



## ***DiaM*- Integrated Mobile-Based Diabetes Management**

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### **ABSTRACT**

Mobile technology is showing a wide acceptance in the health-care system. As technology is changing there are many health-care applications in the market. The need of these applications is increasing day by day because of unhealthy lifestyle. Among the various ailments, the most common lifestyle disease is diabetes. As we know diabetes can't be cured, it can only be controlled by managing one's lifestyle. In this paper, we propose a new application *DiaM* for managing and mentoring a diabetic patient. *DiaM* is Artificial Intelligence (AI) based mobile application which not only connect to manage one's lifestyle but to build the strong will power. Our application has been designed in such a way that all the aspects are covered to manage one's lifestyle. We have implemented an AI based system which smartly categorizes the patients in different states, which utilizes the different parameter like eating habit, stress, exercise, sleep time, smoking, genetic, BMI, and various other symptoms. On the basis of these states suggestions are been provided to the patient for improving the lifestyle. *DiaM* also enables patient to connect with the Doctor for monitoring and mentoring. Our application provides real-time alerts to doctor so that they can monitor patient anytime. It is extremely necessary to manage health conditions therefore our application provides a better, accurate and sustainable health-care system.

**Key Words:** Artificial Intelligence (AI), Body Mass Index (BMI), Lifestyle, Artificial Neural Network (ANN), Management of Diabetes (MD), Web-of-Things (WOT).

### **1. INTRODUCTION**

Diabetes is a disease which occurs due to the presence of high blood sugar level or the blood glucose in body. Main source of energy is the blood glucose and this we get this from the food we eat. Insulin is the hormone which is produced by the pancreas and it helps glucose to get into the cells for generating the energy. In other words, we can also say that the diabetes is the disease in which body is unable to process the food properly, to be used as energy.

There are mainly three types of diabetes Type 1 diabetes, Type 2 diabetes and gestational diabetes [2]. Type 2 diabetes is the most common type of diabetes. The Type 2 diabetes is caused due to several factors like physical inactivity, overweight, and obesity also including genetic and lifestyle factors. If a person is not much active physically, overweight

or obese then there are more chances of having diabetes. One of the main reason for insulin resistance is having extra body weight and due to this body does not effectively uses the insulin produced or the glucose gets developed in blood instead being used by cells which leads to pre-diabetic condition or Type 2 diabetes. Number of diabetic patient is increasing worldwide rapidly. It is estimated that number of diabetic patients will increase from 415 million in 2015 to 642 million by 2040 [3]. Diabetes is one on the major cause of increasing morbidity and mortality now a days. India is second highest in terms of diabetic patient numbers and has 77 million of diabetic patients and it is predicted that by year 2045 India will have 134 million people suffering from diabetes. Every sixth diabetic patient in the world is from India. India has mainly Type 2 diabetic patients which are increasing at an alarming rate. Unhealthy diet, less physical activity is the main factors of increasing diabetic patients in India.

Diabetes is everlasting, lifelong disease which can't be cured but, diabetes can be controlled with the proper management of various factors which causes the diabetes. If a person manages its lifestyle properly than diabetes can go in remission, which means although person will not show any symptoms of diabetes but technically that person will have diabetes. Proper care like exercise, meditation, physical activity and strict discipline will help in managing the diabetes [2]. Self-management will be the key for success in this case but due to hectic daily schedules, ignorant behavior and in some cases people forget to follow these recommended advise. A wide range of mobile based (mHealth) applications are present for better diabetes self-management [1]. Studies has reported that remote monitoring of the diabetic patient has increased the outcomes of patient in terms of hemoglobin (HbA1c) and the other issues related to diabetes [1].

In this paper, we have proposed a user friendly *DiaM* mobile application, which includes all the aspects to manage diabetes and live a better lifestyle. Our application not only helps the patient to keep the record of their day to day activity but also based on the information provided by patient it suggests how they can improve their lifestyle. This platform also has a separate section for the doctor, through which a patient can get in touch with the doctor anytime and doctor can review the patient's performance or activity and get real-time updates of patient's condition.

## 2. RELATED WORK

According to American Diabetes Association, consider mobile application to be an effective way for lifestyle modification to prevent diabetes [3]. Diabetes is the chronic disease which leads to the development and implementation of DiaM for diabetes management.

The review covers 273 articles from journal database and 1004 applications from the online market out of which 29 articles and 43 applications satisfies the selection criteria [2]. The integration of all the features in a single application is very rare. All the diabetes management applications have one common parameter of measuring the blood sugar. Some application takes other parameters and physical activity or few applications have diet plan. But the integration of most features in a single application is not available [2].

In our research we have emphasized on the self-management of diabetes on different parameters by machine learning methods. We have identified that there are several ways for diabetes self-management. “e-health” system for Type 1 diabetes is designed with the concept of Web-of-Things (WoT) [4]. It is a web application in which data is collected remotely and through real-time decision support system and behavioral changes are seen in them.

Systems ANN is currently the most promising area in solving the health care problems [8]. The classification is done majorly on the Pima Indian Diabetes data sets [8]. A Hybrid ANN Model was developed for the classification of diabetic patient [9]. Wearable Health Monitoring System called prognosis is being developed using fuzzy regular formal language, which describes the patient’s current health [7]. In these two types of measurements are done physiological measurement and pathological measurement [8] for detecting the health condition.

Systems are there which provide a combination of diabetes management using ANN. Traditionally a system requires input of Blood Glucose level in combination of different parameters. As IoT is newly emerging therefore, it is also used in self- management of diabetes [1]. A mHealth application has been developed for remotely collections of data in result provide Health indicator and warning [1].

Our work presented in paper aims in developing a mobile based application with ANN intelligent system integration with IoT devices. DiaM is capable of estimating patient’s health state and providing them the current status and the suggestive measure to manage their lifestyle and manage diabetes. The proposed framework, there is connectivity provided with the doctor. Also, provides the current status and real-time alerts of the patient to the doctor. We observed wide variability among the analyzed apps in terms of features and functions for diabetes management (Table 1). Smart phones are not just important to society at large; it can change lives of individuals. The world health organization defines mHealth as medical and public health practice supported by mobile devices. These devices provide real-time monitoring of the patients.

Mobile technology is helping with chronic disease management, empowering and reminding people to take medications at the proper time, extending service to understand areas, and improving health outcomes and medical system efficiency.

A study on mobile base applications on diabetes management shows that, there are many applications available which are related to diabetes around 1004. Among these applications some applications are capable of doing multiple actions and some applications researched to be use augmented reality.

There are lots of mobile applications are out there, with all these applications people face some difficulties to choose a right one for their need. People generally choose top rated application for their use. However, highest ranked are not always best one in practical use.

Application Name	Blood Glucose Management	Physical Activity Measurement	Services
DeXcom5 Mobile	Yes	No	Diabetes Education
mySugar	Yes	No	Coaching services
One drop for diabetes management	Yes	No	Can connect to experts
Diabetes-M	Yes	No	Data export option

TABLE 1

COMPARISON TABLE OF DIFFERENT APPLICATIONS

### 3. TECHNOLOGY BASED MANAGEMENT

Technology is a set of tools which promote development, use and exchange of information and mainly making a task easier and solve problems of mankind. Now as day's technology is important because it is more convenient, secure and easy in every area of a life whether personal or business. Technology is used to achieve goals and provide goods and services. Technology has revolutionized our world. With the help of technology amazing tools and resources are being created to provide solutions at our fingertips.

Management is a set of principles which include planning, organizing, directing and controlling functions or process of an organization to reach its goals efficiently and effectively. The four main key functions areas of organization: planning, organizing, leading and controlling. The principle function of the management is universally applicable to all the group activities performed at any level of the organization.

Technology management is a simple way through people and technologies work together in a systematic method for managing the process of applying knowledge to extend the human activities and produce defined products. We live in the time of unprecedented technology change; a good technology management involves what strategy should be followed by proper matching and alignment to business need.

Technology has potential effects of management:

- Reduces the cost of organization.
- New product and new market creation.
- Adoptions to changes in format and scale.
- Improve customer services.
- Reorganized administrative operations.

### 4. SCOPE OF TECHNOLOGY BASED MANAGEMENT

There is lot of technological innovations done for the growth of a better world. These innovations better reflects to the science and consideration of improving the business and its value by working on the technology aspects of the product. All new products launching in every field aim to the ease of working. It is easy to access the information from all around the globe; technology management saves the time, ease of mobility, better communication means, cost efficiency, better learning technology and artificial intelligence. Technology management allows managing the following:

- Use of technology in business.
- Use of technology in medical field.
- Use of technology in institutes for academics.
- Technology used in communication.
- Technology used in computer science.

In India health-care system is growing at a better pace. Health-care system helps to maintain or resolve physical, mental or emotional well-being of a person. With the growing technology health-care systems are also adopting the better

ways of treatment with the improving technology.

The most common health care technology these days are artificial intelligence, block chain, voice search chat bots and virtual reality.

Artificial intelligence affects number of advantage to the health-care system but the most important advantage is of decision making. With the help of AI, one can find out the pattern of the patient's and determine the probability of getting effected by a disease. AI increases the accuracy and outcome precision of the patient. AI do not only help's patient but also helps the doctor to analyze patients in a better way and understand the need of the patient for day to day care. The onemore advantage of using AI in health care system is, that doctor and patient can be connected virtually and reduces unnecessary visits to the doctors and create time saving administrative duties.

### 5. PARAMETERS IN SCOPE

There are many factors which influence the blood sugar level to increase. These factors should be kept in control. We can broadly classify the parameters in three categories:

#### i. Clinical Parameter:

The clinical parameter is the blood sugar level. Blood sugar level should be in control a fasting blood sugar level should be 100 mg/dL for normal range, 100 to 125 mg/dL for pre-diabetic and 125 mg/dL or more is considered as diabetic. In every three months a test is required known as HbA1c to test the percentage of blood sugar attached to hemoglobin, the oxygen carrying protein in red blood cells of the percentage of HbA1c is higher than 6.5 percentage then person is diabetic. If it is in the range between 5.7 percentages and 6.4 percentages indicates pre-diabetic and normal if it is below 5.7 percentages. The blood sugar level is affected by the other parameter and the lifestyle of a person for keeping blood sugar in range person should maintain the factors in a proper.

#### ii. Habits:

One can manage his or her diabetes by following change in daily lifestyle. Person diagnosed with diabetes should manage certain habits to maintain the blood sugar level or lower the blood sugar level. Adopting a healthy lifestyle decreases the risk of diabetes; if diabetes is not managed it can give rise to other disease like heart attack, high blood pressure, obesity and many more. On the basis of our study, we found that certain habits should be in control for managing diabetes and keeping a healthy and better lifestyle.

There are certain Habits which directly effects diabetes areas described below:

**Stress:** Stress has a major effect on the metabolic activity. Stress hormones might stop or reduce the amount of insulin producing cells in pancreas. Which results in elevate the blood sugar level. The factors which lead to developing of stress are general emotions, anger, work stress, distressed sleep. Therefore, the metabolism of the body is getting affected and causes a person with unhealthy lifestyle habits.

**Eating Habit:** Risk of diabetes is increased by eating a diet high in fat, calories, sugar and cholesterol. There is an undesired rise in the blood sugar level when we take an unhealthy diet. A diet should contain low fat food, fruits, vegetables, low calories and whole grains. If the blood sugar level is not kept in control by maintaining a diet plan and tracking it, this will lead to various diseases like heart damage, long term complication and obesity.

**Exercise:** Exercise on a regular basis helps to manage diabetes, insulin sensitivity cells are increased when exercise is done. So, less insulin is required to keep blood sugar level in control. There are many type of physical activity which a person can perform like aerobics, gym, yoga, weight lifting. According to studies that an adult suffering from diabetes should burn more than 2000 calories weekly, which prevents the progression from pre-diabetic to diabetic or normal to pre-diabetic condition.

**Sleep:** It is reported that the people with diabetes report less than six hours of sleep, which leads to the higher risk of increasing the blood sugar level. High blood sugar makes uncomfortable while sleeping or irritable and unsettled. The disrupt sleep patter leads to tiredness through the day, stress, depression. Good sleep habit is important and to have good sleep the most important is to maintain a regular bedtime, keeping room calm and dark and regular exercise.

**Smoking:** Smokers have difficulties in maintaining the blood sugar level because there is high level of nicotine present in their body, in result decrease the effectiveness of insulin. Therefore, need more insulin to maintain blood sugar level. The addiction increases the risk of kidney disease, nerve damage, eye disease, lung infections and cancer. There are many successful programs which help a person to quit smoking habit like nicotine replacement therapy, lifestyle changes and oral medications.

**BMI:** Body mass index is the value which is derived from height and body mass of the person. It is calculated by dividing the means mass of the body and the height of the body and unit of the value received is  $\text{kg/m}^2$ . So, by the definition of the BMI it is quite clear that one of the main factors in BMI is body weight. BMI range from 18.5 to 24.9 is considered to be normal or healthy BMI. Person with higher BMI means that the person is either overweight or obese, and increase in the weight is associated with the increase in risk of getting metabolic disease like Type 2 diabetes. So, it is recommended that one

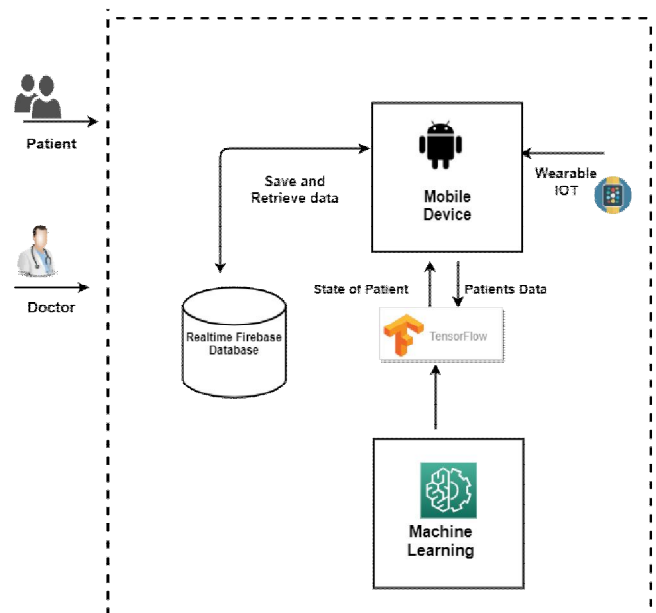
should keep his or her body in shape to keep BMI in normal rage to prevent him from getting affected by such diseases.

**iii. Symptomatic Data:**

- **Tiredness:** When insufficient sugar is moving from blood stream to body’s cells. Therefore, the energy level of a person is decreased hence patient feels tired.
- **Urine frequency:** When the blood sugar level is high in the body, the excess sugar level in the blood is filtered out by the kidney. Thus it leads to frequent urination.
- **Thirst:** As there is frequent urination the body losses the additional water in result one feel thirstier than usual.

**6. SYSTEM ARCHITECTURE**

The architecture of DiaM application is presented in Figure 1. The system is comprised of two components: Management of Diabetes (MD) and secondly the Classification of patient. The major component of MD is patient, doctor, mobile phone and wearable IoT devices like smart watches. For managing diabetes certain parameters are required like eating habit, stress, exercise, sleep time, smoking habit, genetic, BMI, age and various other symptoms like urination, thirst and tiredness is provided by patient.



**Figure 1:** System Architecture of DiaM

Patient can provide this data either manually or directly by IoT device, which is then stored to the real-time firebase database. And then this data is send to the trained ANN, and on the basis of that states are obtained and suggestions are provided to the patient to manage healthy lifestyle. The data which is stored on the database are available to both the patient and the doctor. The doctor is able to see the patient data and state provided by artificial neural network anytime. Real-time alerts are also provided to the doctors and in an emergency situation doctor can call patient or vice-a-versa.

Classification of patients is done with the help of artificial neural network or prognosis model. Artificial neural network works in a similar way like human nervous system. In training the artificial neural network, the classification is done with the help of supervised learning. Parameters mentioned above are set as input to neural network which is use to classify patient in different state like, good habit with/without severe condition, average habit with/without severe condition and bad habit with/without severe condition.

Tensor flow lite (tflite) is an open source deep learning framework. Tensor flow lite is used to load neural network onto the mobile device with low latency. So, we can take advantage of classification without going to the server. The work flow of Tensor flow lite is picks a model, convert the model, deploy to your device and optimize the model.

### 7. MANAGEMENT CYCLE

Our application DiaM provides an easy way to patient for managing diabetes and their lifestyle. DiaM management cycle is described in Figure 2. DiaM has been designed and developed by taking following requirements under consideration:

- i) Need for diabetes self-management.
- ii) Doctor can see patient’s data anytime and anywhere.
- iii) Classification of patients and advised provided on the basis of it.

#### A. Patients Data

The registered patient’s need to provide three types of data, clinical data, self-habits and symptomatic data.

- 1. **Clinical data:** The existing system for measuring the blood glucose is done with the help of Glucometer. The meter reads the amount of sugar present in the blood using the fingertip. There is no non-invasive method till date or for continuous measuring the glucose sugar level. Therefore, user has to provide blood sugar level (mg/dL) manually to our system. The blood sugar value tells us the condition of the patient whether the patient is normal, marginal or diabetic.

- 2. **Self-habits:** The data which is initially filled by the patient falls under the category of self-habits. The information provided by patients is used by mental model which tells the habits of patients, like patient is having stress or not, eating habits of patient is good or not. Here the mental model works on some question which is initially asked to patient by DiaM. There are total seven parameters as follows stress, age, sleep time, smoking habit, BMI, exercise and eating habit. This is required by trained artificial neural network with the symptomatic data for classification of patients.

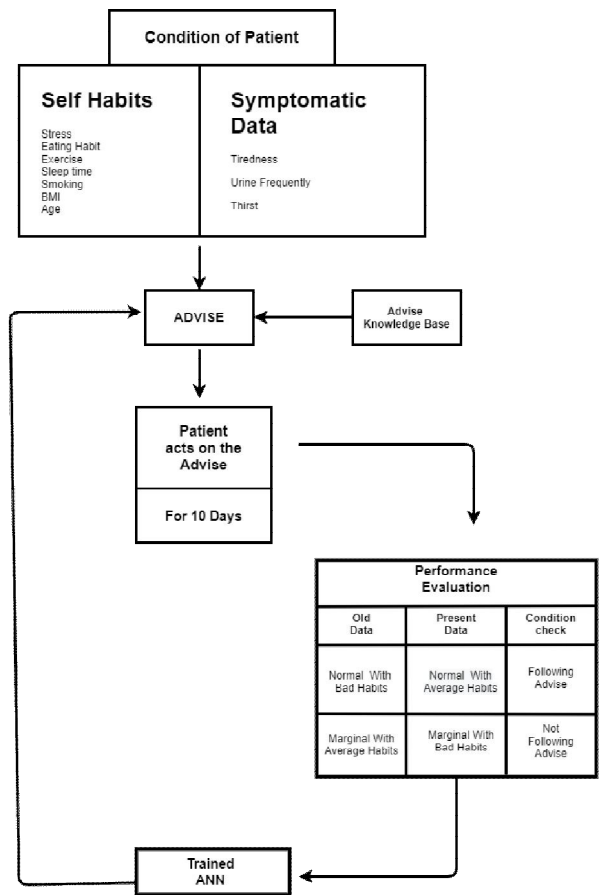


Figure 2: Management Cycle

- 3. **Symptomatic data:** Including symptomatic data with the habits is very important for classifying the patients. Symptomatic data is required for observing the condition of the patient is severe or not so severe. We have taken three major symptoms of diabetes Tiredness, Urine frequency and Thirst.

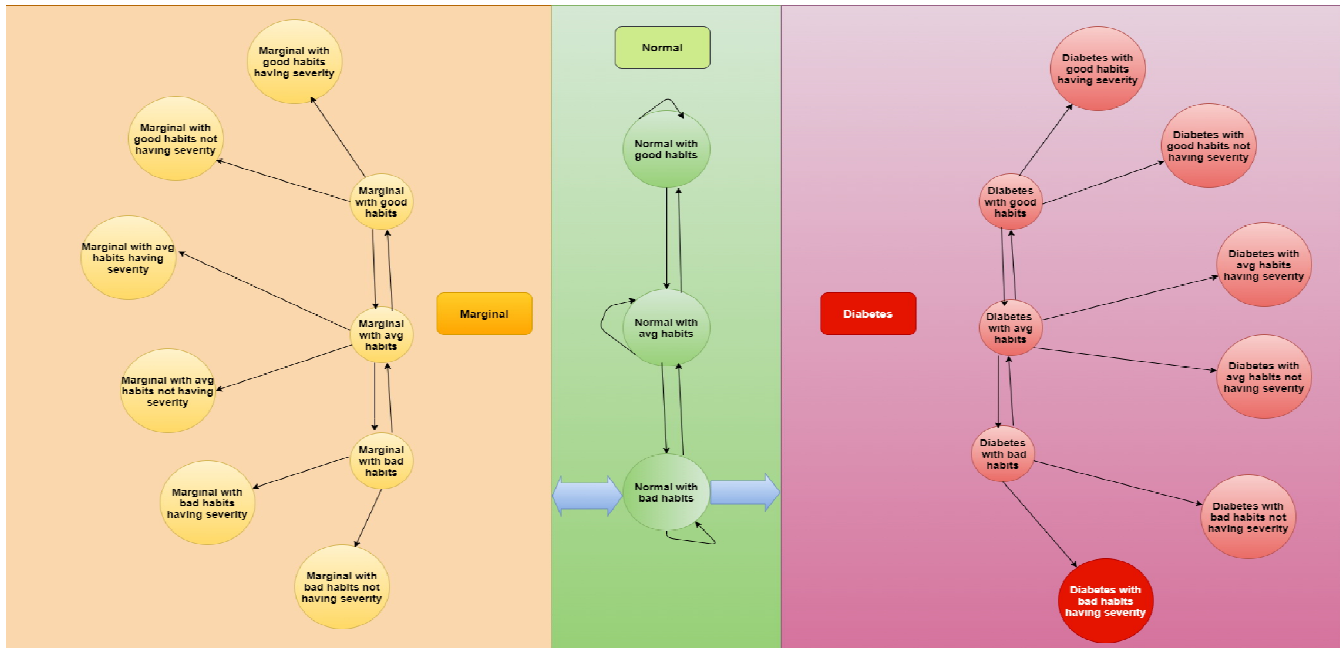


Figure 3: State Diagram for Advise

Combining self-habits and symptomatic data is sent to the artificial neural network for the classification and states are provided to the patient. On the basis of clinical data and states provided by artificial neural network we obtain total fifteen states shown in Figure 3.

- **Normal:** When the blood sugar level is in normal range then patient falls under this condition. The normal condition has three states normal with good habit, normal with average habit and normal with bad habit.
- **Marginal:** When the blood sugar level is in marginal range then patient falls under this condition. The marginal condition has six states marginal with good habit having severity, marginal with good habit not having severity, marginal with average habit having severity, marginal with average habit not having severity, marginal with bad habit having severity, marginal with bad habit not having severity.
- **Diabetic:** When the blood sugar level is in diabetic range then patient falls under this condition. The marginal condition has six states diabetic with good habit having severity, diabetic with good habit not having severity, diabetic with average habit having severity, diabetic with average habit not having severity, diabetic with bad habit having severity, diabetic with bad habit not having severity.

### B. Advise

Advices are being provided on the basis of diabetic condition and the state obtained from the artificial neural network. Advices are stored in the knowledge base. As we have discussed earlier diabetes can't be cured it can only be managed by managing one's lifestyle. Therefore, a systematic knowledge base has been designed to provide advices on the basis of different conditions and states of the patient like diabetic with good habit not having severity, marginal with good habit having severity.

### C. Patient's advise on acts and performance evaluation

Patient's are provided advise to maintain a good lifestyle for managing the diabetes, patients have to follow the advices provided. After every ten days patient's are asked to enter the data again to evaluate whether the patient has followed the advise given or not. A notification is sent in every 10 days to update the data.

### D. Trained ANN

The current new data is sent to the Artificial Neural Network for the classification. On the basis of the output obtained by ANN advise is given to the patient and patient need to work on the given advise for the next 10 days.

## 7. CASE STUDY

Let us consider a hypothetical situation where person of 40 year of age weighs 80 kg measures following:

- **Clinical data:**  
Blood glucose level 122 mg/dL
- **Habits:**  
Smoking Habit: No  
Genetic: Yes  
Physical activity: Occasionally  
Sleep time: Bad  
Stress: Yes  
Eating habit: Bad  
BMI:Overweight
- **Symptomatic:** Yes

The above data is entered in our application DiaM. Figure 4 Shows the screenshot of our application where patient provide the Self Habits and Symptomatic Data of our Management Cycle.

6:04 75%

Fill your information in every 10 days for better results

**Please fill additional information**

Name Pankaj Sharma

Mobile Number 9563214780

Age 40

Height (CM) 173

Weight (KG) 80

**LifeStyle**

Smoking Habit  
 YES  NO

Do your Parent's have diabetes  
 YES  NO

Exercise Information  
 Regular  Occasionally

Sleep Time  
 Good Sleep  Not so Good

NEXT

Figure 4: Screen shot for data input of DiaM Application

Figure 5, 6 shows the questions asked for the mental model to know patients thought process. There are different set questionnaire for knowing the stress level, eating habits, symptomatic condition of a patient. This mental model helps to give advise to the patient. Figure 7, Shows the Blood sugar data of the patient. The blood sugar value tells us that the patient is Normal, Marginal or Diabetic.

6:04 75%

Fill your information in every 10 days for better results

**Please fill additional information**

Name Pankaj Sharma

Mobile Number 9563214780

**LifeStyle**

1) Do you have frequent urination these days  
 Yes  No

2) Do you have excessive thirst these days  
 Yes  No

3) Are you feeling more tiered these days  
 Yes  No

NEXT

Good Sleep  Not so Good

NEXT

Figure 5: Questionnaire for Mental Model of DiaM Application

6:05 75%

Fill your information in every 10 days for better results

**Please fill additional information**

Name Pankaj Sharma

Mobile Number 9563214780

**LifeStyle**

1) My Job  
 Pleasant  Not so Much  Stressfull

2) I am energetic always  
 True  Not so Much  Generally tiered

3) I am sensitive to comments  
 Not at all  Not so Much  Yes

NEXT

Good Sleep  Not so Good

NEXT

Figure 6: Questionnaire for Mental Model of DiaM Application

The symptomatic data, habits data and the clinical data is then sent to the trained ANN and on the basis of the state obtained from the ANN the suggestions are provide to the patient for managing its lifestyle. Figure 8, Shows the advise given to the patient for living a healthy lifestyle.

After 10 days patient is sent a notification to update its data. The updated data is:

- **Clinical data:** Blood glucose level 105 mg/dL
- **Habits:**  
 Smoking Habit: No  
 Genetic: Yes  
 Physical Activity: Yes  
 Sleep Time: Good  
 Stress: Yes  
 Eating Habit: Bad  
 BMI: Overweight
- **Symptomatic:** Yes

After 10 day's patient is asked to update its data and performance evaluation is done. Figure 9 Patient's blood sugar level reading after 10 days in DiaM Application.

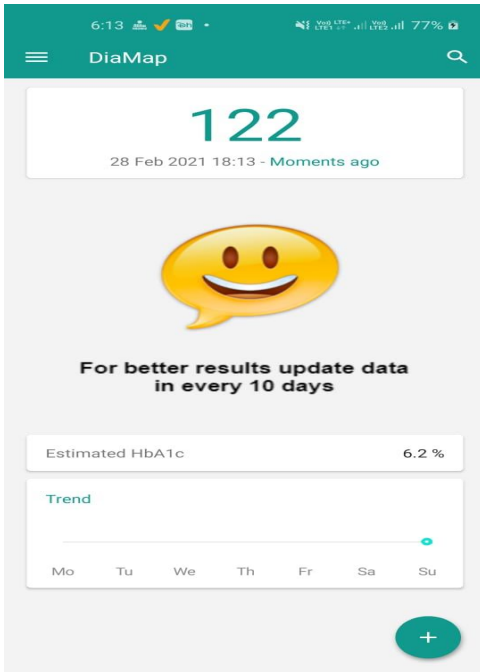


Figure 7: Blood Sugar Data



Figure 8: State of the patient and advise to be followed for next 10 days

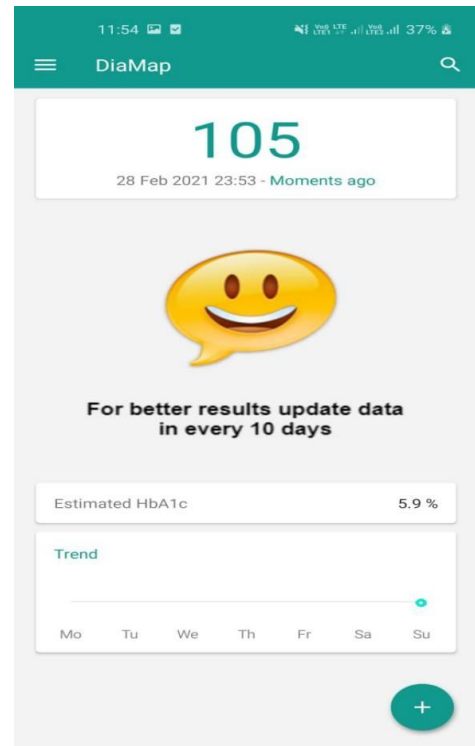


Figure 9: Blood sugar data after 10 days

We have observed that patient follows the advice provided by the advice knowledge base for 10 days is done and found that the patient has followed the advise and the state of the patient is changed from Marginal with average habits having severity to Marginal with good habits having severity. Figure 10 shows the new state obtained by ANN and the advise on the basis of the new state obtained.





Figure 10: State of the patient after 10 days and advise

## 9. RESULT AND DISCUSSION

Driven with the future vision of diabetes self-management with ANN and IoT devices DiaM is designed and implemented successfully. The developed application DiaM offers several attributes like patient's self-management, diabetes module, and doctor can see patient's states anytime anywhere, classification of the patient with the help of trained ANN, with a good user interface providing better, accurate and sustainable health-care platform for managing diabetes. Our goal is successfully implemented by making more robust and clinical expert system.

## REFERENCES

- [1] Majid A. Al-Tae, Waleed Al-Nuaimy, Ali Al-Ataby, Zahra J. Muhsin, Suhail N. Abood, "Mobile Health Platform for Diabetes Management Based on the Internet-of-Things", 2015 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT).
- [2] Md Abul Basar, Hassan Nomani Alvi, Gazi Nowrin Bokul, M Shahriar Khan, Farzana Anowar, Mohammad Nurul Huda, Khondaker Abdullah Al Mamun, "A Review on Diabetes Patient Lifestyle Management Using Mobile Application", 18th International Conference on Computer and Information Technology (ICIT), 2015, pp. 379-385.
- [3] Adam Bouras, Kat Usop, Mihail Popescu, "Empowering Diabetes Self-management by Gamifying Intelligent System: myTrybeCare Concept", 2018 IEEE 4th Middle East Conference on Biomedical Engineering (MECBME), pp 137-140.
- [4] M. A. Al-Tae, A. M. Sungoor, S. N. Abood and N. Y. Philip, "Web-of-Things Inspired e-Health Platform for Integrated Diabetes Care Management", IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT'2013), Amman, 3-5 December, 2013, pp. 1-6.
- [5] Nitesh Pradhana, Geeta Rania, Vijaypal Singh Dhakaa, Ramesh Chandra Poonia "Diabetes prediction using artificial neural network", In book: Deep Learning Techniques for Biomedical and Health Informatics (pp.327-339).
- [6] Nesreen Samer El Jerjawi and Samy S. Abu-Naser, "Diabetes Prediction Using Artificial Neural Network", International Journal of Advanced Science and Technology Vol.124 (2018), pp. 1-10.
- [7] Alexandros Pantelopoulos and Nikolaos G. Bourbakis "Prognosis—A Wearable Health-Monitoring System for People at Risk: Methodology and Modeling". IEEE Transactions On Information Technology In Biomedicine, Vol. 14, NO. 3, MAY 2010.
- [8] Sareh Mortajez, Amir Jamshidinezhad. "Neural Network Model to Diagnosis of Type II Diabetes". Journal of Research in Medical and Dental Science 2019, Volume 7, Issue 1, Page No: 66-70.
- [9] T.Jayalskshmi, Dr.A.Santhakumaran "Impact of Preprocessing for Diagnosis of Diabetes Mellitus Using Artificial Neural Networks" 2010, International Conference on Machine Learning and Computing, Page No: 109-112.