Workout Retrieval System

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ABSTRACT

It is during the dire times when people realize the importance of well-being. During the Covid-19 pandemic, people moved towards the virtual fitness regimes and workout generators. The applications which curate virtual fitness regimes usually work on the assumption that either the user has access to all kinds of workout equipment or does not have access to any of the equipment. Moreover, the availability of the equipment is not the primary focus of such applications. In this project we addressed this limitation and created a workout retrieval system where the primary focus lies in the availability of the gym equipment.To recognise the gym equipment image we have used ResNet50 and achieved the maximum accuracy 83% via transfer learning. The system uses parameters such as the equipment available and muscle targeted to recommend effective exercises.

KEYWORDS

Information Retrieval, Computer Vision, Workout Suggestion

1 INTRODUCTION

1.1 Motivation

The COVID-19 pandemic followed by lockdowns throughout the world resulted in increased sedentary lifestyle, social distancing norms, remote learning, and work-from-home, which aided the transformation of the traditional studio and gyms to virtual fitness regimes. A report by World Economic Forum in 2020 stated that India had the most significant increase in the fitness apps download at 156% and the highest growth in Daily Active Users by 84% more people using the apps every day.[8] Due to the pandemic, awareness regarding cardiovascular health and the risk of diseases because of obesity has also increased.[6] The increasing awareness regarding physical and mental well-being is also motivating people to start working out and maintain a better lifestyle. Furthermore, according to studies, the market for home fitness equipment is projected to grow at a CAGR(Compound annual growth rate) of 9% in revenue from 2019-2025.[7]

1.2 Problem Statement

During the COVID-era there was an exponential increase in people practising home workouts. However, people are generally not qualified enough to curate a workout schedule for themselves. Thus, they use computer-generated workout plan creators. These software tools either assume that the users have access to all gym equipment or do not have any equipment at home. They don't consider the possibility that users might have access to limited types of equipment. Moreover, primarily their focus lies on the muscle targeted and not the equipment available.

Our workout retrieval system will take care of this limitation of existing systems and recommend activities effectively by also taking into consideration other parameters such as the muscle groups the user wants to work on. We will also focus on the equipment based exercise suggestions. Thus, we work on a system which takes the available equipment as the primary input and the targeted muscle as the secondary input to provide the top five best exercises as a result. We have created a basic prototype for the same.

2 RELATED WORK

2.1 Literature Review

In this theme, the majority of the research work has been done with the aim to curate a workout plan for the user. The workout regime is created by taking the weight and height and other physical parameters into account. Some studies in the same theme created an expert system that suggested the exercises based on the user input and the hypothesis. This study created a rule-based expert system to generate an exercise plan for the user based on their diseases and physical characteristics.(Darejeh et al.) There are some other studies that have created a system that works in a similar way. This study programmed a OntoGymWP which creates and suggests the user a gym workout plan based on the user's features and the feedback given. (Catini et al.) However, as mentioned in the previous report none of the studies has focused on the equipment availability and equipment association with the workout regime.

2.2 Existing Applications

There are plenty of applications/programs available to provide assistance in gym workout, each with their own unique ideas.

(1) **HealthifyMe** [5] - Suggests personalized fitness service based on users' day-to-day activities and eating habits. The main focus of the application is on the user's fitness and weight loss. They provide dieting and workout plans, analyze user-entered meals in the form of calorie counters, and give warnings for unhealthy diets. The app lacks search features for particular exercises and detailed information on targeted muscles for their exercises.
(2) **Adidas** [1]- Provide home-specific workouts based on the user's level(beginner, intermediate, and advanced) and target muscles. Their database consists of 180+ body workouts, each with an example video and a plan editor to create a sequential workout. However, equipment-based exercises exist only for Resistance Bands.

(3) **Home Workout by Leap Group** [3] - Workout planning and weight tracking app also feature an automatic plan creator based on gender, focus area of body, goals (lose weight, build muscles, and keep fit), fitness level, experience, and the number of hours. the exercises are presented in an intuitive manner with animated graphics. Just like other works this app also lacks suggesting exercises based on availability of the equipment.
(4) **MuscleWiki** [4] As the name suggests, MuscleWiki is a website where access to fitness-related information is immediately accessible and easily digested. It majorly focuses on the accessibility to the kind and type of exercise in accordance with the targeted muscle. The user has to input the body part and the output will be the exercise to train that muscle. The output is presented in a GIF format along with the exercise description.
(5) **exrx.net** [2] ExRx.net is a resource for the exercise professional, coach, or fitness enthusiast. It offers evidence-based exercise prescription tools and resources including reference articles, comprehensive exercise libraries, and fitness calculators.

3 METHODOLOGY

3.1 Iteration 1 - Prototype and baseline results

Our system aims to help a user find various workouts Our system aims to help a user find various workouts they can perform with limited equipment available to them. Our platform would allow a user to search different exercises via regular text search and select as well via searching via images of equipment. For iteration one, our team collected a database for exercises and implemented the text search and select feature on the frontend as well as backend. We decided to add image recognition capability in the next iterations.

The current work of the project has multiple branches growing simultaneously. The project has multiple aspects that the team is managing efficiently.

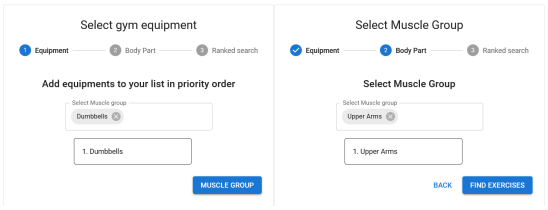

Figure 1: User interface of the system from first iteration.

3.1.1 User Interface. Our team started with making the base UI for our workout recommendation system. Though we aim to include Image-based search and natural language processing based searching, we constructed our base UI to follow a simpler text search and select method.

The UI has multiple aspects, a user can select body parts as well as the equipment they process and exercise can be suggested to them based on their input.

3.1.2 Initial UI Features. A user can simply write select body part and equipment and the system would return the suggested exercise with a preference order.

(1) Multiple equipment can be selected at once
(2) Users can also delete equipment after mistakenly selecting.
(3) Multiple body parts can be selected at once.
(4) Users can also delete body parts after mistakenly selecting.
(5) Users also get suggestions while typing out their requirements.

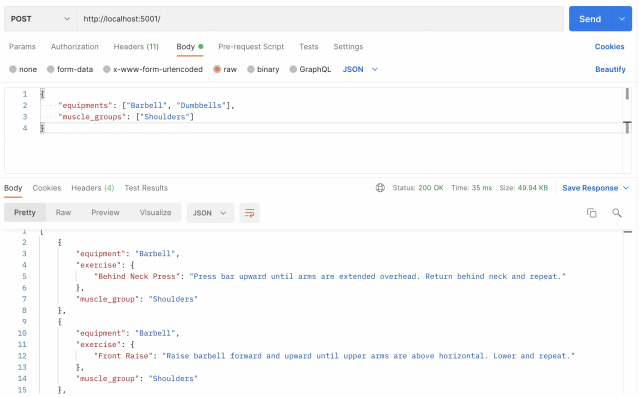

Figure 2: Postman's snapshot for checking our APIs constructed using Flask.

3.1.3 API. We used Flask, a micro web framework in Python for building the API. The API only has one endpoint which takes a list of equipment and muscle groups and serves the React JS front end with the list of required exercises by reading the scraped data.

3.1.4 Data Collection. Exercise Data Exercise data was scraped from two websites MuscleWiki and ExRx. This was done using requests, bs4 and json libraries in python. This process also involved mapping equipment as parents of various muscle groups and subsequently of the exercises. On the existing platforms like MuscleWiki and ExRx, muscle groups are given the most priority for exercise selection rather than the equipment. With the primary focus of our platform being getting best out of the equipment that you already possess, we have prioritized the equipments over the muscle group.

Image Data Image data was collected from 3 different data sets. (Table 1) These datasets had unique and mutually exclusive images.

Datasets	Available Classes
Github@siddharthkhincha	Bench Press, Cycle Machine, Leg Press, Pec Deck, Rowing Machine and Treadmill
Github@xfated	Treadmill, Cycle Machine, Dumbbells, Lat Pulldown, Rowing Machine, Shoulder Press and Smith
Kaggle@dutt2302/gym-equipment	Aerobic steppers, Bench press, Dumbbells, Elliptical, MultiMachine, Rowing Machine and Treadmill

Table 1: Avaialble classes for verious gym equipment datasets.

3.2 Final Iteration

For the final iteration we made improvements in the equipment image recognition model, user interface, and exercise recommendation model.

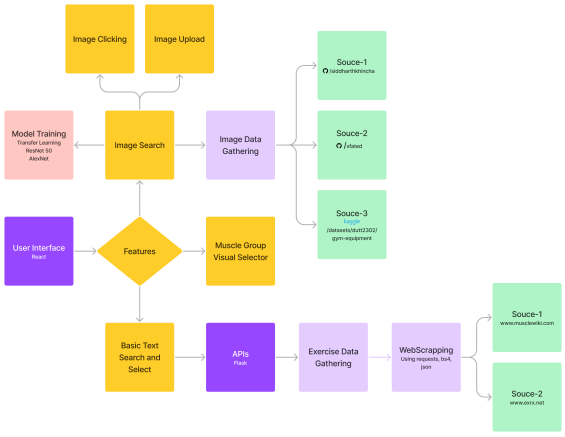

Figure 3: Final Architecture

3.2.1 Image recognition model. Since the size of our dataset was small (500 to 600 images per class), we implemented a transfer learning approach. For this iteration, we used a pretrained Alexnet model from pytorch's library https://pytorch.org/hub/pytorch_vision_alexnet/. We trained this pretrained alexnet model on our dataset to get much better accuracy of 81%, shown in table 2, row 2. We also tried a pretrained Resnet50 model for transfer learning, to get even better results. To increase our domain, we merged Github@xfated and Kaggle@dutt2302/gym-equipment datasets to create an augmented dataset. Github@siddharthkhincha data set was discarded because of its poor quality of images, since they were scraped from google images. Further, we trained the ResNet50 dataset on newly formed dataset to get satisfactory results.

3.2.2 Exercise Retrieval. Initially, the exercise data was stored as a JSON object in a file. For each exercise we had a name, description, muscle group and the equipment associated with it.

We created a list of exercises and each exercise was assigned an ID. We then created posting lists with the exercise IDs for all equipment and muscle groups.

Earlier each exercise was mapped to only one equipment. However, we noticed that there were exercises which required multiple types of equipment. For different equipment, we parsed the descriptions of the exercises to see if other equipment were also being used in it.

To fulfill the search request, we first take the intersection of the exercise ID posting lists of the equipment and muscle groups selected by the user. After that we add more exercises for the selected equipment.

3.2.3 User Interface. In the user interface department we made a muscle selector for easy visual selection, even if the user is unaware of the name of the muscle as shown in Figure 5.

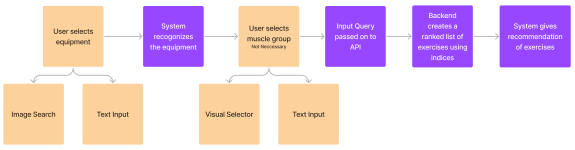

Figure 4: Final user flow.

3.2.4 Final User Flow. The final output of the project is a web system with backend deployed on Heroku, APIs and ML model hosted on flask and frontend hosted on Repl.it. The landing page gives users the choice to either input equipment or do an image search with the equipment they have. Next, if they prefer to do an image search, the system gives them the feedback if it is able to recognize the equipment from the image. Users can select multiple equipment by repeatedly typing or uploading images.

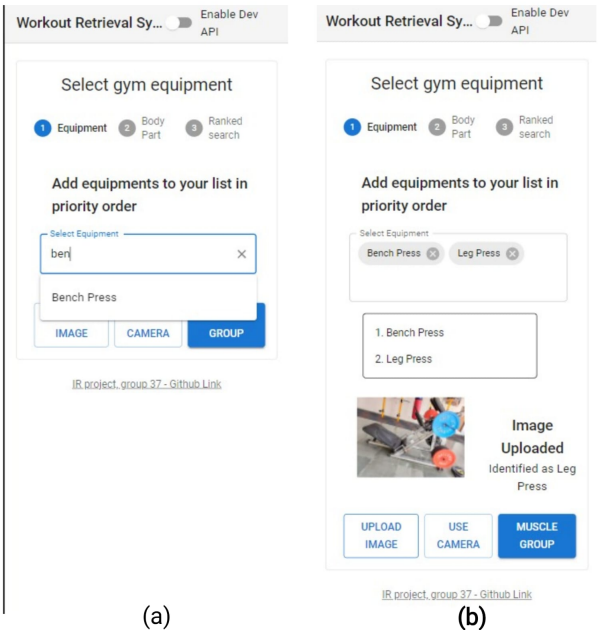

Figure 5: (a) Selecting equipment using text search. (b) Selecting equipment using image input.

Next, the user selects the muscle group. Users can select the muscle group in two ways, either via a text search or via visual muscle selector. This step is not necessary but the user has been given the choice to select one or multiple muscle groups as well.

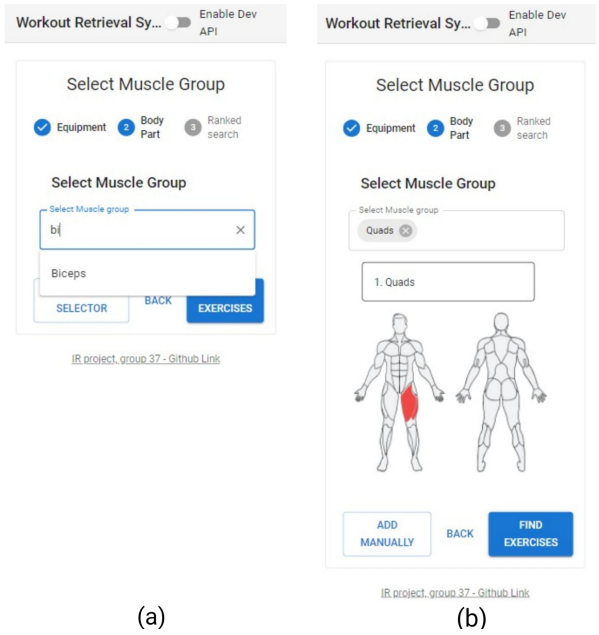

Figure 6: (a) Selecting muscle group using text search. (b) Selecting muscle group using visual selector.

Model	Accuracy	Dataset	Number Of Classes
Alexnet	58%	Dataset 3	7
Alexnet (Transfer Learning)	81%	Dataset 3	7
Resnet50 (Transfer Learning)	87%	Dataset 3	7
Resnet50 (Transfer Learning)	83%	Augment Data	9

Table 2: Final results from image recognition task.

Then the user is shown the results with exercise ranked according to the input given by the user.

4 EVALUATION

4.1 Model Result & Accuracy

Our image recognition model showed following insights:

(1) Resnet50 gave better accuracies than Alexnet
(2) Applying transfer learning improved the results drastically.
(3) A slight tradeoff of combining two datasets for increasing the number of classes from 7 to 9 resulted in a slight decrease in accuracy but covered many use cases for the users.

4.2 User Testing

Figure 7: Real life equipment images from (a) home environment, (b) Gym environment, entered by participants in user testing.

We also did user testing of this platform. We circulated a fully working version of this platform. The testing invites were sent via instant messaging platforms. Users were asked to use the platform and give reviews about it. This helped us evaluate our platform and recommendation model on the following lines:

(1) Does the system perform well in house settings?
(2) Does the system perform well in gym settings?

(3) How frequently does the system misclassify an equipment?

In total, we had 5 participants from the house setting and 3 participants from gym settings. Overall the reviews received were positive. People were able to identify various exercises with respect to equipment that they had at home.

5 CONCLUSION

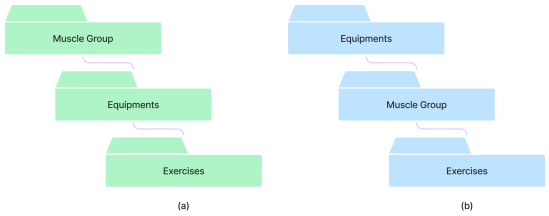

Figure 8: Fig. a - Current data hierarchy on popular platforms: Muscle group prioritized over equipment. Fig b - Hierarchy followed by our system: Equipment prioritized over muscle group.

Softwares usually suggest workout assuming that the user either has access to all kinds of equipment or has no access to any of the equipment and target the focussed muscle majorly. The system which we have programmed primarily focuses on the equipment availability. With the functionality of searching via text and image, the system fetches exercise suggestions and the user is able to workout in a more effective manner.

The unique proposition of our system is the feature to search the effective workout via image. The user has the option to click a live image or input an already clicked image from its gallery. Upon uploading the image and selecting the targeted muscle our system searches the data-set and provides the user with top 5 effective output. From the literature review it is plutonic to affirm that the image search option was not present in any of the existing applications/studies.

6 LIMITATION AND FUTURE WORK

- Currently we have targeted only the most common 9 gym equipment. However, the system can be extended to cover more types of equipment to help the user.
- Currently we are using pretrained ResNet with an accuracy of 83
- The DL model cannot detect multiple equipment from the same image and this feature can be added in future iterations.

7 OTHER IMPORTANT LINKS

(1) **Github Repo:** Click Here
(2) **Models and Colab File:** Click Here
(3) **Data sets** Click Here

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