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AI AND IOT ASSISSTED NON INVASIVE GLUCOSE MONITORING DEVICE

- **Problem Statement ID –**SIH1528
- **Problem Statement Title-** AI and IoT Assisted Non Invasive Glucose Monitoring Device
- **Theme-**Miscellaneous
- **PS Category-** Hardware
- **Team ID-** 44632
- **Team Name (Registered on portal)-**Future Twinklers

Proposed Solution

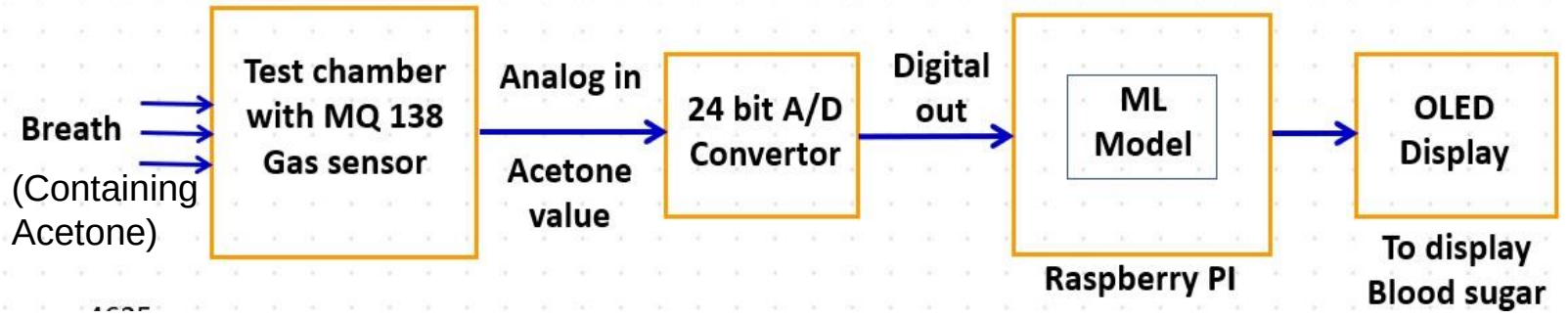
Describe your Idea:

- Current blood sugar measuring technique involves invasive blood extraction and pricking which is painful and carry the risk of hospital-acquired infection.
- The level of testing results are not constant and vary depends on the enzymatic strips and the quality of the instrument used.
- The proposed Innovative idea leverages **correlation between acetone present in human breath and blood sugar levels**. Therefore, the acetone present in human breath can be used to monitor the blood sugar value of diabetes **without taking out blood**.

Solution:

- **Real World Data Collection** : Breath Acetone of a person will be measured using Acetone Gas Sensor and blood sugar value of same person will be measured from Lab.
- **Machine Learning Model** : Neural Network based ML model will be developed (after training, testing and validation) using acetone as input and Blood Sugar value as output.
- **Deployment:** The developed ML model will be deployed on Raspberry PI. If breath of a new person is blown into non-invasive glucometer, it will display blood glucose value on OLED display.
- **Mobile APP** : A mobile APP will be developed to display history of blood sugar value of a patient and which can also be viewed / analysed by doctors.
- **Email Alert** : If sugar value reaches lower/upper threshold value, email alert is sent to relatives/doctors.

Prototype:



Technical Approach

Technologies to be used:

- **MQ-138 Sensor Board**: This sensor is used to detect acetone (Range ; 0 – 5000ppb) in the breath whose output is 0 – 5V range
- **24-bit A/D Converter**: Converts the analog signal from the MQ-138 sensor into a digital signal that can be interfaced with Raspberry Pi.
- **ML Model** : Artificial Neural Network will be used as ML model and will be trained using 500 real world and 5000 simulated datasets
- **Raspberry Pi:** Acts as the main processing unit which runs ML model
- **OLED Display**: Displays real-time blood glucose readings.
- **Software:** Python will be used as programming language
- **IoT** : Blood sugar data will be updated in ThingSpeak cloud using IoT and can be accessed any time from any where
- **Mobile APP** : A mobile APP will be developed to display history of blood sugar value of a patient and which can also be viewed / analyzed by doctors.
- **Email Alert** : If sugar value reaches lower/upper threshold value, email alert is sent to relatives/doctors.

Methodology and process for implementation :

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1. FABRICATION OF TEST CHAMBER

- **Acrylic sheet will be used for building the air tight test chamber**
- **MQ – 138 Gas sensor will be placed inside the test chamber to measure Acetone from breath**
- **Exhaled breath will be drawn into test chamber through input valve and then closed for measurement**

2. INTERFACING RASPBERRY PI, A/D CONVERTOR AND OLED

- **A/D converter and OLED will be interfaced with Raspberry PI**
- **Python program will be developed to display breath acetone of a person on OLED display**

3. COLLECTION OF DATASET

- **500 Real-World data set will be collected from labs and hospitals**
- **5000 Simulated data set will be generated**

4. TRAINING AND TESTING OF ML MODEL

- **Artificial Neural Network will be used as ML model and will be trained using real world and simulated datasets**
- **Acetone as input data and Blood glucose as output data for training**
- **70% data for training and 30% data for validation**

5. DEPLOYMENT ON RASPBERRY PI

- **The developed ML model will be deployed on Raspberry PI. If breath of a new person is blown into chamber, Gas sensor measures acetone and give it as input to ML model. It predicts sugar value and display it on OLED display.**

6. ADDITIONAL FEATURES

- **Blood sugar data will be updated in ThingSpeak cloud using IoT and history can be viewed at any time from anywhere**
- **Email alerts will be sent to family members and doctors if the sugar value falls below or exceeds the threshold value**

Analysis of the feasibility of the idea:

1. **Technology Readiness**:
   - **AI:** Machine learning model will be trained to predict glucose levels based on non-invasive input (Breath Acetone). AI can improve accuracy by analyzing complex patterns in the collected data (Input : Breath Acetone, Output : Blood Sugar value)
   - **IoT:** The Internet of Things (IoT) will be used to connect blood sugar value to mobile application and cloud platform, allowing real-time monitoring, Data storage, trends in glucose levels and Email alerts.
2. **Non-Invasive Sensors**: Advancements in sensor technologies like MQ-138 sensor could enable glucose monitoring without the need for blood samples. Continuous monitoring system, enhanced by AI, can analyse trends in glucose levels, providing a more comfortable experience than traditional finger-pricking.
3. **Market Demand**:
   - With the rise in diabetes cases globally, there will be significant demand for a convenient, painless, and accurate method of glucose monitoring.
   - AI and IoT could add value by enabling predictive analytics, sending early warnings, and integrating with broader health ecosystems.
4. **Reusability** : All family members can use this instrument by using new straw
5. **Comfort** : Non-invasive and painless. No risk of hospital prone infections. No recurring cost for test supplies except for straws

Potential challenges and risks:

- Instrument has to be trained on huge volume of real world data collected from diverse population and different parts of the country
- Obtaining clinical approval Central Drugs Standard Control Organization(CDSCO) under Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India is very challenging
- Accuracy and sensitive to environmental conditions (e.g., temperature, humidity), which could affect sensor reliability

Strategies for overcoming these challenges:

- By conducting "**Free Sugar Camp**" it is possible to collect huge volume of real world data from diverse population and different parts of the country and can be used for training
- MQ-138 sensor is readily available in the market. We can get more accurate Acetone measuring sensor from sensor manufacturer with proper specifications
- Obtaining clinical approval is lengthy and rigorous process. But it is possible to obtain the approval from regulatory body.

Potential impact on the target audience:

- 1. **Improved Quality of Life**: For diabetic people, the device could help for frequent blood glucose testing without taking out blood and it is painless, It provides real-time monitoring, which can help users manage their condition more effectively and prevent complications.
- **2**. **Real-Time Monitoring and Alerts**: IoT integration allows for continuous monitoring and historical monitoring . It sends data directly to users' smartphones or Doctors / relatives. This could offer instant feedback and alert users about dangerous glucose levels.
- 3. **Broader Access to Monitoring**: By offering a more convenient solution, the device could appeal not only to diabetics but also to individuals with prediabetes or those at risk of developing diabetes, encouraging regular glucose monitoring for prevention.
- 4. **Cost-Effective Healthcare**: Over time, the device could reduce the need for traditional blood glucose test strips and hospital visits for glucose management, which might lower healthcare costs.
- 5 **Greater Connectivity and Data Sharing**: IoT enables seamless integration with electronic health records, allowing healthcare providers to monitor patients remotely and adjust treatments as needed.

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Social Benefits of the solution:

- By providing a more convenient and non-invasive way to monitor blood glucose levels, this device encourages regular health check-ups and early detection of glucose irregularities. This can help individuals manage diabetes better, preventing serious complications and reducing the overall burden on the healthcare system.
- This device can empower people in remote, rural, or underserved areas to take charge of their health with greater ease and affordability.

Economic Benefits of the solution:

- With non-invasive glucose monitoring, users can **avoid the recurring expenses** associated with traditional methods like test strips, lancets, and regular clinic visits. Over time, this can lead to significant savings for both individuals and healthcare systems, as fewer complications from poorly managed diabetes would result in reduced hospitalizations and emergency care needs.

Environmental Benefits of the solution:

- **Reduction in Medical Waste:** Traditional glucose monitoring methods generate significant waste from disposable items like test strips, lancets, and alcohol swabs. A non-invasive device reduces or eliminates the need for these disposable materials, helping to minimize the environmental footprint of diabetes management by decreasing plastic and biohazardous waste.

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