Wireless ECG Monitoring System with Integrated Wifi Technology

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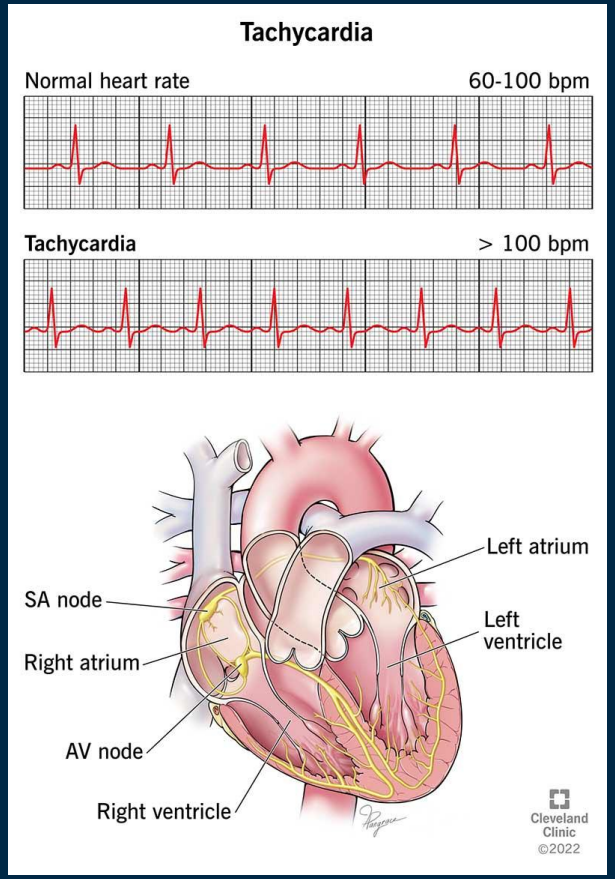
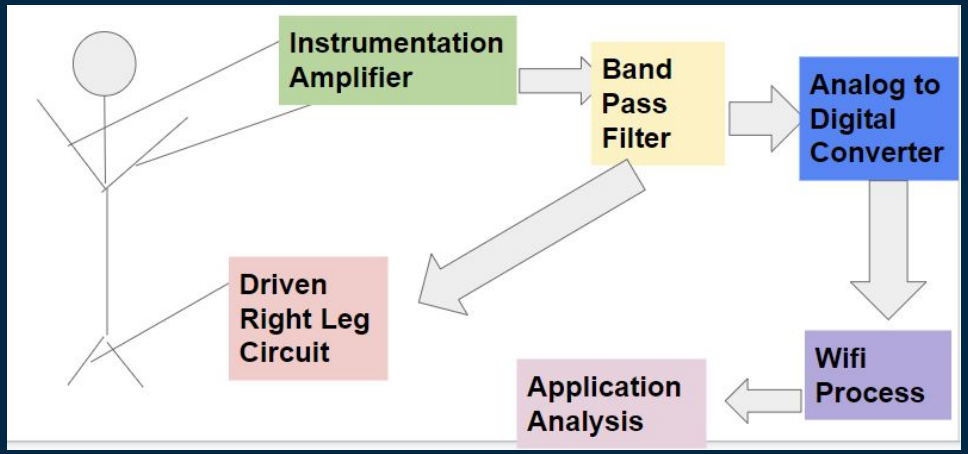
ECG: Modern Implementations

- Heart rate can identify distress in a patient
- High resting heart rate may indicate a greater risk of a heart attack
- Indicator of mental health
  - Prefrontal cortex



MAIN GOAL

Objective of the project



Circuit Inputs

Electrode 1

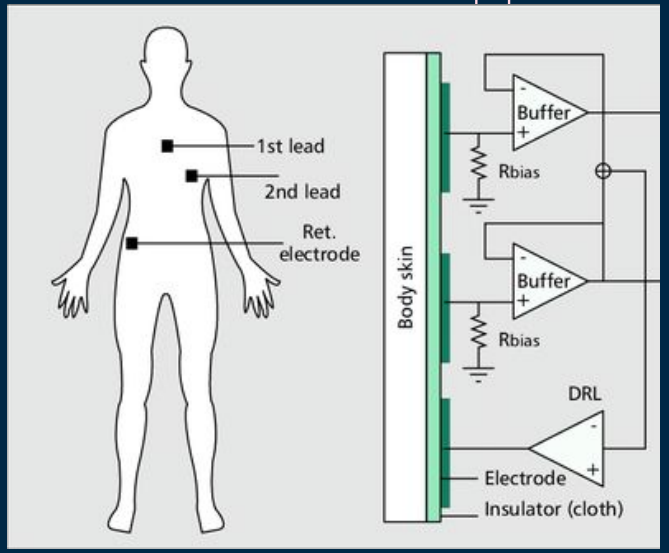
...

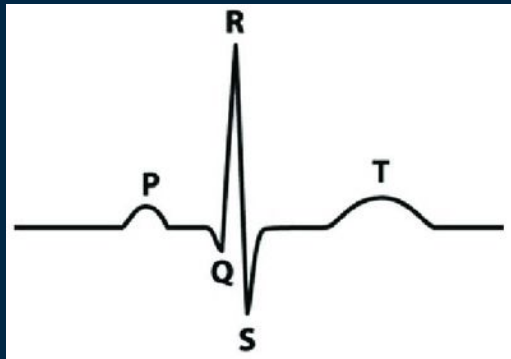
Electrode 2

...

Ref Electrode

...





P wave	Depolarization of the atria
Q wave	Activation of the anterioseptal region of the ventricular myocardium
R wave	Depolarization of the ventricular myocardium
S wave	Activation of the posteriobasal portion of the ventricles
T wave	Rapid ventricular repolarization

(b)

Circuit: Instrumentation Amplifier (IA)

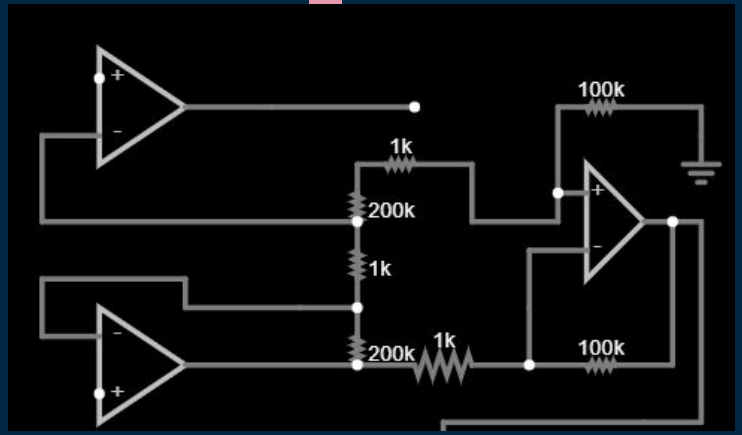
$$Ad = (1 + 2(\frac{200k}{1k})) * \frac{100k}{1k} = 40{,}100.$$

$$Adin = 1 + (2 * \frac{200k}{1k}); Adout = \frac{100k}{1k}$$

$$Ac = 0.04 * \frac{100k}{1k}$$

$$\text{CMRR} = \left|\frac{Ad}{Ac}\right| = \frac{401 * \frac{100k}{1k}}{0.04 * \frac{100k}{1k}} = 25 * 401 = 40{,}100$$

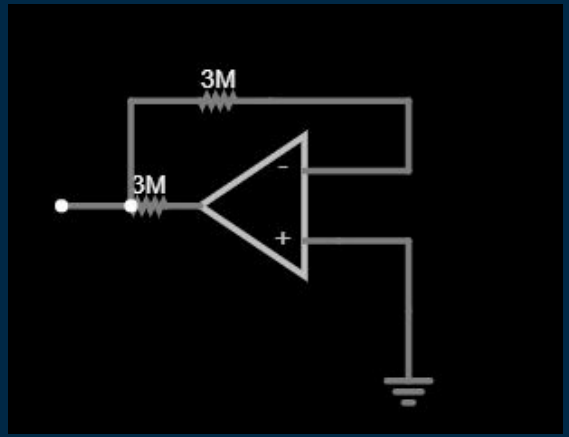
CMRR in dB = 20*log(40,100) = 92dB

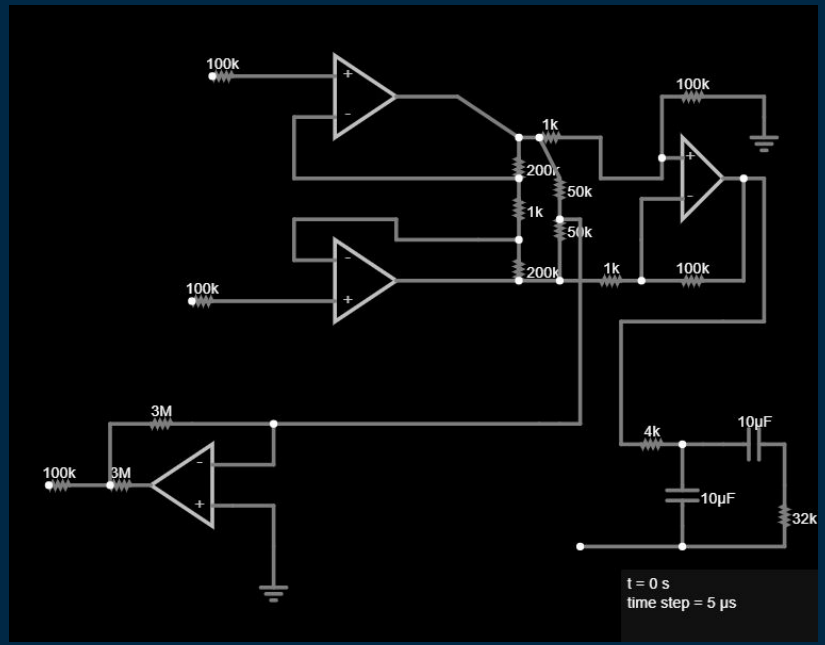


Circuit: Driven Right Leg (DRL)

$$\frac{9V}{3M\Omega} = 3\mu A$$

$$R_{RLeffective} = \frac{100k\Omega}{1+2*\frac{3M\Omega}{50k\Omega}} = 826.45\Omega$$

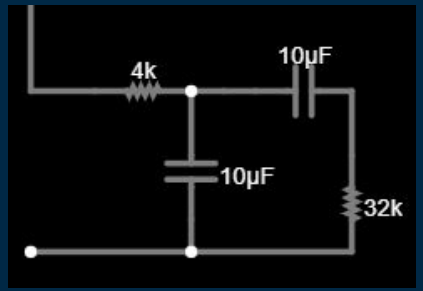


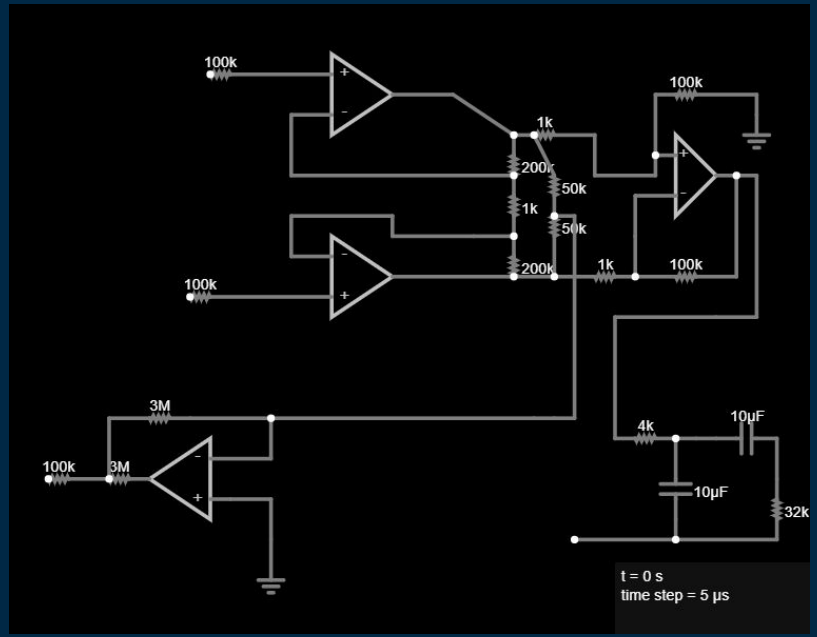


Circuit: Band Pass Filter

$$\text{Low Pass Frequency} = 4\text{Hz} = \frac{1}{2*\Pi*4k\Omega*10\mu F}$$

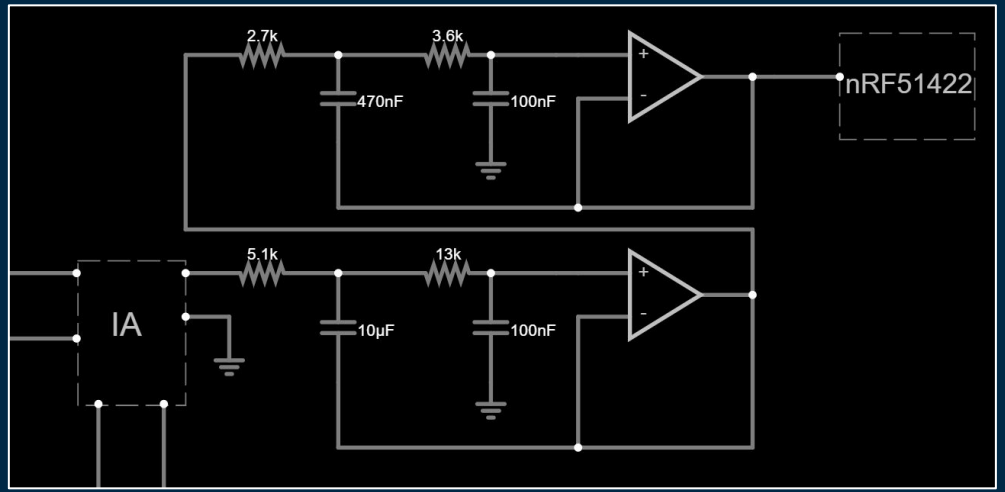
$$\text{High Pass Frequency} = 0.5\text{Hz} = \frac{1}{2*\Pi*32k\Omega*10\mu F}$$





Circuit: Sallen-Key Low Pass Filter

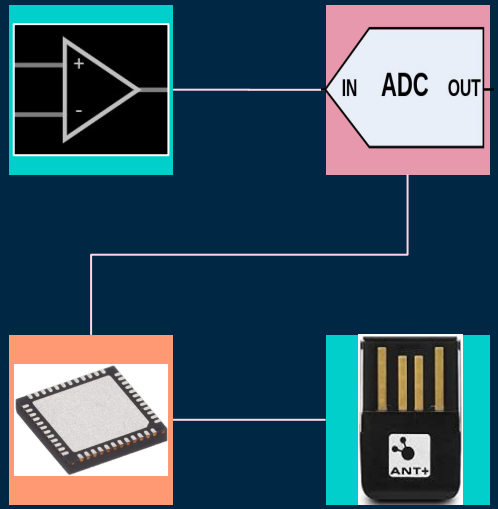
- 2 MCP6022 chips
  - Function on low voltage supply and current
  - High speed operating
  - Max output signal swing
- Fourth order 150 Hz low pass filter
  - Anti-aliasing
  - Voltage gain control
- Collective 56 dB gain
- Analog output of circuit converted to digital signal via 10-bit ADC
- Radio frequency module: nRF51422
  - Ultra-low power system-on-chip (SoC)



Circuit diagram including the output of the instrumentation amplifier to the nRF51422 module

RF Module to Wireless Transmission

MCP6022 Output
Acquired and filtered analog signal from the body



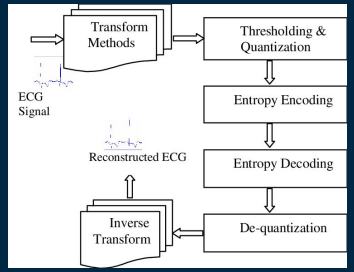
A/D Converter
Analog signal is converted to digital signal

2.4 GHz Transceiver
Signal is transmitted

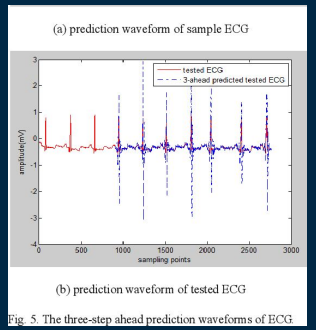
ANT USB
Signal is received

Digital Data Acquisition

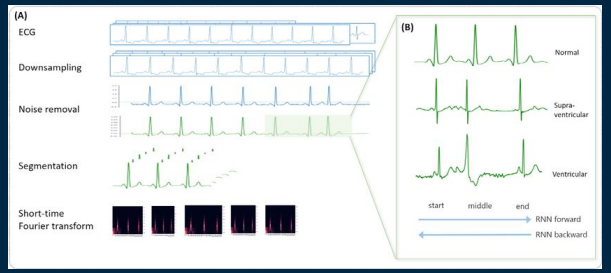
Transform Based Compression
Method 1



Predictive Coding
Method 2

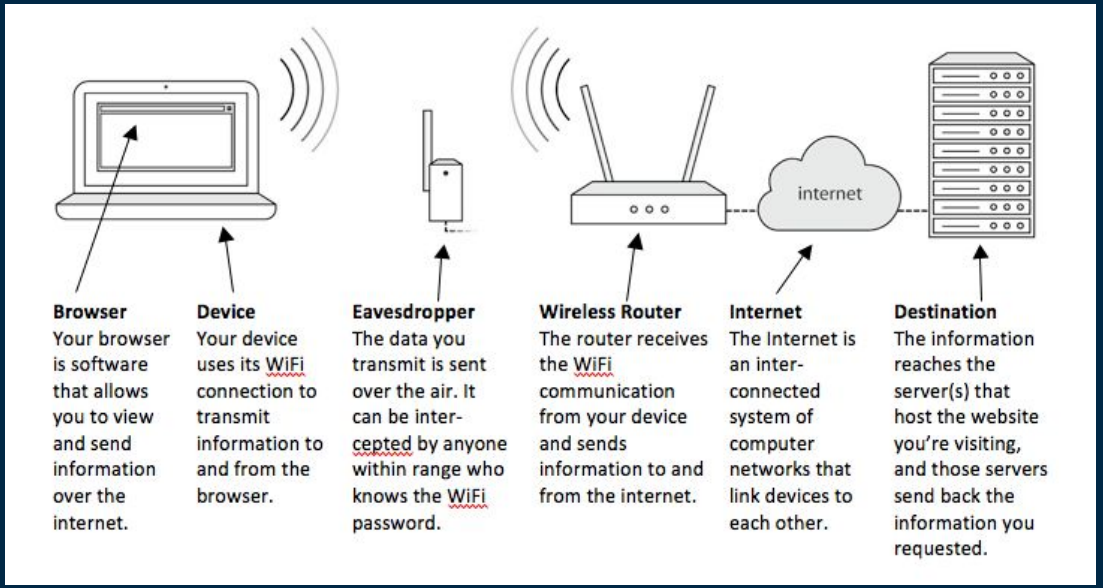


Subsampling
Method 3



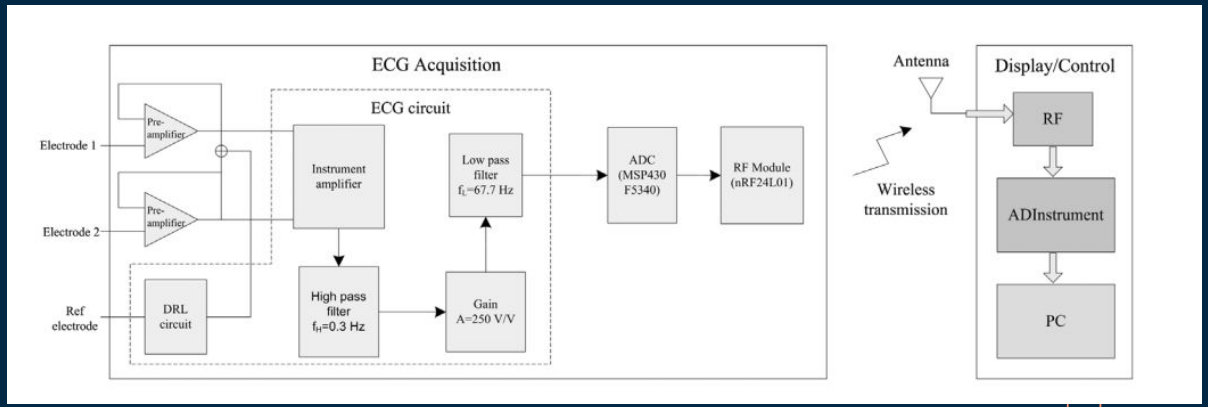
Digital Data Acquisition

Data to Wifi



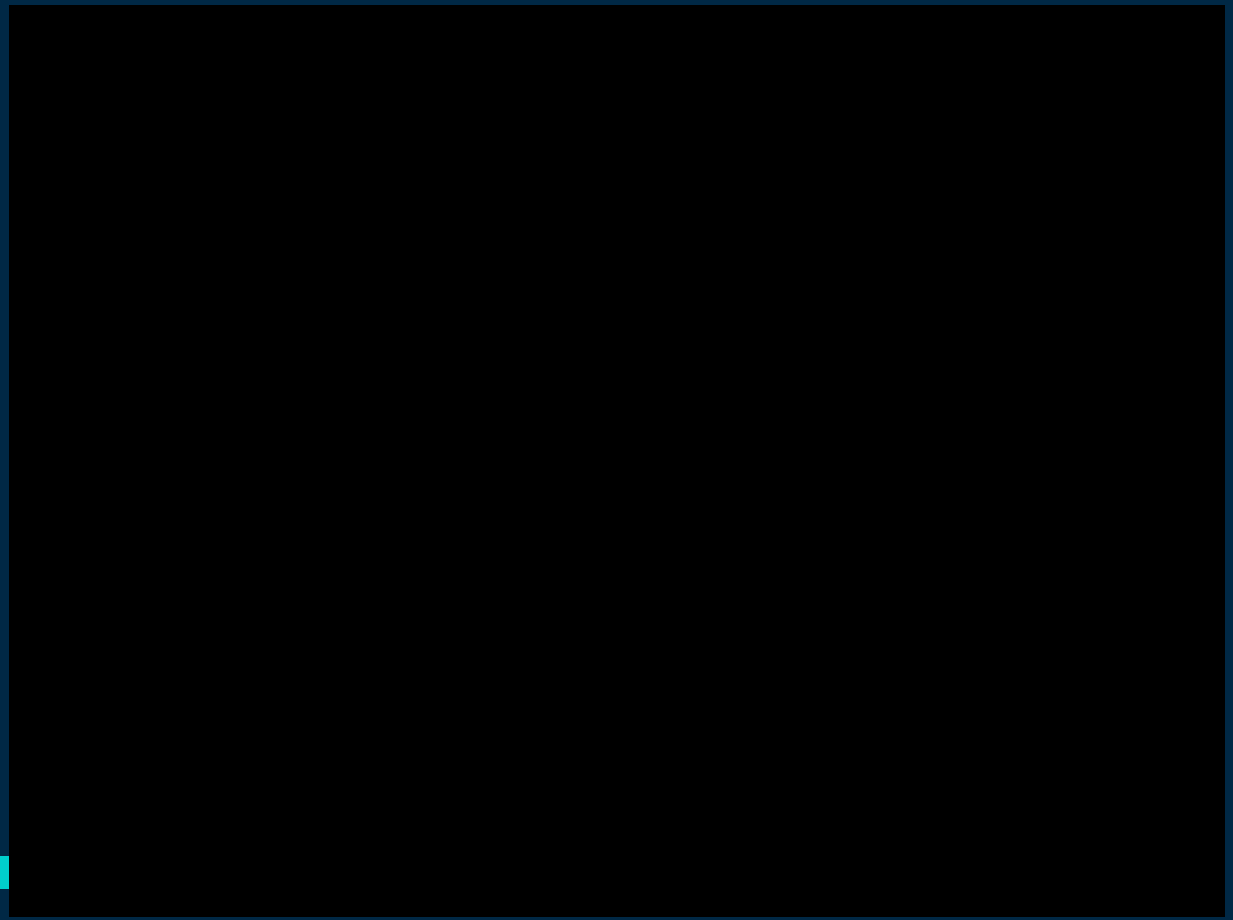
RESULTS

- Application is capable to record and transmit the ECG data of the patients to doctors.
- Before any data can be received, a Wi-Fi connection must be established between the smartphone and the RF module, which is the main wireless unit that includes a microcontroller.
- The main thread real-time displays the ECG waveform on the graph view of the application.



Schematic for wireless ECG measurement system. From Journal of Biomaterials Science, Polymer Edition

Circuit Simulation



CONCLUSION

Significance of project

- Wireless, portable, and low power consuming= easily accessible
- The wireless technology greatly improved the mobility, flexibility, and usability of the ECG monitoring system in telemedicine.
- To promote data sharing and compatibility between many platforms and systems, the stored and transmitted ECG data can be shared between patient and physician
- It has the capacity to acquire, transmit, record, and display the ECG signal in real time with accuracy and dependability.

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THANK YOU!