Cardiac Rhythm Generator and Temporary Pacemaker Training Simulator

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Clients: Dr. Hagen and Dr. Medow

Problem Statement and Client Description

- Medical students require a better method to learn how to use and adjust pacemakers
- Currently by physician demonstration or limited and expensive models
- Our training device would be a more affordable and extensive learning tool
- Dr. Hagen would implement it into his teaching

Design Constraints

Client Requirements:

- Ammeter to read current from pacemaker (0 to 25 mA)
- Bluetooth communication
- Voltage output must simulate heart rhythm (0 to 25 mV)
- Customizable EKG waveform

Design Requirements:

- Withstands repetitive use
- Display replicates hospital monitor
- Easily portable
- 10 m Bluetooth functionality

Competition:

Figure 1: Interactive EKG/Pacemaker Simulator [2]

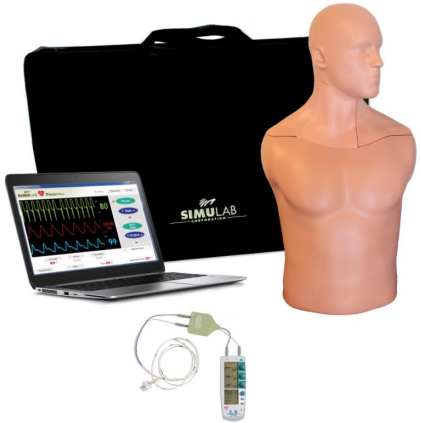

Figure 2: PacerMan System for Intravenous Cardiac Pacing [1]

Broader Impact

- Cheaper and more robust alternative
  - Simulator - $750
  - PacerMan - $16,750
  - Ours $400 - $500
- More mobile and adaptable
  - Used on any hospital monitor
  - Can create any arrhythmia
- Training of students in a low-risk environment
- Able to be implemented in hospitals globally
- Trainees more prepared, practiced, and capable to save lives
- Simulation is a more effective teacher of skills than traditional teaching methods [6]

Design

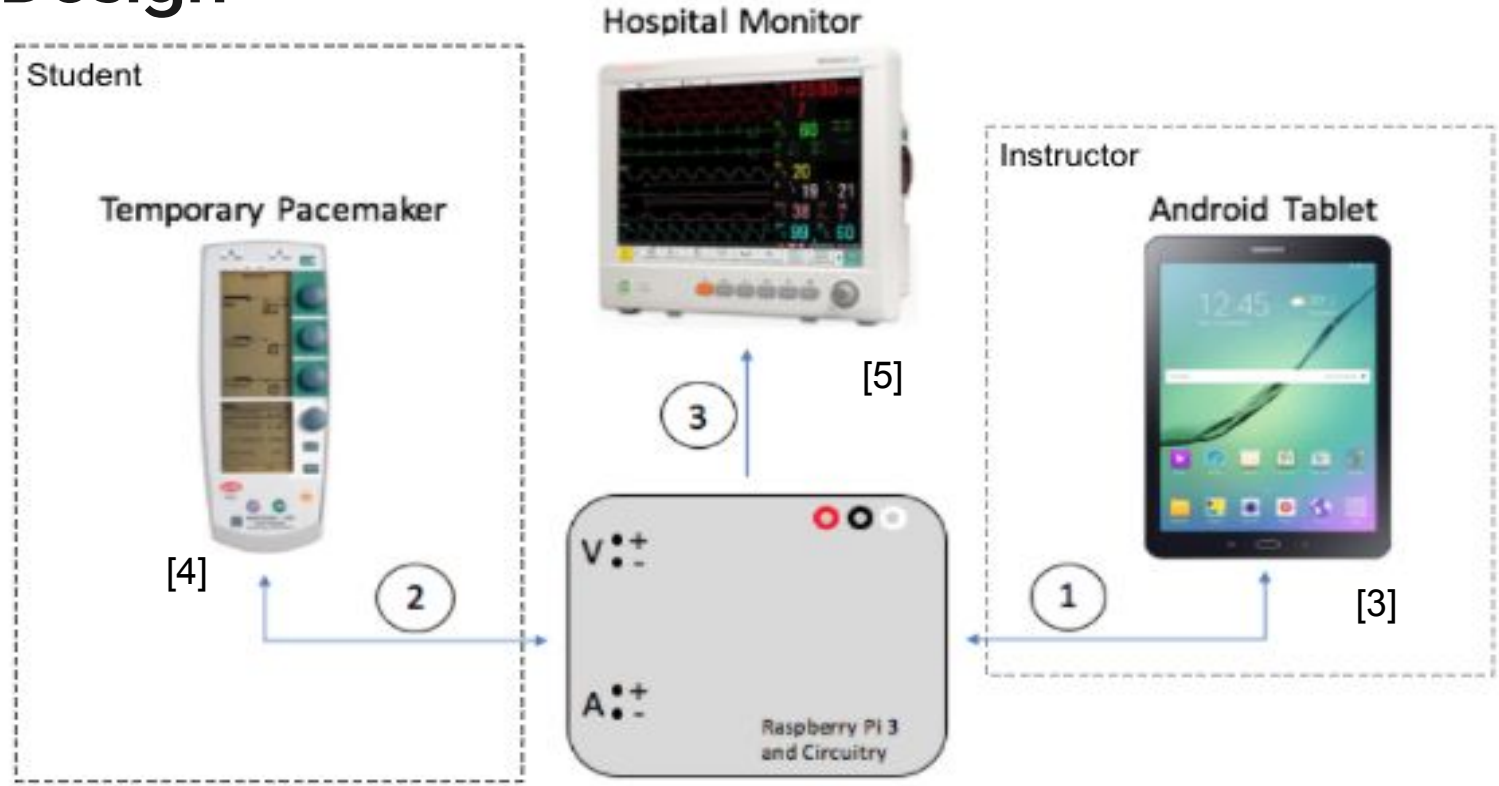

Figure 3: Hardware block diagram

What was completed last semester?

- Continuous waveform generation with default parameters and DAC
- Pi to hospital monitor communication
- Pacemaker spike quantification

Figure 4: Tablet UI for EKG

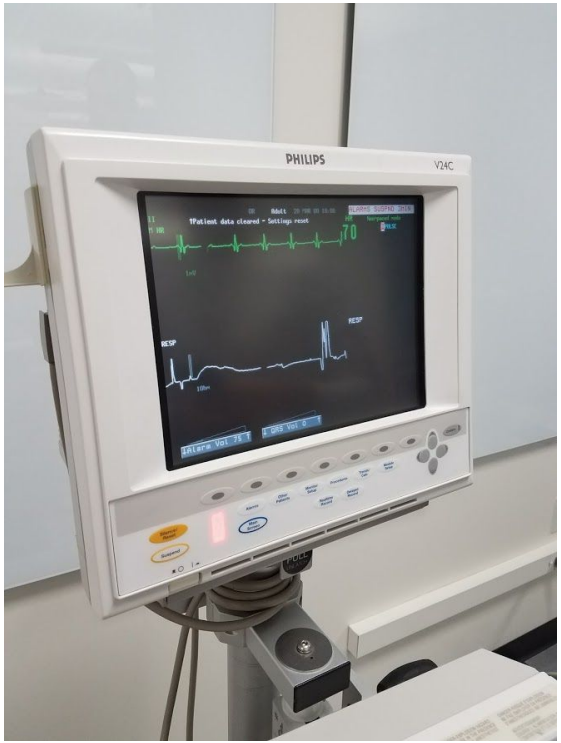

Figure 5: Simulated EKG output on hospital monitor

Fabrication Goals

Project Development	Feb		March				April	
Task	21	28	7	14	21	28	7	14
General Bluetooth Communication	X	X						
Bluetooth Communication of Pacemaker Data to Tablet		X	X	X				
Bluetooth Communication of EKG to Pi				X	X	X		
Finalize Circuitry	X	X	X					
Fit Pacemaker Leads and Solder Monitor Clips					X	X		
Fit Electronics Box						X	X	

Testing Goals

- Test accuracy and reliability using Gage R&R of quantified pacemaker data - 3/1
- Test Bluetooth communication - Is any data left out or not transmitted properly? -3/1
- Test Pi output and pacemaker response to pacemaker atrial and ventricular leads - 3/15
- Test for delay in communication between Pi, tablet and hospital monitor - 4/1

Budget

Current Expenses: $231.66 Total

- Wire kit: $6.27
  - Connect to Raspberry Pi
- Two MCP3008 10-Bit ADC: $15.42
  - Convert signals from analog to digital
- Three Raspberry Pi 3 Starter kits: $209.97
  - Main component of our device, computing element

Anticipated Expenses: ~$235.00

- Galaxy Tab A: $229.99
  - Utilize customizable waveform interface
- Electrical components: <$5.00
  - Diodes, Operational Amplifiers, Others
  - Finalize circuitry

Acknowledgments

Dr. Hagen, Dr. Medow, Dr. Puccinelli, Dr. Nimunkar, and Quan Chen

References

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[3]: Samsung Galaxy Tab A 8" 16GB Android 5.0 Lollipop Tablet - Titanium. (2015). Best Buy. Retrieved from https://www.bestbuy.ca/en-ca/product/samsung-samsung-galaxy-tab-a-8-16gb-android-5-0-lollipop-tablet-titanium-sm-t350nzaaxac/10369795.aspx

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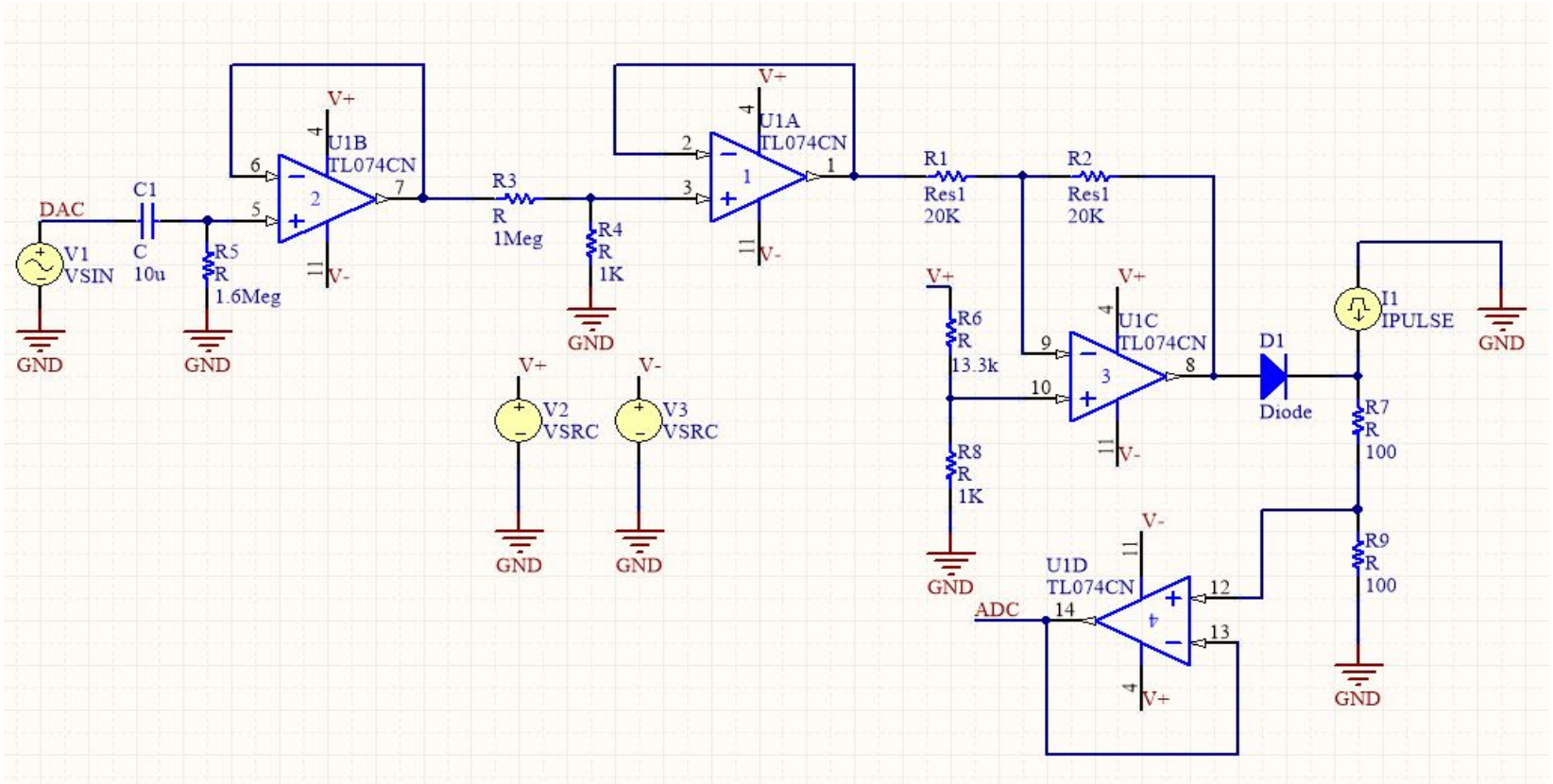
[5] Edan M80 Patient Monitor. Medical Equipment Inc. Retrieved from https://mfimedical.com/products/edan-m80-patient-monitor?utm_source=google&utm_medium=cse&utm_term=edan-m80-patient-monitor&gclid=Cj0KCQjwsNfOBRCWARIsAGITapaLUt9wt5_OKmet-cpA5rVsjqQXUg3nmtudOvc3HBjILh-ZMA-aDf4aAruoEALw_wcB

[6] M. D. Beal, J. Kinnear, C. R. Anderson, T. D. Martin, R. Wamboldt, and L. Hooper, “The Effectiveness of Medical Simulation in Teaching Medical Students Critical Care Medicine: A Systematic Review and Meta-Analysis,” *Simul. Healthc.*, vol. 12, no. 2, pp. 104–116, Apr. 2017.


DAC
V1
VSIN
C1
C
10u
R5
R
1.6Meg
GND
GND
V+
U1B
TL074CN
V-
R3
R
1Meg
R4
R
1K
GND
V+
U1A
TL074CN
V-
R1
Res1
20K
R2
Res1
20K
V+
R6
R
13.3k
R8
R
1K
GND
V+
U1C
TL074CN
V-
D1
Diode
I1
IPULSE
GND
R7
R
100
R9
R
100
V+
V2
VSRC
GND
V-
V3
VSRC
GND
V-
U1D
TL074CN
ADC
V+
GND