provide their name and frames of the camera feed which detect their face will be added to the training data for that patron. If they are a new patron a new set of training data for that patron will be created. In this way, the recognition process will be improved on its own without need for external calibration.

4 Navigation

As previously mentioned, this module will only be active when a refill is needed. This is when too few types or number of drinks can be made with the remaining ingredients. When such an occasion arises, ROS will deactivate the other modules and activate the navigation module. The navigation module will be operated with the ROS Navigation Stack.

At each event, a pre-acquired map data of the venue will be stored. The DrinkWise robot will have 2 locations of concern, the Refilling Station and its Operation Booth. The Open Motion Planning Library (OMPL) will be used for route planning and navigation.

When the robot is navigating, it will need to avoid collision with people and obstacles in its path. The robot will be equipped with some sonar sensors and a laser scanner (SICK LMS200), used to scan the environment, to achieve collision avoidance. The Simultaneous Localisation and Mapping (SLAM) will be used in this navigation module. Additionally, odometry messages can be read from the P3-AT during the navigation process.

Eventually, the navigation module will guide the robot back to a Refill Station where the ingredients will be manually refilled. After the DrinkWise robot is refilled, it navigates back to its Operation Booth where it will continue serving drinks. When this is completed, ROS will deactivate the navigation module and reactivate the other modules, thereby allowing the DrinkWise robot to continue serving drinks to users.

B. Hardware

1 Robot Selection

Both the P3-AT and the PeopleBot were possible robotic platforms. However, due to the size and weight of the shot dispenser, the P3-AT was a better choice. It also provided more flexibility for structural design. As the PeopleBot only has two wheels, it is less stable than the P3-AT's 4-wheel base. Combined with the placement of the touchscreen laptop above the drinks dispenser, the system would be too top-heavy, risking the teetering and even toppling of the robot. The decision to use a touch-screen laptop instead of a tablet cemented this design choice.

2 Drink Making

The rotary drinks dispenser machine will be operated by an Arduino controlling the two mechanical subsystems:

1. Bottle Selection

2. Shot Dispensation

The Bottle Selection subsystem will consist of an Arduino operated servo affixed to the central rotary pillar of the drinks dispenser. After receiving an instruction from ROS, the Arduino will command the servo to rotate in multiples of 90°s to move the correct bottle into place. These bottles will have QR codes attached onto them which can be read using a camera. This feeds back to ROS allowing it to know which bottle is prepared to be dispensed.

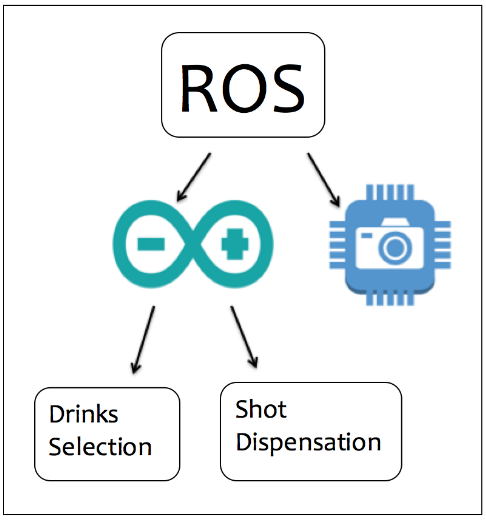

Figure 3. Drink Making System Design

The Shot Dispensation subsystem will consist of a platform onto which the user's cup is placed that can be raised and lowered by a set of servos. This will press the cup's rim into the dispenser, releasing the valve and pouring one shot of drink into the cup, before being lowered again. Working in conjunction with the drinks selection subsystem, shots of different drinks can be poured into the user's cup.

The Arduino PWM function can be used to control analogue servos with 50 Hz pulse trains with varied duty cycles. However the use of digital servos allows them to be set to specific angles using the Arduino Servo library. The servos will be powered by a separate power supply to the Arduino since the current required may exceed that which the Arduino can provide, especially as the current drawn increases as the load increases (more liquid in the cup).

Several of the parts for both subsystems will be designed using Fusion 360, 3D printed or laser cut using the Imperial College Advanced Hackspace. This will include the platform for the cups and the parts rotating the bottles.

V. Testing and Evaluation

A. Hypothesis 1

Hypothesis 1 will be tested by providing patrons with feedback about their consumption stats in a qualitative manner and assessing whether the information is better understood by the patron than just providing numeric stats. For instance the user interface might provide a simple higher/lower comparison of the patron's consumed units to the blood alcohol limit for passing a breathalyser test. In this way it is proposed that the patron would find the information more relatable and useful than an abstract number system such as units consumed. However, care will be taken to ensure the robots responses do not possess an authoritative tone. The robot should ideally not be telling the person what to do but merely presenting the information.

B. Hypothesis 2

Hypothesis 2 will be tested by providing patrons user interface features that simplify the process of picking a drink out of the many options available. These features should allow patrons who know what sort of drink they want to find the drink which best fits their preference. The performance of the features will be assessed on whether the average serving time per patron is reduced.

VI. Conclusion

In this report the project team has presented the methodology and design of the DrinkWise robot. The next step will be to implement and, if required, reevaluate this design.

In the following weeks the team will complete the construction of the robot and then test the hypotheses discussed in a series of trials, and present the findings in the final report.

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