# Background

Diagnosing and delivering treatment to remote locations where doctors, and other medical professional, are not easily available has been an ongoing challenge for the healthcare industry. With the growing number of wearables devices, many healthcare organizations are seeking to overcome these challenges by using IoT-enabled medical devices to help deliver healthcare services.

Iot-enable medical devices often run on a high-speed processor with a rich operating system interface. These medical devices can also interface with cloud-based systems to upload and store patient data in cloud. Finally, as these devices often are “wearables”, they can be used for continuous diagnosis, such as for measuring “glucose” or “blood pressure” measuring for diabetic patients.

# Business Benefits

By using medical devices enabled with IoT, many healthcare facilities have identified use cases for:

1. Conducting certain medical tests remotely to speed up process for determining if treatment options are working
2. Remotely diagnosing specific medical conditions and diseases in patients,
3. Delivering treatments to patients in certain situations, e.g. “Smart Inhaler”
4. Addressing lack of availability of healthcare professions in remote areas.
5. Decreasing the cost and effort required to provide high quality treatment

# How IoT Medical Devices Work

IoT medical devices work by connecting to different hardware for examination purposes. The “edge” devices often have a touchscreen interface for “users” to input data for analysis and processing. They may also allow the users to capture video or snapshots to assist the medical professionals with verify diagnosis or determine how treatment is progressing.

These devices can store data of each patient on the cloud and use them for different analysis and diagnosis purposes on a repetitive basis, decreasing the overall treatment turnaround.

The diagram below shows the workflow for how some of these IoT-enabled (edge) medical devices operate

A screenshot of a cell phone

Description automatically generated

**Content source:** [Edge Medical Device Workflow](https://dzone.com/articles/understanding-the-working-of-embedded-iot-medical)

As a user inputs data related to the diseases, the system looks for symptoms pre-loaded into the file and tries to match with the provided input. If the match is found with the pre-loaded symptoms, the system responses with the disease name and generates a prescription for general medicine.

Prescriptions and other important details are stored on the cloud-based database management solution, which can be used for future analysis.

## **Embedded Medical Device with IoT**

Being able to monitor patients practically 24/7 is something of a holy grail for the medical industry, especially for patients with long-term conditions that require early detection of complications.

The embedded medical device receives inputs from the user to match the symptoms with a pre-loaded symptom file and tries to find the matching disease for same. It performs tests suggested based on the pre-loaded symptom file to get the exact match for the disease if the disease is not found by examining the symptoms. If the disease information is not found, the system involves the doctor with the given information, who will consult the user, diagnose the disease, and accordingly update the symptom file and disease file in the system.

## Prescription for General Medicines

Based on the input provided by the user, once the disease is found by the embedded medical device, it will look for generic medicine information in the pre-loaded prescription file, mapping the disease and medication.

## Cloud Database Management System

In this stage, the embedded device will store all the user details in the cloud database. This cloud-based solution can store the following information for future analysis:

* User’s personal information
* Information about symptoms
* Information about tests performed and their results
* Information about disease(s) diagnosed
* Information about prescription and medication
* Information about doctor's consultation, if any
* Device information from where all data is getting logged
* Device health information on cloud just to make sure that device is working fine, including all the sensor status and other basic information.

# More Information

For additional details, checkout the following links

1. Talati, Darshan, “Understanding the workflow of IoT medical device, published August 13, 2018, <https://dzone.com/articles/understanding-the-working-of-embedded-iot-medical>
2. <https://dzone.com/articles/podcast-nick-alesandro-on-blockchain-edge-and-clou?fromrel=true>
3. Gaskell, Adi, “The Self-Powered Sensor That Could Enable Remote Medical Monitoring”, <https://dzone.com/articles/the-self-powered-sensor-that-could-enable-remote-m?fromrel=true>
4. [Embedded machine learning in asthma inhalers changes lives](<https://community.arm.com/developer/ip-products/system/b/embedded-blog/posts/embedded-machine-learning-in-arm-based-asthma-inhalers?_ga=2.66796590.1255640725.1580488134-768902895.1580488134&_gac=1.219649387.1580488134.Cj0KCQiAvc_xBRCYARIsAC5QT9mBivwQJxOVT8E9Fbe3ef9B6-92FLm9XeiQTYNk0WGfzy5Rozbq1z4aAlaSEALw_wcB>)

# Solution Architecture

# Enriching Scenario with AI

The user will provide the input via a touchscreen panel for the symptoms into the [embedded medical device](https://www.einfochips.com/blog/a-5-step-guide-to-risk-management-for-medical-devices/).

The wearable will collect any information that it

1. As a user inputs data related to the diseases, the system looks for symptoms pre-loaded into the file and tries to match with the provided input.
2. If the match is found with the pre-loaded symptoms, the system responses with the disease name and generates a prescription for general medicine.
3. In case of a partial or no match, the system undergoes a different test based on the input given by the user and pre-loaded file, matching to identify exact disease and provide a prescription accordingly.
   1. If proper disease information cannot be found by the given input and other tests performed, the system contacts the doctor with the given information.
   2. The doctor will then diagnose the patient and update the symptom and disease files for future use.
4. Prescriptions and other important details are stored on the cloud-based database management solution, which can be used for future analysis.
5. This patient information stored in the cloud can be also used for different analysis.

The Personal Information that the user must provide often include

* name,
* contact number,
* age,
* Insurance Information
* Preferred Pharmacy
* List of medicines the patient is currently taking

IoT-enabled medical devices often possess a number of sensors that can be used to conduct tests on patients to aide in diagnosing the medical conditions.

Here is a list of some common medical device sensor:

* Blood Pressure Sensor
* Temperature Sensor
* Glucometer
* *Airflow Sensor*
* *ECG Sensor:*
* EMG Sensor