A MOBILE APPLICATION TO ASSIST IN TRACKING ALCOHOL CONSUMPTION USING MACHINE LEARNING AND OBJECT DETECTION

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ABSTRACT

Statistics show that excessive alcohol consumption has been a problem and remains a problem in many countries. This paper proposes an application that encompasses a solution which allows users to log and track their alcohol intake over time. It leverages features such as object recognition for drink identification, a history calendar for reflective analysis, and a real time blood alcohol level indicator for health measurements. During experimentation we found that the accuracy of the AI to be exceptional when used on drinks that it has been trained on. Furthermore, the blood alcohol calculator demonstrated a level of accuracy comparable to, if not surpassing, that of online calculators. This heightened accuracy is attributed to its real-time updating capability, ensuring precision in the calculations throughout the user's engagement with the application. The ultimate goal of this initiative is to create a user-friendly, technology-driven solution that empowers individuals to make informed decisions about their alcohol consumption. It promotes responsible drinking behavior and contributes to overall health and well-being.

KEYWORDS

AI, Flutter, Firebase, Alcohol

1. INTRODUCTION

Efforts to mitigate the harmful effects of alcohol and reduce overall consumption have recently become paramount in public health discourse and for good reason. Excessive alcohol usage leads to over 100,000 annual deaths in the United States, which includes drunk driving as well as chronic misuse [12]. It is ranked third in the United States for preventable deaths [1]. This is nothing new as Egyption historical manuscripts mention alcohol abuse [4]. Previous studies show an increase in alcohol consumption between 1990 and 2017 where younger adults have a higher volume of consumption [5][7]. Additionally there are increases in alcohol use disorders despite efforts to reduce alcohol consumption by the World Health Organization [6][13]. Binge drinking has also become more prevalent especially with adults in their 20s [2][3]. These numbers are projected to grow as we go deeper into the twenty-first century. This issue is not just isolated to America, the largest increase in consumption comes from Asian regions [8]. With all of this data on the dangers of alcohol there have been multiple methods proposed to study and reduce consumption, although with little success [11]. Unfortunately, some of the greatest obstacles are

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lobbying from those that benefit from the sale of alcohol [10]. While various strategies have been put forth to address this and mitigate alcohol consumption, formidable challenges still persist. The alarming rise in alcohol consumption among younger demographics and the concurrent surge in alcohol-related fatalities underline the urgent need for effective measures aimed at reducing alcohol consumption.

The first source uses AI recognition by using unique patterns on each humpback whale to trigger the detection. This works well with whales that are already accounted for, but will not work for unknown whales. The second source looks at the different factors that lead to metabolism being different and is very comprehensive. However, it fails to look at alcohol metabolism based on weight. The last source uses an app to track alcohol use disorder, but does not give the user an estimate of their current blood alcohol level, and is not meant to be used for everyday people, as it includes features that are specialized to treat sufferers of alcohol use disorder, such as a GPS that tells the user when they are near bars. My application takes on a different approach than that of these sources to make the app more generalized and suitable for everyday usage. In a way, it is a simple version of what these sources had to offer.

We propose a method for solving this issue by creating a mobile application that tracks and records daily alcohol intake. The main feature of this application is that by simply taking photos of the alcoholic drink, users can log their individual consumption. By only needing to take a photo of the alcoholic beverage, there is much less hassle and users will be more encouraged to use the application. The incorporation of a drink history would allow drinkers to see their daily alcohol intake trends, such as on what days they consume the most alcohol and which types of alcohol are consumed the most. With this information they can see if their consumption has decreased for the purpose of gradually abstaining from alcohol. Additionally, with the implementation of a blood alcohol level estimation, users will easily be able to know if they have had too much to drink or if they are fit to drive. An application would be easy to implement using Flutter which facilitates the development of both Android and IOS apps in one code base. The accessibility of an application makes it more attractive than other solutions since most people have a smartphone. The application is also free to use for anyone. With the low amount of effort needed to snap a picture of the alcoholic beverage, users will be more incentivized to take photos. Compared to other forms of alcohol tracking, this application is easy to utilize. The goal is to revolutionize how individuals monitor and regulate their alcohol consumption, promoting responsible drinking habits and fostering user well-being while contributing to a culture of informed and mindful alcohol consumption.

The experiments run in section four were to test the AI and blood alcohol content calculator's accuracy. Both experiments were set up similarly and they were performed using the app interface. To test the efficiency of the AI, I placed ten images of different alcoholic beverages and saw if the AI guessed it correctly. The AI did not guess any incorrect, meaning it was quite accurate. This is because I have hundreds of different photos for alcohol, so the AI had enough images to reference. To test the blood alcohol content calculator, I compared results for the same drinks with an online calculator, and looked at how much they differed. The results were also as expected, the difference in results are attributed to rounding. My results, as predicted, were similar, because the way the app-based calculator works is very similar to the way that online blood alcohol content calculators work.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Implementing Artificial Intelligence

One challenge to the program will be implementing artificial intelligence to recognize different types of alcoholic beverages. This technology is frequently subject to mistakes, so its estimations may not be accurate. It may guess the wrong volume of the drink or type of drink, which will completely ruin the alcohol calculation. To resolve this issue, we could add a function for people to manually select and enter the volumes of their drinks, which would help a lot with the accuracy of the AI output. This way, even if the AI guesses wrong, the human can manually change the calculation to be accurate.

2.2. Implementing the Blood Alcohol Content Estimate

Another problem is implementing the blood alcohol content estimate. As it varies with each person and gender, there is not a perfect way to obtain a decently reliable estimate. This would skew the data and give people widely incorrect data about their blood alcohol content, which would negatively impact their judgment. One possible solution to this is to add a profile section where the user of the app can manually enter in their weight and gender, so the calculator can make a more accurate prediction to their blood alcohol content. To make sure the blood alcohol calculator is accurate, we would implement similar strategies that blood alcohol content calculators from reputable sources use.

2.3. Creating How the App Logged Each Drink

One problem we stumbled upon was creating how the app logged each drink. We did not have a way of showing how much each user drank and on which days, which made the app a bit unclear. A potential solution to this problem was to implement a calendar screen, in which the user could be able to click on specific days and see their alcohol usage. We also could put a graph on the home screen, so that users could see when they had their last drink, and on what days. This way, users are provided with a streamlined visual of their alcohol consumption.

3. SOLUTION

The mobile application is developed within the Android Studio framework, leveraging the robust and null-safe features of Flutter for its development. This choice was made due to Flutter's flexibility, simplicity, and adaptability, making it an ideal platform for efficient application creation. It also integrates Firebase as its database solution. This selection is based on Firebase's reputation for reliability and its swift setup process, accommodating a diverse range of applications seamlessly. When the app is run the user logs in to the account which connects to Firebase to fetch their information and drinking history. Users can view their history by going to the history tab. This tab provides a calendar view of all past recorded drinks and their amounts. Users can log a new drink by clicking on the camera tab. This lets users take a picture of their beverage and will determine what type of drink it is by using AI object detection. This AI was trained on many different types of alcoholic drinks using machine learning and 500+ images for each drink. When the AI determines what type of drink the user has, it will prompt the user to enter how many ounces they have drunk or plan to drink. The drink will be logged on the database and the time it was logged will also be recorded. The time is very important for determining and displaying blood alcohol levels to the user as well as giving recommendations on if the user is above or below the legal limit for driving. The machine learning for the application was done using Google's Teachable Machine to train the data and exporting the results to Tensorflow to be imported to the application.

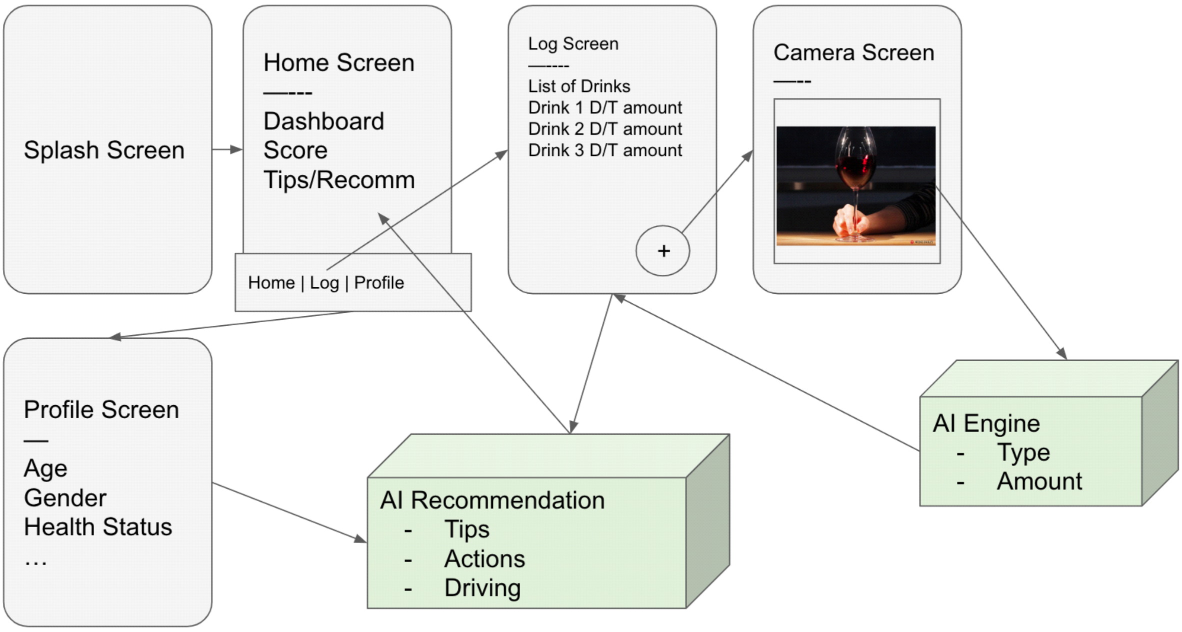

Figure 1. Overview of the solution

One central component in the application is the object detection system. Users can capture images of their drink and the AI will identify the alcoholic drink. Users are then prompted to input the quantity consumed or planned. The AI has been trained to identify drinks by using machine learning techniques and runs locally using Tensorflow Lite.

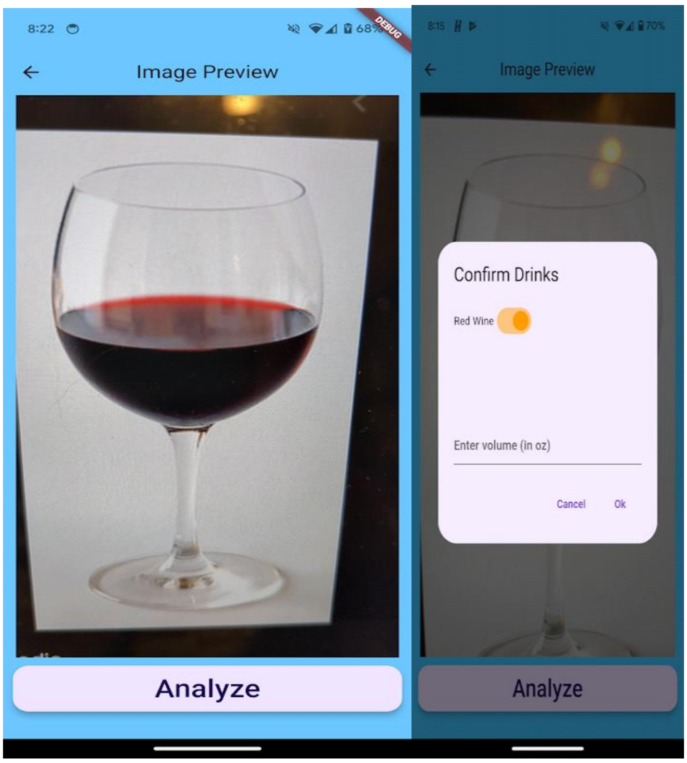

Figure 2. Screenshot of the image

```
Future<void> tensorFlowSetup() async {
  interpreter = await Interpreter.fromAsset("asset/model.tflite");
  inputTensor = interpreter
      .getInputTensors()
      .first;
  outputTensor = interpreter
      .getOutputTensors()
      .first;
  image = img.decodeImage(await File(widget.picture.path).readAsBytes());
}

Future<void> _loadlabels() async {
  final labelText = await rootBundle.loadString("assets/label.txt");
  labels = labelText.split("\n");
}

Future<void> processImage(File imagePath) async {
  final imageData = imagePath.readAsBytesSync();
  image = img.decodeImage(imageData);
  setState(() {});
  classification = await imageClassificationHelper.inferenceImage(image!);
  setState(() {});
}
```

Figure 3. Screenshot of code 1

In order to identify the type of drink the user has taken a picture of, the app uses Tensorflow Lite, a streamlined version of the Tensorflow framework. Tensorflow Lite needs to be fed machine learning data to be set up. The AI also needs the labeled dataset which contain the drinks that the machine learning data is based off of. The last method processes the image taken from the user and calls upon the now set up Tensorflow Lite AI to classify the image. The AI classifies the image based on the machine learning data and it compares the image to the machine learning data. The AI determines the closest match in the dataset, generating a prediction on the classification of the drink. In scenarios where the AI encounters uncertainty or provides multiple predictions, the user is granted the opportunity to manually select the accurate prediction. This user-driven validation mechanism ensures a refined and accurate classification process, enhancing the overall reliability of the application's beverage identification feature.

Another component present is the drink history calendar. Users have the capability to access the history screen, where a calendar view is presented, highlighting specific dates on which a drink was recorded. Furthermore, users have the option to click on a particular day to access a comprehensive summary detailing the drinks logged on that specific date.

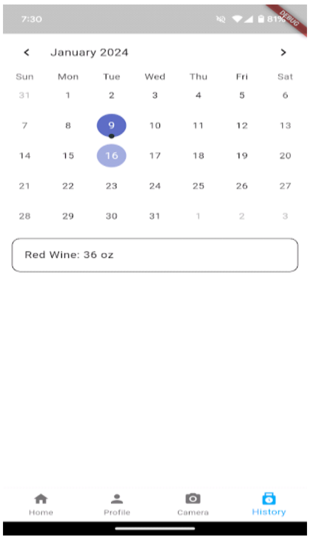

Figure 4. Screenshot of the calendar

```
TableCalendar(
  firstDay: DateTime.utc(2010, 10, 16),
  lastDay: DateTime.utc(2030, 3, 14),
  focusedDay: _focusedDay,
  eventLoader: (day) {
    return _getEventsForDay(day);
  },
  availableCalendarFormats: {CalendarFormat.month:'Month',},
  selectedDayPredicate: (day) {
    return isSameDay(_selectedDay, day);
  },

  onDaySelected: (selectedDay, focusedDay) {
    setState(() {
      _selectedDay = selectedDay;
      _focusedDay = focusedDay;
    });
    _selectedEvents.value = _getEventsForDay(selectedDay);
  },
),  // TableCalendar
```

Figure 5. Screenshot of code 2

The calendar is implemented by taking advantage of a Flutter package called table_calendar. This package allows the use of a prebuilt calendar that can be modified to fit the needs of our application. The calendar has an event loader which is used to gather a list of events for the current day and does this for all days in an active month. This populates the days with events, which in our case, is the drinks that have been logged on that day with their amounts. These events are gathered from Firebase by looking at each time a user has logged a drink, calculating the total amount of ounces, and adding them to a list for each day. The calendar also allows for users to click on different days to view events from the past. The selected day variable keeps track of what day is selected and loads the events for that day if there are any.

The third component is the blood alcohol level indicator. When a user logs their drink, the alcohol content and the size of the drink is taken into consideration along with the user's gender and weight to produce an accurate blood alcohol level that is personal to the user. This level also updates as time goes by and alcohol is filtered out of the blood.

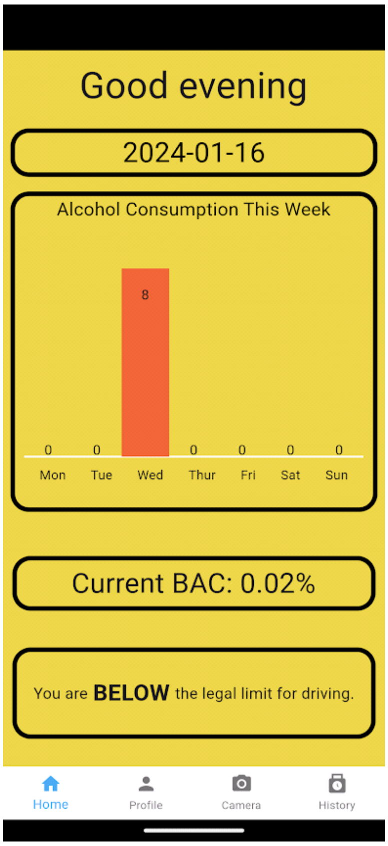

Figure 6. Screenshot of alcohol consumption

```
Future<String> getBloodAlcoholLevel() async {
  final _firestore = FirebaseFirestore.instance;
  final auth = FirebaseAuth.instance;
  late User loggedInUser;
  double sum = 0;
  double genderConstant = user_Info_gender == "Male" ? maleConstant : femaleConstant;

  try{
    final user = await auth.currentUser;
    if (user != null){
      loggedInUser = user;
    }
    var docRef = _firestore.collection('drinks').doc(loggedInUser.email);
    DocumentSnapshot doc = await docRef.get();
    final data = await doc.data() as Map<String, dynamic>;
    String today = DateTime.now().toString().split(" ")[0];
    Map<String, dynamic> drinksforToday = data [today];
    drinksforToday.forEach((k, v) {
      Map<String, dynamic> timeAndOunces = v;
      if (k == "Beer") {
        timeAndOunces.forEach((k, v){
          sum += ((v* 29.5735 * beerBAC * 0.789) / (genderConstant * user_Info_Weight * 454) * 100) -
              (0.015 * DateTime.now().difference(DateTime.parse(k)).inMinutes / 60);
          print(sum);
        });
      }
      if (k == "White Wine" || k== "Rose Wine") {
```

Figure 7. Screenshot of code 3

For the blood alcohol level, we have created a function which will calculate and return the current blood alcohol level. This function first needs to access Firebase to load the drinks that have been logged in the last 24 hours. It loads the drinks, a time stamp for when they were logged, and the amount drunk into a list and calculates the blood alcohol level using the mathematical formula for blood alcohol. This formula uses the user's gender and weight in order to accurately predict and personalize the alcohol level for each user. The function goes through each drink and is able to determine how much alcohol is in the drink by using an average constant for each specific drink. For example, beers have on average 5% alcohol content and wines have on average 12%. These percentages are used in the formula for calculating the alcohol levels. Lastly, the time difference between now and when the drink was consumed is taken into account when calculating the levels. This is because as time goes on, the levels of alcohol decrease.

4. EXPERIMENT

4.1. Experiment 1

The object detection is a potential fault point. The AI could mistakenly identify our beverage, which would skew results. As different alcoholic beverages have different alcohol contents, if the AI was to guess wrong, the overall blood alcohol content would be incorrect.

We will provide the AI with ten photos for each type of alcoholic beverage and see how many it gets incorrect. 10 photos will provide a very general estimation of the AI's reliability, while being quick and easy to set up. I also have 10 random photos of water, which will act as a control as the AI has not been exposed to photos of water, so it will guess randomly. These images are all just images I have found on the internet.

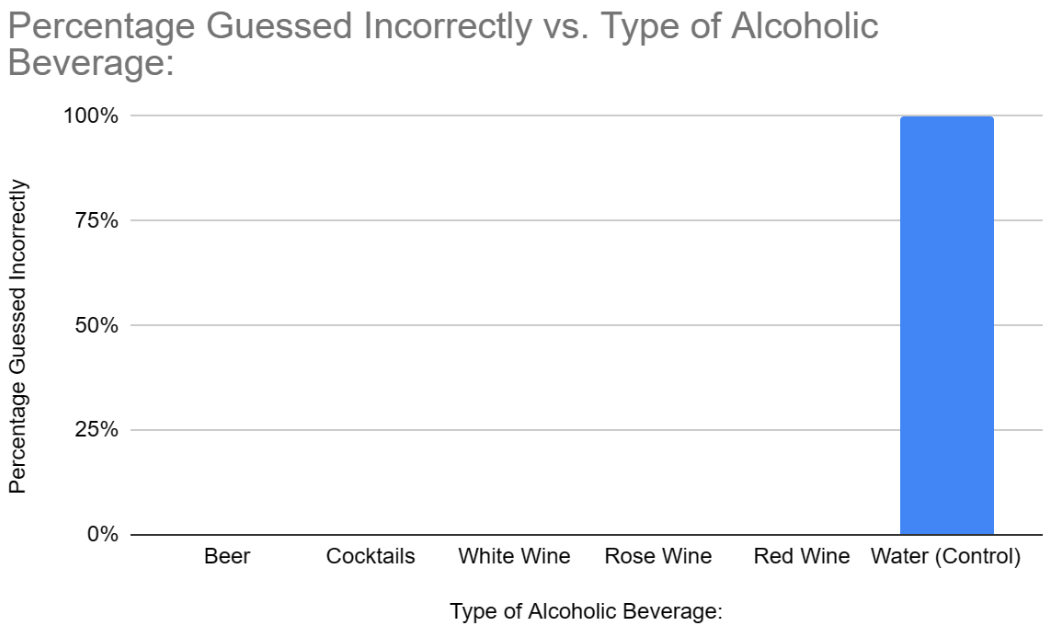

Figure 8. Figure of experiment 1

Based on these results, the AI must be quite reliable. The mean and median guess is 0% incorrectness. The AI was spot on with every single guess, meaning that it is quite reliable. The reason for such a low percentage of incorrect guesses is because the AI has been provided hundreds of reference photos, meaning that it can correctly sort out each photo it receives. However, because of the small initial test size, the AI is not always perfect. 10 photos is quite little, meaning that the AI will still have room for error. Hence, I have decided to incorporate a manual input for the alcoholic beverage to assure that the accurate amount of alcohol is being entered every time. Also, the AI is unable to guess the volume of a drink, so I have added a function to manually input the volume.

4.2. Experiment 2

Another blind spot is the blood alcohol content calculator. It could incorrectly calculate the user's blood alcohol level, which would cause an inaccurate measure to the user's blood alcohol level.

I will compare the app's calculator results to those of the online blood alcohol level calculator on Calculator.net, and calculate the blood alcohol level. I will use 12 ounces of each type of alcoholic beverage with a weight of 150 for both male, and compare the results to the online calculator results. I will find how much the results differ by subtracting the greater value from the smaller. The experiment is conducted like this because I will be able to compare my own data with preexisting, reliable data, from a source other than my own. This will be the best way to test my app's accuracy.

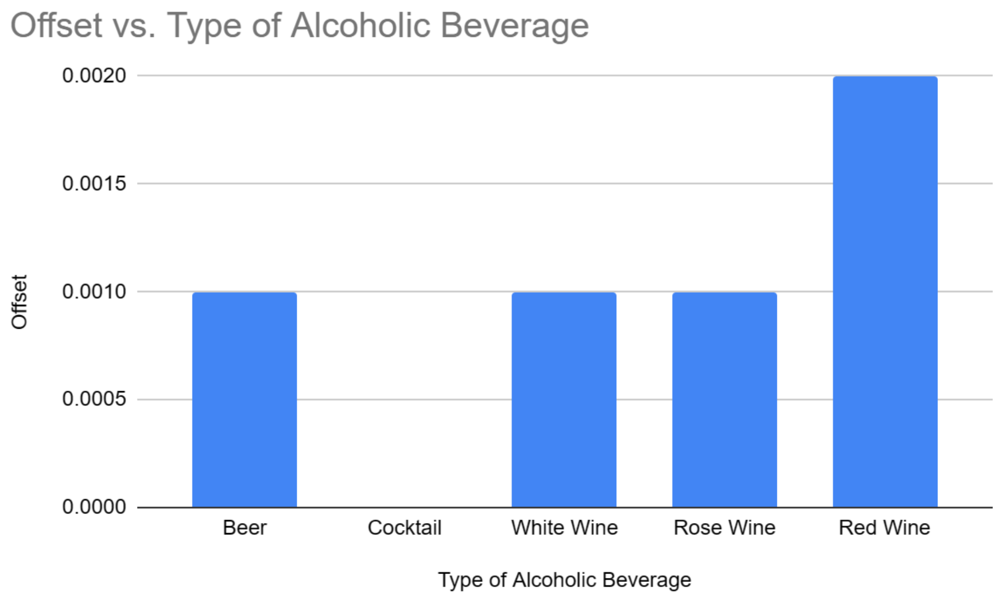

Figure 9. Figure of experiment 2

The results we got are just what I had expected, as our source of information for our calculator was closely related to those used in online calculators. Since my calculator used similar data with online calculators, the results were obviously going to be similar. The small offset (between 0-0.002) is mainly because our application rounded to the nearest thousandth, rather than ten-thousandth. This was the biggest impact on our results. I believe rounding was the only reason why our results differed altogether. Using floating numbers we could achieve increased accuracy when compared to these online calculators but at the cost of extra storage and more computational power in the app. The median and mean value both were 0.001, which is somewhat insignificant as it is so miniscule. The results signify that our calculator is quite accurate when compared to these online calculators, and there does not need to be any adjustments to the system.

5. RELATED WORK

One scholarly source that tackles the problem of AI in image recognition is image recognition in identifying humpback whales [9]. It uses a special algorithm to look for specific points of the image, and then uses another algorithm to look for identifying marks within the specific predetermined points, which helps the AI be extremely precise. The solution is very effective, but quite limited in usage, as it can only be used on whales that have already been recognized. All that it is doing is taking familiar markings on whales and recognizing them. It does not identify unknown whales. My project is able to identify specific types of alcoholic beverage, but minimizes error by allowing the user to manually enter in the beverage.

Alcoholic metabolism rates differ per person. Several factors influence the blood alcohol content after drinking, including sex, amount consumed, and meal consumption [15]. This study shows that women tend to have higher peak concentration than men, and that amount consumed played the largest role in determining peak alcohol consumption. Meal consumption also showed that the meal composition played an important role in blood alcohol content. The order went: high protein < high sucrose = high complex carbohydrate < high fat. This source uses breath analyses, which are very accurate and effective. It however ignores the weight of an individual, which also plays an important role. My project will be able to give a rough estimate of the blood alcohol content based on weight, instead of based on the other factors mentioned above.

This study looks at the efficiency of smartphone apps at reducing alcohol use disorder. They have been found to be quite effective, with the most effective being named the Alcohol - Comprehensive Health Enhancement Support System [16]. This application is based on CHESS, a system that manages various diseases, like HIV, developed by University of Wisconsin-Madison. The app uses GPS systems to alert users when they are near areas with alcoholic beverages, a panic button, and information services [14]. It is very comprehensive, but does not get the actual estimated blood alcohol content for the user, which my program does.

6. CONCLUSIONS

The application possesses certain limitations that merit consideration. Primarily, the reliance on object recognition for drink identification introduces the possibility of misclassification, in which the AI may incorrectly identify a drink as something other than its actual type. In specific scenarios, the AI may present the user with multiple options for selection but there are cases where the AI misidentifies the drink completely and the user must retake the picture. A solution to this would be allowing the user to enter their own drink if the AI is incorrect and submitting this as future reference so the AI can learn and predict the correct drink next time. An additional limitation is that the accuracy of the blood alcohol formula is contingent upon alcohol content averages for drinks, yet discrepancies arise when certain drinks go beyond the average. To address this, the AI should be updated to not only discern general drink types but also identify specific brands, enabling it to retrieve accurate alcohol percentage information by looking up the brand of alcohol. Lastly, the current AI model is trained only on five common types of alcohol. While these encompass the most common drink types, the application's support is confined to these five. Enhancing the application's coverage involves expanding the AI's training to include more drinks.

Addressing the limitations of the AI would entail implementing strategic measures to enhance its predictive capabilities. First, We could retrain the AI with a more extensive dataset, which would refine its predictive behavior. Additionally, we could introduce multiple AI models to enhance the predictive results for features like brand recognition and the recognition of drink sizes which would make the user experience better and more accurate.

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