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DATABASE MANAGEMENT SYSTEM FOR SMART GYM USING IOT

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Abstract

Currently, in a modern world where people are getting busier, it is hard for them to take time to work-out or exercise regularly by themselves. People have been using the gym as a place to make their body fit and it is right as Health and Immunity are an important part of a person's life and everyone would always like to be fit and healthy. To achieve that level requires motivation and discipline. And lack of motivation results in quitting the gym in a very short span. Now Generally in Gym, there are only a few that keep track of everything, others we have a huge marketplace for the people who joined but quit soon since doing exercise doesn't give you short-term results. The changes in your body start appearing after months. The slightest changes and every other important aspect can be hard to keep track of them altogether, now using smart gym approach, the slightest change can be measured, using IoT and later one can curate all the training regiments, diets and exercises properly according to it. We propose an overall IoT-based-system to monitor the user's Health and Fitness Records in an effective way of using a database management system. It plans to collect data from the machines when the user uses it, keep track of its workouts and diet intake, with a gym social media that would help to maintain a competitive environment, also including management of membership, payment, trainers, and employees. This would result in a whole new way of looking towards the gym.

Keywords: *Smart Gym; database; IoT; Health and Fitness monitoring*

1. Introduction

Currently observing the existing systems that revolve around excel file system, paperwork recording the details of Employees, Inventory, and payments or a traditional computer software which generally focuses on management. The vision which we have is a system that records data of users for example machine, record user's heart rate, calories burnt, sweat burnt. Converting a whole gym to a smart gym with add-ons as well as smart machines, displays, and competitive features on the app is really new and very opportunistic. Using different metrics and noted parameters it can also use to map the status of the member's body. An interactive platform with a good environment will make the gym more exciting, not a burden, unlike the current system. Detailed schedules and trainer connection would help people to wait for less for the machines and frequent notifications and motivation would also help to eliminate laziness. Using IoT ambient lighting, air quality, and temperature will be maintained. Also maintaining the data from the protein bars and different products will help improve the body.

1.1. Application

Our system aims for the following purposes:

• Motivating users by giving them regular feedback on their training that is by storing the exercise data from the sensors.

• Giving them a feeling of competitiveness with the other gym users with a social platform

1.2. Our Contribution

Databases in the modern world are an integral part of every system. As we can see the use of the database in almost every management system [20]. In most of the existing gym management systems, the data stored revolves around the management part rather than the user. The notion of including vital information about the user is a much important task. The relationship between the trainer and the member needs to be stronger to make the required actions clear.

Our system follows a user-centric approach and describes an overall smart gym environment. Our strong focus considers to incorporate current available machines instead of new-smart machines which is economically viable option by assuming machine-addons with RFID tags [14] that detect which user is actually using the machine and time period of its use and wrist bands to fetch the data and monitor the health activity. We have also tried to eliminate the traditional paper diets, exercise and handling of other records.

Vision for a smart futuristic gym is still conceptual and we are limiting our scope to just show an overall approach to manage basic things, health-data that can serve as a valuable input which is very useful to the trainer and user in monitoring health activity and in changing a user's work out, diet routine according to it.

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2. Technologies

With IoT having wide variety of applications has also established its roots in field of exercise and workouts for instance researchers have already thought of its use-cases and frameworks to successfully manage the whole process [1]. In [2] Authors have shown how web technology has ensured an efficient way to manage basic activities like payments, inventories, members, trainers, employees. Another approach of a gym management system shows how people can do exercises at places other than the gym is shown in [10]. According to [6] use of mobile phones have also been considered for this regiment with an interesting motivating concept called gamification to boost and track the progress at your hands [19][20][21]. With this valuable time of researchers has been invested for developing smart devices as smartwatches as shown in the patent [12], smart Mirrors [16] automatically detecting user movements and providing guidance, smart Matrix that uses a beautiful alternative of multiple motion sensors with a smart pressure sensing matrix [5].

Tracking one's fitness is necessary as the feedback from the data received tells us their progress, shows them a path, motivates them to work accordingly as the changes in one's body are long term [17][18]. In the time of COVID-19people with some health conditions be it physical or mental are doing the least physical activity and prefer to spend their time on other activities staying at one place [8][9].

3. Proposed Approach

Our database management system is applied to the IoT concept to overcome the limitations of current Gym Management Systems. Fig.1. shows the relational view of our system. The implementation shown in our system assumes the most common way of getting health-related data that is a wristband with basic-common sensors. We primarily focus on the database management part which can be hosted on the cloud and integrated with smart-IoT devices consisting of microprocessors and microcontrollers according to the flow in Fig. 2. The aforementioned features in our system work in tandem to provide a reliable method for the concept to store the data. Incorporating, we have designed a scalable, customizable, robust database design. Keeping User as the main focus. Since if we consider the current scenario replacing current machines with smart ones is still a costly process so we have only considered Machine as in general to note for time user used it which can be practically achieved using RFID tags [14].

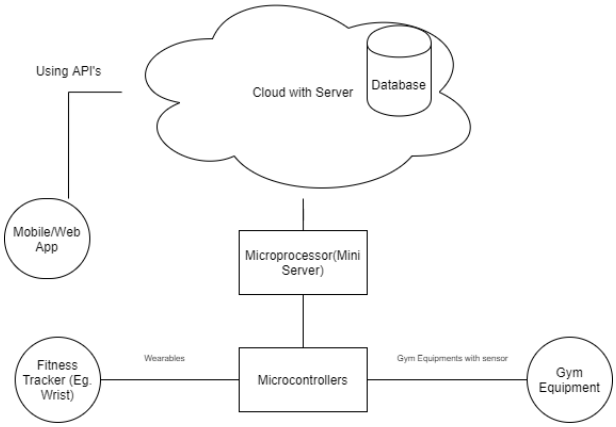


Fig. 2 Concept of the Smart Gym [1]

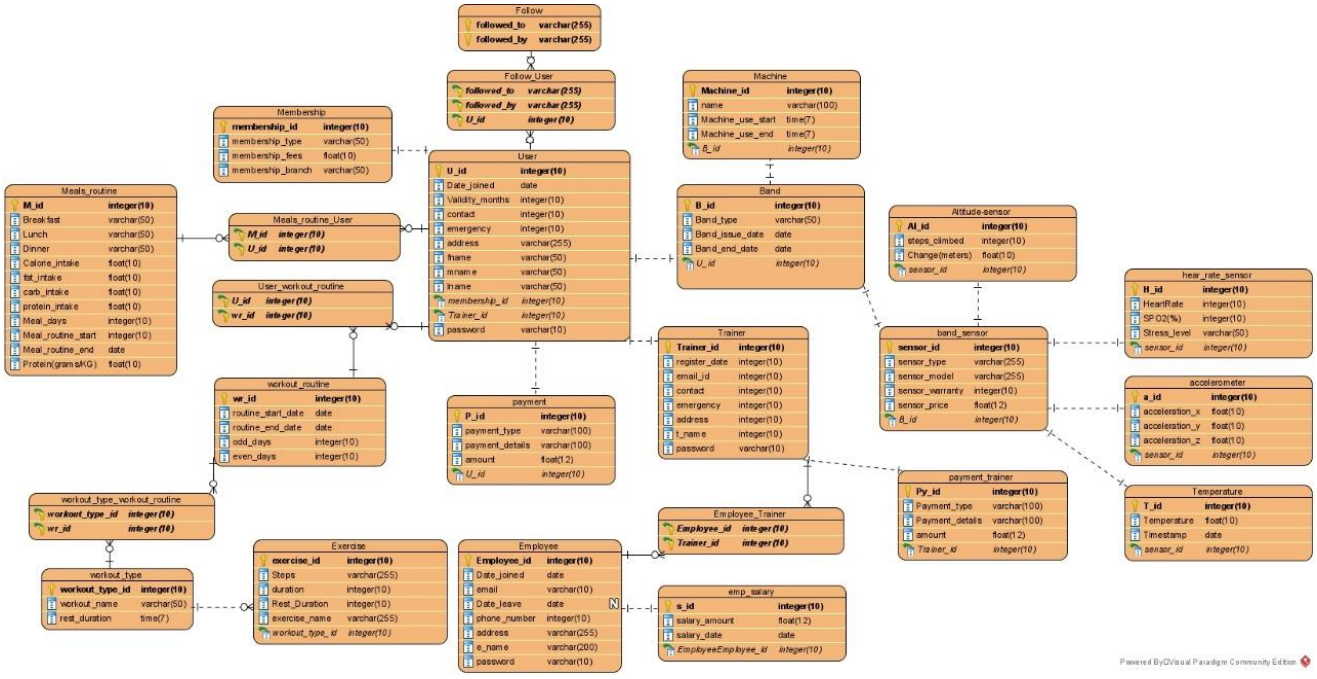


Fig. 1 Relational View

The system can be seen in the form of the following sections.

3.1. Management

Whenever a user registers for a gym membership, he is registered or assigned a trainer which is registered under an employee. A relationship is established between the user, trainer, employee.

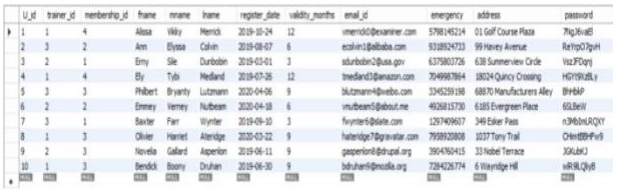


Fig. 3 User–Data of the User registering for the Gym

Fig. 4 a) Employee–Data of the Employee that serves as the main entity. b) Trainer–Data of the Trainer that registers/trains User

3.2. Data

Now we have assumed the data collection mode as bands, each user is assigned a band and each band is associated with some sensors here assumed sensors are Temperature, Heart-Rate, Altitude, Accelerometer referring to Fig. 6. We have tried to induce customizability per band as well and one can also extensively add sensors of its choice. These sensors can also be external, communicating to the band or inside the band as well referring to Fig. 5. Major challenges are to customize each machine into a smart machine using addons to fetch their data. New smart machines can be used but importance is given to the existing machine. We have assumed machines with RFID tags that can identify the band(user) performing the exercise and cannot the time have used referring to Fig.7. This is done to provide extensibility on the machine side as well later this can be extended in a similar way as band sensor and can be connected with the inventory system too.

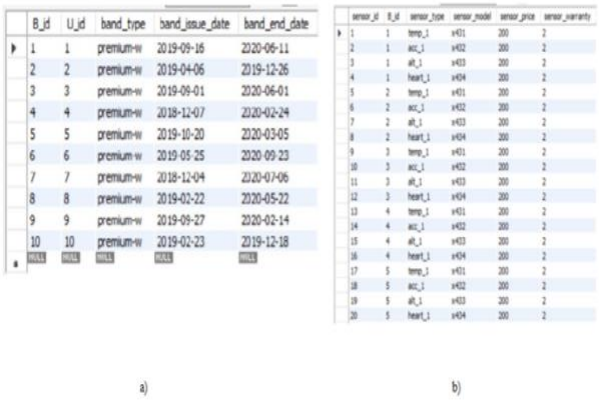


Fig. 5 a) Band–Data of the Bands that are assigned to per user. b) Band Sensor–Data of the Sensors for the Bands

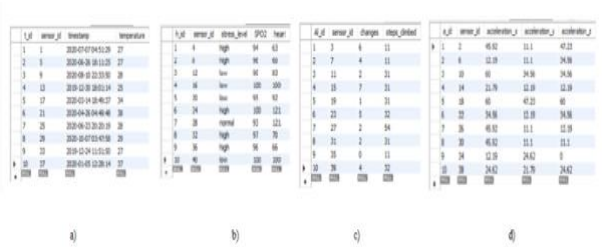


Fig. 6 a) Temperature – Data of the Temperature sensor. b) Heart – Data of the Heart Rate sensor. c) Altitude – Data of the Altitude sensor. d) Acceleration–Data of the Acceleration sensor

m_id	B_id	machine_name	machine_usedstart	machine_usedend
1	3	treadmill_x1m	2020-11-12 15:10:55	2020-11-12 15:20:55
2	1	bench_press_xm3	2020-01-15 15:03:51	2020-06-27 00:46:55
3	5	hammer_strength_xm4	2020-04-17 09:51:56	2020-10-05 12:50:54
4	3	treadmill_x1m	2020-01-11 20:02:35	2020-03-17 07:29:55
5	3	bench_press_xm3	2020-02-14 06:16:56	2020-10-15 19:19:32
6	3	bench_press_xm3	2020-05-02 09:11:58	2020-02-19 11:45:49
7	5	treadmill_x1m	2019-12-24 00:25:10	2020-11-12 15:40:55
8	1	hammer_strength_xm4	2020-06-03 03:57:37	2020-10-28 16:33:59
9	2	bench_press_xm3	2020-06-04 15:02:42	2019-12-30 21:49:36
10	1	treadmill_x1m	2020-07-26 17:14:30	2020-10-04 06:36:53
NULL	NULL	NULL	NULL	NULL

Fig. 7. Machine – Data of the Machine used by User.

3.3. User Meal and Workout

This section is designed for workouts and meals. Work out types can be defined here that consist of Exercises. The workouts as well as meals defined can be assigned to the user by specifying a routine.

Fig. 8 a) Workout–Data of the Workouts. b) Exercise–Data of the Exercise for a particular workout

wr_id	U_id	workout_type_id	days	routine_start_date	routine_end_date	odd_days	even_days
1	1	2	60	2019-08-10	2019-11-30	1	0
2	2	5	60	2019-05-22	2019-12-27	1	0
3	3	3	30	2019-07-23	2020-10-01	0	1
4	4	3	60	2019-04-11	2020-08-19	1	0
5	5	5	45	2019-04-06	2020-10-29	0	1
6	6	4	15	2019-06-02	2020-05-20	1	0
7	7	1	45	2019-01-04	2020-03-31	0	1
8	8	5	45	2019-06-30	2020-11-23	0	1
9	9	2	15	2018-12-21	2020-10-01	0	1
10	10	1	45	2019-02-09	2020-04-29	1	0
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Fig. 9 Workout-Routine –Data of the Workout Routine for the User

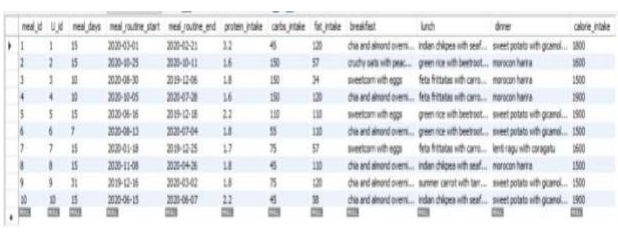
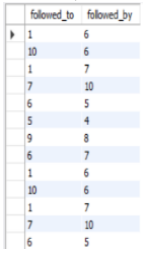


Fig. 10 Meal-Routine–Data of the Meal Routine for the User

3.4. Social and Payment

To induce a sense of competition a relationship between users is established where one user is followed by another one just as a social media and can view the progress of the one as well. Payment details can be entered here respective for Employee, Trainer, User as well as described in the fig11.



followed_to	followed_by
1	6
10	6
1	7
7	10
6	5
5	4
9	8
6	7
1	6
10	6
1	7
7	10
6	5

Fig. 11 Follow–Data of Records to maintain inter-user relationships

Table 1. Comparative Analysis

Legends	F1	F2	F3	F4	F5	F6
[1]	No	Yes	No	No	No	No
[2]	Yes	No	No	Yes	No	No
[4]	No	Yes	No	No	No	No
[6]	No	No	No	Yes	Yes	No
[10]	Yes	No	No	Yes	No	Yes
[19]	Yes	No	No	Yes	Yes	No
Our Approach	Yes	Yes	Yes	Yes	Yes	Yes

Legends:

F1 Basic Database handling management of members, employees, trainers and payment.

F2 Concept of Gym Management incorporating IoT

F3 Database that incorporates sensor and machine data.

F4 Integrability for website or app.

F5 Social Info that is a competitive environment

F6 Virtual Gym (Gym from Home) with help of the assigned work out and meal routines

4. Experimental analysis

Few queries have been demonstrated to showcase our system and output has been shown assuming random data.

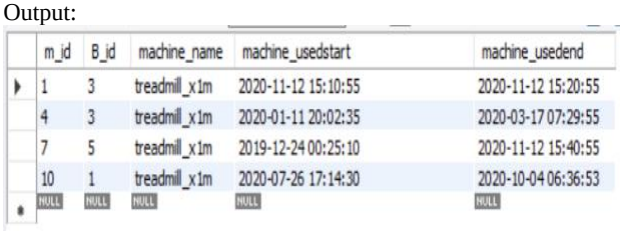
Query: No. of users following User1
Statement: select count (*) as followers from friends as fr where fr.followed_to = 1

Output:

followers
10

Query: Displays details of machine "treadmill_x1m" used more than 3min or 180 sec.
Statement: select * from machine as mc where mc.machine_name = "treadmill_x1m" and TIMESTAMPDIFF (SECOND, mc.machine_used, mc.machine_usedend) > 180

Output:

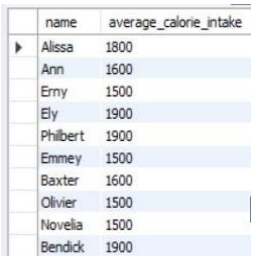


m_id	B_id	machine_name	machine_usedstart	machine_usedend
1	3	treadmill_x1m	2020-11-12 15:10:55	2020-11-12 15:20:55
4	3	treadmill_x1m	2020-01-11 20:02:35	2020-03-17 07:29:55
7	5	treadmill_x1m	2019-12-24 00:25:10	2020-11-12 15:40:55
10	1	treadmill_x1m	2020-07-26 17:14:30	2020-10-04 06:36:53
NULL	NULL	NULL	NULL	NULL

Query: *Find the average calorie intake of all the users*

Statement: select user.fname as name, AVG(calorie_intake) as average_calorie_intake from meal_routine as mr, user where mr.U_id = user.U_id group by mr.U_id

Output:

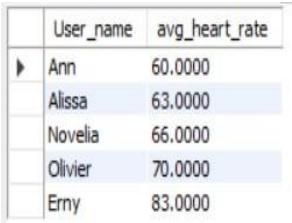


name	average_calorie_intake
Alissa	1800
Ann	1600
Erny	1500
Ely	1900
Philbert	1900
Emmey	1500
Baxter	1600
Olivier	1500
Novelia	1500
Bendick	1900

Query: *Display AVG heart rate of users (Can be Applied on Dashboards)*

Statement: select u.fname as User_name, avg(hrs.heart) as avg_heart_rate from heart_rate_sensor as hrs, user as u where u.U_id = (select U_id from band where B_id = (select B_id from band_sensor where sensor_id = hrs.sensor_id)) group by u.fname order by avg(heart) limit 5.

Output:



User_name	avg_heart_rate
Ann	60.0000
Alissa	63.0000
Novelia	66.0000
Olivier	70.0000
Erny	83.0000

7. Conclusion

Our efforts have been made to make our system efficient and extensive. Using our database, it would be easier to handle the smart gym concept. Our System can be extended at the Machine level as we have shown in the Band Level. The machine would also contain add-ons that can easily be tracked. Meal Routine, Workout could be extended to make more descriptive, custom Diets, and Workouts. The social aspect can be extended by adding features of comments and likes.
The concept of gamification [6] can be applied branching out from that. Our system will provide a seamless way to integrate more features without much complex change. A fully-fledged web system with a database and server hosted on the cloud could be established that would also help to incorporate home workouts in the time of COVID-19 and post COVID-19 [8-9], and already existing smart machines. A social media with challenges for fitness freaks, different smart add-ons that help

to collect data from each exercise that can be used. The rate at which development in the field of IoT is rising with new research on fitness devices like wrist bands, Smart Mats [5], Smart Gloves [7] coming up we expect to dive deeper and focus on the Hardware part. The use of Big-Data and Machine Learning is also expected to analyze results for example Heart-Rate [4] and recommend workouts and diets.

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