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IoT based Smart Fitness Tracker for Gymnasiums

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Abstract - *Objective of this project is to design a smart fitness tracker system which will record users' indoor fitness routine by minimizing the hassle of manually counting the sets and repetitions, especially of weight exercises. An attempt has been made to distinguish between each member of the gym using Radio Frequency Identification (RFID) scanner and tag. This aids in separately feeding and updating users' respective data on the database which will further contribute to the Fitness Tracker App. This project can help solve problems of the traditional way of mentally logging the data which tends to be inaccurate. We analyze the recorded data to give suggestions about users' progress which helps in setting a goal for the future. This project comes under the category of Green IT since it uses cloud services. Furthermore, many such trackers for various equipment can be evolved from this project.*

Key Words: **IoT, tracking, workout.**

1. INTRODUCTION

Exercise is an important contributor to physical and psychological well-being. Regular exercise reduces many chronic diseases, such as heart/cardiovascular diseases, diabetes, hypertension, obesity, etc. Also, according to a study by Institute of Health Metrics and Evaluation (IHME), percentage of Indians living with obesity will go up to 5 percent in 2025[1].There are movements and awareness programs to shed a light on this issue, as well as, people are themselves realizing the need to exercise regularly and keeping a track of their daily performance. Due to widespread of fitness in today's society, fitness apps are on a boom. Most of them focus on tracking cardio (running) exercises. Weight training, in addition to aerobic exercises, is an important component of a balanced exercise program. Manual counting of weight exercises, chest, back, legs exercise machines, manual logging of data on to fitness apps can make the data inaccurate. However, mechanisms for tracking free weight exercises have not yet been explored. Weight training involves combinations of different types of exercises, varying weight amount to lift, number of repetitions and sets to be done, and so on. Human intervention causes wrong interpretation of data. Managing a diverse training sequence should be well supported on site. Even though people may try to organize by keeping notes on their progress, this is tedious and easily turns the workout into a chore.

Free weights such as dumbbells activate smaller stabilizing muscle groups to control the exercise. Resistance machines on the other hand, tend to work muscle groups in very strict planes of movement. The downside of this very strict movement is that while some muscle groups will become significantly stronger, other smaller muscles are neglected. Athletes typically favor dumbbell exercises over machines as they can replicate sport-specific movements more accurately. They also know that they will develop a more balanced physique and structure if most of their routine employs free weight exercises.

Hence, we came up with a tracker whose sensor (accelerometer) counts and calculate the data, feed it to the database (Firebase) wirelessly and then further updates the Fitness Tracker App. In this way we can keep a check on our routine accurately. Also, data of each individual will be updated on the app separately because we make use of Radio Frequency Identification (RFID) scanner and tags for each member of the gym. Along with tracking free weight exercises this system also takes into consideration the cardio exercises i.e. treadmills. With the help of Optical Character

Recognition (OCR) user can keep a track of his/her running distance displayed on the screen of treadmill.

2. LITERATURE SURVEY

There are several types of trackers being used in different forms such as smart fitness machine, fitness wristbands, pedometers, fitness apps, Nike Run club etc. The smart fitness machine which is available is an aftermarket product that is designed to automatically track a user's performance for a specific workout machine. It is a solution for non-smart modern weight lifting machine. Microcontroller collects sensors data of counts, reps, sets and sends it over internet to a database, later user can view this workout information via Android phone. Fitbit bands calculate calories burned, counts steps and distance and can also reset data. It makes use of accelerometer which is a 3-axis implementation that allows measurement in any motion making it more precise than the single axis pedometers. Mechanical and electronic pedometers make use of a pendulum/hammer that swings between the center to open and close the circuit for step counting. It then shows a count of your steps on LCD display, most will convert this information into distance in kilometers or miles at the push of a button.

Kevin C. Tseng describes about an integrated physical fitness testing system to evaluate the degree of physical fitness of the elderly by saying that aging process can be partially slowed by proper training [2]. Furthermore Otto et al. have strengthened the capabilities of health monitoring systems by using networks and Lee and Chung have integrated

sensors in a smart shirt for real time ECG monitoring. Yan Sun and Qun Liu describes the investigation and analysis on fitness coaches of fitness clubs in Wuhan [3]. With the development of the national fitness, fitness coaches will no doubt demand in growing. The main aim is to promote the aerobics instructor team and provide the theoretical reference for development of the clubs rapidly by analyzing the age, gender, education levels, income, technical level and working conditions by means of using literature and questionnaire. HaiYing Yu, YanYan Wang and ZhaoFeng Liu had a research on android based data management system for fitness equipment for the strength fitness equipment, which can display, storage and manage fitness data [4]. Yaping Zhong and Wiehong Hu made a research on WebGIS based information integration and data analysis platform for China's physical fitness and the National fitness program [5]. This study provides a new approach for the analysis and evaluation of the national physical fitness monitoring data, as well as a reference for the future development of the National Fitness Program.

Fletcher Lu and Kei Turner wrote about improving Adolescent Fitness attitudes with a mobile fitness game to combat obesity in youth [6]. This mobile fitness game prototype included 13 exercises with functionality to socialize with friends regarding exercise progress and collaboration. Results indicate that the application's socialization features were able to improve subject's views on fitness activities. Nisheeth Gupta and Sruti Jilla proposed Digital Fitness Connector architecture leverages existing technologies of smartphone and sports and fitness devices [7]. This allows compatibility with over 80 ANT+ health and fitness sensors to track heart rate, speed, cadence, distance, pace, power and more and it allows users to monitor physical activity either in real time or post workout. It works with majority of smartphone platforms - iPhone, Android, Windows. Chao Yang, Xu Zhao, Long Zhou describe the analysis on college student's physical fitness testing data [8]. The test includes body mass index, lung capacity, run, standing long jump, sit and reach, pull-up (male)/sit-up (female). Final result is the weighted sum of the seven items. The learned weights give students a reasonable evaluation of physical ability and also present a solution algorithm. S. Sahoo, V. N. Tiwari and R. Narayanan describe a personalized fitness planner based on endurance [9]. The proposed model provides a device to predict future endurance of a test subject following particular exercise regime. This facilitates a test user with a fitness planner with the provision to fix exercise regimes to reach set fitness goal.

3. OBJECTIVES

The proposed system has a major edge over prevailing mobile applications in the sense of data input given to the system. Raw data is directly sent to the processing and controlling data from the sensors mounted on or embedded in each of the equipment. This minimizes much of the error that occurs in the data calculation and hence predictions, due to human intervention. Raw data is filtered and then stored on the cloud. It is then displayed on a mobile application in a user-friendly interface. Data is analyzed over a number of parameters based on daily workout and the previously recorded progress. Timely notifications are provided on the app about a user's daily progress and the necessary suggestions. Also, the design aims for an economic system with considerable precision.

4. SYSTEM DESCRIPTION

4.1 Hardware

The system consists of both hardware and software. Microcontroller used is Arduino Nano and ESP8266 Wi-Fi (IEEE 802.11 b/g/n) enabled chip is interfaced with it to facilitate sending the data to the database maintained on Firebase by Google Inc. This microcontroller can be programmed using the Arduino IDE. It is fully acquired with TCP/IP stack and is a lower cost and low power consuming chip. With the help of appropriate libraries and the acquired data can be pushed to the cloud. Database services being used by the system are Google's Firebase. Firebase helps to maintain a real time database. It allows the admins to push and get data for the required fields. To maintain a distinguished identity for each user this system makes use of RFID (Radio Frequency Identification). The RFID reader (MFRC522) has range of 2cm for detection of RFID cards/tags and works on 13.56MHz for contact-less communication. This helps in maintaining integrity of the system. Each card/tag has a unique ID (UID) which helps the system to identify the user after authentication with the pre-mentioned database. This RFID reader is interfaced with Arduino Nano which is connected to an external power supply. Maximum voltage handling capacity is of 2.6-3.3V.

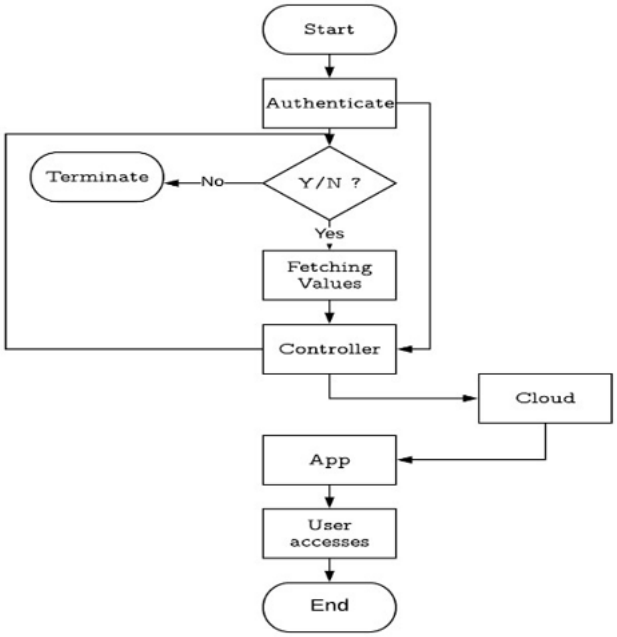
For tracking Free Weight Exercises, accelerometer module i.e. ADXL335. This module helps in acquiring acceleration in all three axes i.e. X, Y and Z. This module has a temperature stability from -40-85 C and measurement range of +-3-3.5g.

It is necessary to consider all three axes while tracking and calibrating the values accordingly so as to get an accurate output. ADXL335 gives analog values as the output which is obtained on analog pins of another microcontroller i.e. Arduino Nano. An external replaceable and rechargeable power supply is connected with ADXL335, Arduino Nano and ESP8266 chip.

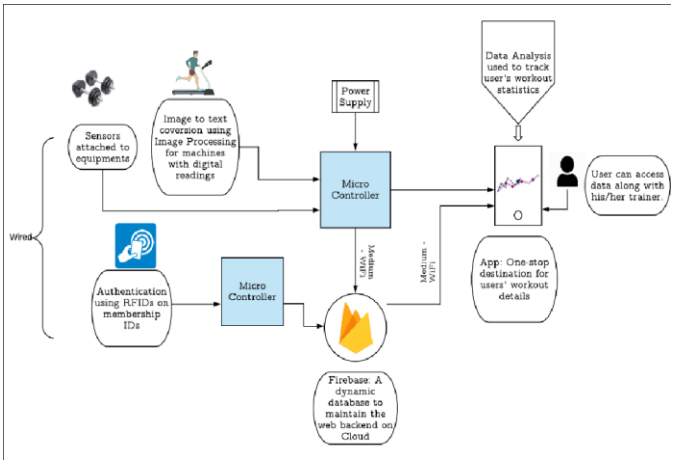
4.2 Software

Raw data from sensors is generated, achieved and synchronized by the microcontroller using Arduino IDE supporting a wide range of libraries that help in calibrating the data in a useful format. The processed data is then stored on Google Firebase, a reliable and secure cloud service by Google Inc. Firebase provides various other services such as mobile applications support, Machine Learning Toolkit for data analysis, etc. Data stored on the cloud is displayed on a

user-friendly mobile application developed on Android platform using Android Studio. Authentication support along with a user session, beginning notification, support for system hardware such as camera for OCR, listing of workout and exercises, and timely notifications are the features designed in the system mobile application. Data analysis for fitness predictions is implemented using IBM Watson that accepts the data set as an input and retains a prediction using a suitable model for analysis. Predictions are displayed in the form of suggestions and notifications to the user on the application.

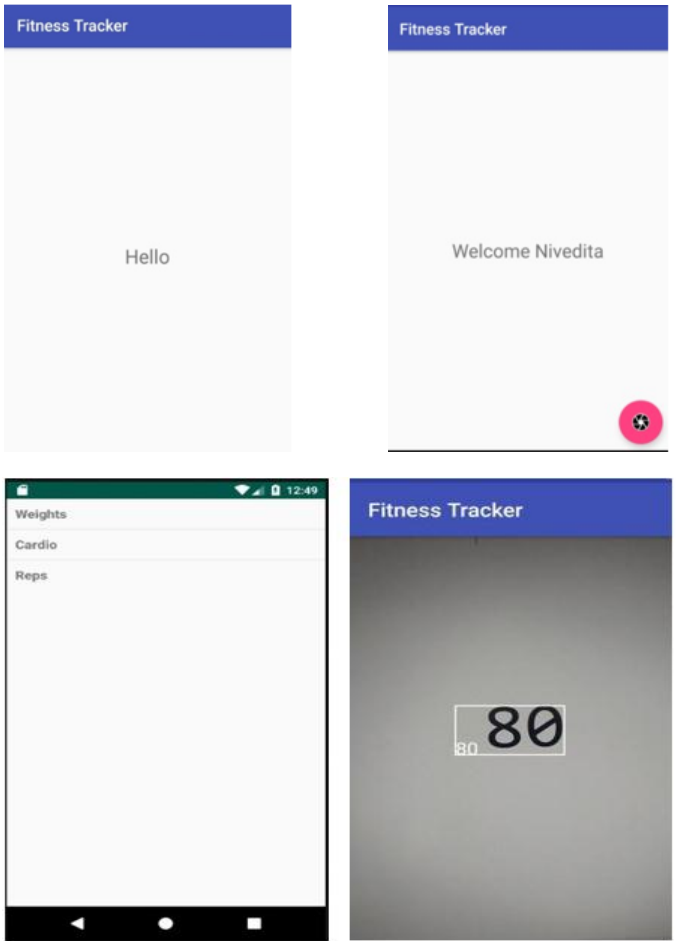


Flow Diagram



System Architecture

5. OBSERVATIONS AND RESULTS



App console

6. IMPLEMENTATION

Process starts with authentication; every card has a unique ID which gets pushed to the database and a query is passed to check the whether the element (UID) is present in the database i.e. Firebase. If the user's ID is verified then his/her session will begin and the user will be able to access his data on the app. If not, the app will not respond. In case of a new user, provision of creating a new account is provided to the user as well as admin of the gymnasium. Similarly, personalized session will begin during the training, sensor data gets pushed on the cloud and app is designed accordingly to retrieve it. Our main aim is to log data accurately and display it for users as mentioned above. This system eliminates the need for a user to manually record weights, sets and repetitions during a workout. Firstly, the

RFID tags are given to each member of the gym for authenticity. The RFID scanner is interfaced with Arduino Nano (ATMEGA328P). The Arduino Nano, which acts as the microcontroller of the system, is then wirelessly connected to Firebase (cloud) using Wi-Fi module ESP8266. The data of each user/member is stored virtually on Firebase. Next the

system comprises of an accelerometer sensor which is fixed on the equipment, along with Arduino Nano, here in our case a dumbbell. As said, an accelerometer is a device that turns movement into analog values. Curated values which go above our set threshold value are taken from the sensor which takes all the three axes into account X, Y, Z axis. Sensor values are recorded and the number of counts, repetitions and sets are calculated. This data is further fed to the Arduino Nano which is again further wirelessly connected to Firebase with the help of ESP8266.

Arduino IDE is used to program microcontroller according to the need of project and Android Studio for our very own mobile application. Now this data/information which is available on Firebase is pulled and displayed on Fitness Tracker App on an Android phone using internet. The mobile application also provides the facility to add treadmill exercise data on the application. Camera icon present in the application is programmed to convert image to text when held over a number i.e. treadmill's display in our case. User is provided with the option to add desired fields from this converted data, for example, distance, speed, calories burnt, etc. This personal information can be accessed only by the user and gym trainer. This app will give personalized diet plans, workout and fitness activity list, number of calories burnt in a specific time period. With the help of IBM Watson, the generated dataset is fed to IBM Watson Cloud Services and Linear Regression algorithm is used to generate analytics of the users' workouts. The user will be notified on a regular basis of his/her fitness regime based on the initial data entry of user, the workout done previously and the amount of workout to be done to accomplish the goal.

7. CONCLUSION

System is designed for hassle free workout. It provides a cheaper solution instead of upgrading the gym setting. The system can be used in activities involving weights and physical tasks. It provides precise tracking of activities. No manual calculation of data is required. Data storage on cloud enables smart working of the system. It is inexpensive and compact, additionally, timely notifications provided. It is a one click destination for user, his/her dietitian and trainer. It also provides analysis of workouts, calories, burnt, etc. As the data can be shared with the trainee and other users, Security measures need to be taken care of which can be implemented in future with the help of modern technology.

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