



IoT Applications in a Dental Practice



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Mission Statement & Goals

“Our dental clinic has a mission of improving patient care satisfaction, efficiency of staff operations, and an increase in the overall net income with the use of IoT technology.”

Key measurable goals that have been established include:

- the reduction in patient wait times/consulting
- higher ratings seen through patient reviews
- positive cash flow statements.

Motivation



- Research gate
 - some of the chief complaints from dental patients include:
 - long wait times
 - quality of services
 - use of old technology/methods
 - and delays in diagnosis.
- Our practice will be utilizing various aspects of IoT technology to help address these complaints and have an overall smoother flow of operations.

Application of IoT Technology

❖ Sensors and Actuators

- Often work in tandem
- Sensors will be used for monitoring conditions
- Our sensors will signal to actuators when changes occur
- Actuators will perform actions based on what signals it receives

❖ Sensors/Actuators our clinic will be utilizing:

- Temperature sensor
- Touch sensor
- Pressure sensor
- Electric actuator
- Linear actuator

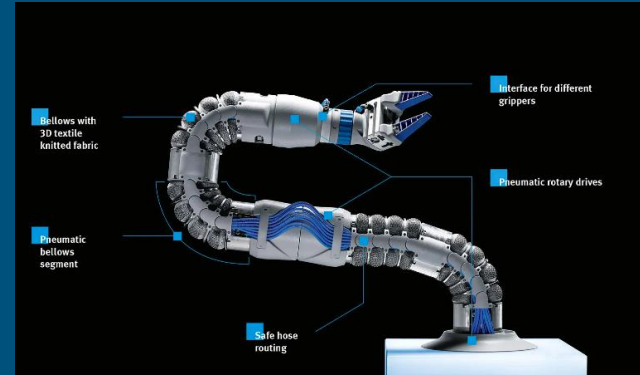


Sensors

- Temperature sensor
 - Healthcare operating in a “post-covid” world
- Pressure Sensor
 - Pressure sensors will provide an automation that will determine the oxygen intake
- Touch Sensor
 - Upon entering the waiting room, patient will insert the key card into the provided slot.
 - Notification sent to the tablets carried by the dental clinic staff.
 - Will provide the staff with the patient’s information and electronic health records.

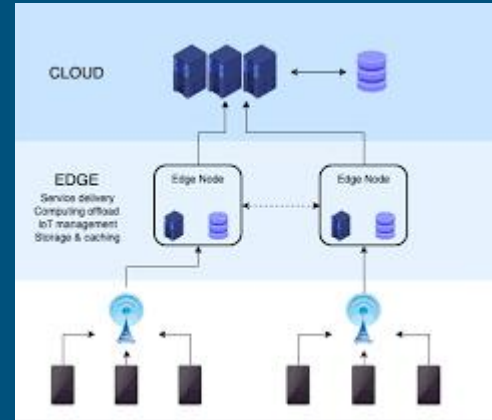
Actuators

- Electric
 - Found in our x-ray equipment
 - Aids the machine in detecting cavities and other problem areas in a small amount of time
- Linear
 - Found in the patient chairs
 - Help the doctor adjust the patient to different positions with the help of a touch sensor by his/her feet
 - For convenience so he or she can operate the chair hands-free



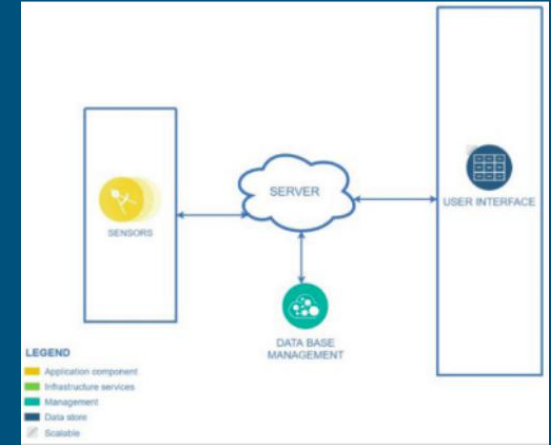
OT/IT Network

- ❖ Data collected from sensors inside dental clinic from equipment analyzed and stored within the Edge and Cloud.
- ❖ Success convergence leads to:
 - Cost savings
 - Higher satisfaction ratings
 - Increase in operation standards and flexibility



Architecture

- ❖ A basic IoT system constitutes:
 - the sensors
 - cloud server
 - database
 - user interface
- ❖ Example: Intraoral sensor
- ❖ Edge vs. Cloud
- ❖ IoT devices that will be used in our dental practice are typically used to monitor and transfer patient data to the cloud and edge for further analysis.



Cloud

- ❖ Functions for the clinic include:
 - Keep track of patient records
 - Protection and security of data
 - Employee tasks
 - Flow of operations
- ❖ Software-as-a-Service (SaaS)
 - Cloud-based dental software
 - Able to access information across multiple devices in various locations
 - Cost savings
 - Reliable and fast data management
 - Improved security



Data Security

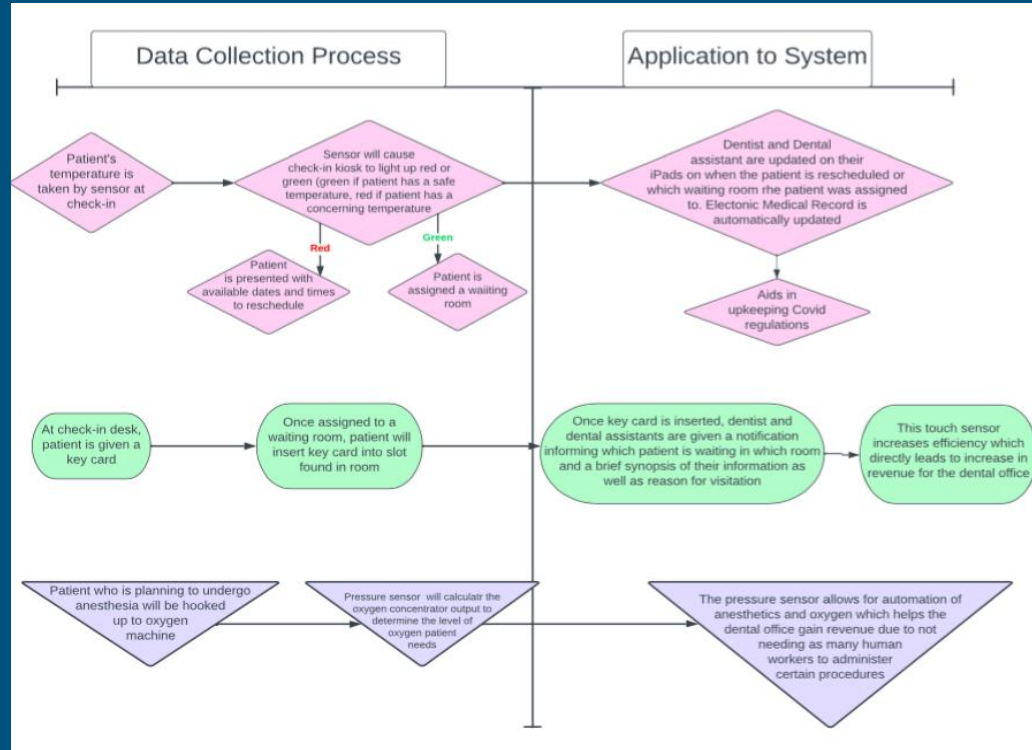
- ❖ Maintaining HIPAA (Health Insurance Portability and Accountability Act) regulations is our clinic's priority
- ❖ Cloud was created with safeguards to protect patient personal information
- ❖ Safeguards include:
 - Encryption of data
 - 2-factor authentication
 - Built-in AWS cloud security



Data and Analysis

Temperature Sensor Mock Data				
Patient Name	Temperature Registered by Sensor (degrees Fahrenheit)	Do they meet Covid-safe regulations?	Light indicator	
Keerthi Raja	98.9	Yes	Green	
Andrew Varghese	101.4	No	Red	
Blake Burris	97.2	Yes	Green	
Devon Jackson	98.6	Yes	Green	
Touch Sensor Mock Data				
Patient Name	Age	Gender	Reason for Visitation	
Keerthi Raja	24	F	Cavity filling	
Andrew Varghese	53	M	Teeth Cleaning	
Blake Burris	19	M	Root Canal	
Devon Jackson	31	F	Experiencing discomfort, potentially due to wisdom teeth	
Pressure Sensor Mock Data				
Patient Name	Oxygen Concetration Output (liters per minute)			
Keerthi Raja	0.75			
Andrew Varghese	2.5			
Blake Burris	2.1			
Devon Jackson	1.3			
Electric Actuator Mock Data				
Patient Name	Cavity or problem area detected by Sensor?	Tooth with Concern		
Keerthi Raja	Yes	Second premolar		
Andrew Varghese	Yes	Canine		
Blake Burris	No	N/A		
Devon Jackson	Yes	Lateral Incisor		

Data Integration



Business Value from IoT Data

- ❖ Transformation of business design and evolution of equipment in the clinic
- ❖ Derive more data for patients in a fraction of the time
- ❖ Less human error occurrences
- ❖ Create more time in daily schedules to see more patients
- ❖ Overall increase in cash flow
- ❖ Automation allows clinic to operate with less human staff members
- ❖ Increased security of clinical records
- ❖ Allow for patients to be more involved in their healthcare journey

Discussion

- Our goals with the use of IoT:
 - Make going to the dentist as effortless and stress-free for our patients through automation
 - Increase revenue for the clinic
 - Protect and increase security of patient records
 - Potentially expand business scope
 - High satisfaction records
- Potential roadblocks:
 - Growing pains with the integration of IoT and altering business design
 - Training staff and patients on how clinic will change in operations
 - Some patients and staff members can be resistant to change
 - Patients may feel a lack of personal connection



References

Balaji Ganesh S, & Sugumar, K. (2020). Internet of things—A novel innovation in Dentistry. *Journal of Advanced Oral Research*, 12(1), 42–48. <https://doi.org/10.1177/2320206820980248>

Engdahl, S. (2008). *Blogs*. Amazon. Retrieved November 30, 2022, from <https://aws.amazon.com/blogs/architecture/building-event-driven-architectures-with-iot-sensor-data/>

Internet of dental things (iodt), intraoral wireless sensors, and teledentistry: A novel model for prevention of dental caries. Home. (2021, June 7). Retrieved November 30, 2022, from <https://www.researchsquare.com/article/rs-487495/v1>

It - OT divide & solutions. bridging the IT healthcare technologies. Kontakt.io. (2022, April 6). Retrieved November 30, 2022, from <https://kontakt.io/blog/bridging-the-it-ot-divide-in-healthcare/>

Javaid, M., & Khan, I. H. (2021). Internet of things (IOT) enabled healthcare helps to take the challenges of covid-19 pandemic. *Journal of Oral Biology and Craniofacial Research*, 11(2), 209–214. <https://doi.org/10.1016/j.jobcr.2021.01.015>

Liu, L., Xu, J., Huan, Y., Zou, Z., Yeh, S.-C., & Zheng, L.-R. (2020). A smart dental health-IOT platform based on intelligent hardware, Deep Learning, and Mobile Terminal. *IEEE Journal of Biomedical and Health Informatics*, 24(3), 898–906. <https://doi.org/10.1109/jbhi.2019.2919916>

Nock, K. (n.d.). *Linking in: The internet of things in the dental practice*. Dental Products Report. Retrieved November 30, 2022, from <https://www.dentalproductsreport.com/view/linking-in-the-internet-of-things-in-the-dental-practice>

Salagare, S., & Prasad, R. (2021). Internet of dental things (iodt), intraoral wireless sensors, and teledentistry: A novel model for prevention of dental caries. <https://doi.org/10.21203/rs.3.rs-487495/v1>