Wireless Biosensor Monitoring System

Danielle Morton*, Niloufar Pourian*, Prof. Luke Theogarajan*
* Electrical and Computer Engineering Department

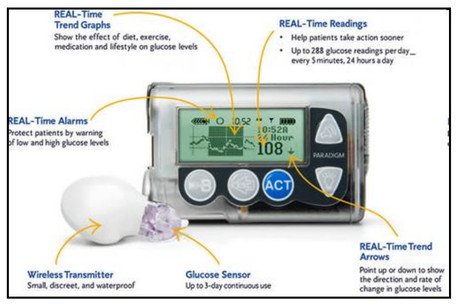
Abstract

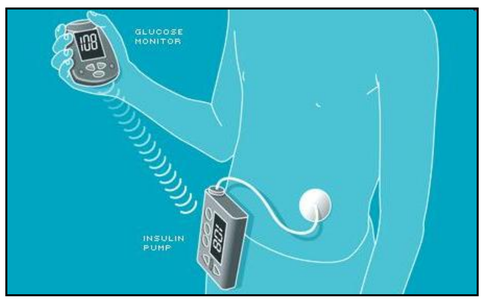
Currently, it is estimated that approximately 180 million people around the world are suffering from diabetes. When a patient's condition is severe enough, i.e. type II diabetics, insulin injections are required on a regular basis to maintain healthy glucose levels. Additionally, the patient must monitor blood sugar levels more often to assess the effectiveness of the prior insulin dose to help determine the next insulin dose. A system that can reliably monitor a patient's blood-sugar (glucose levels) in real-time is crucial to the development of a device that can dispense insulin on-demand. Furthermore, glucose levels change with activity level; therefore, an ideal system would distinguish the patient's current activity and compensate for changes accordingly. Determining activity level requires sensing heart rate, blood pressure, motion, skin resistance, and temperature. We envision that the device would reside in a small wrist band and transmit data wirelessly to an automatic insulin pump or to doctors to enable monitoring of the patient's condition. A successful implementation would allow diabetics to lead a more normal life.

Recent Studies for Continuous Monitoring Systems

Functionality of the glucose monitoring systems currently available

- Monitor and records glucose levels
- Alerts patient of low glucose levels
- Insulin Pump injects insulin a fixed number of times per day





Drawbacks:

- Unable to identify the need for insulin injection
- Not accurate
- High cost

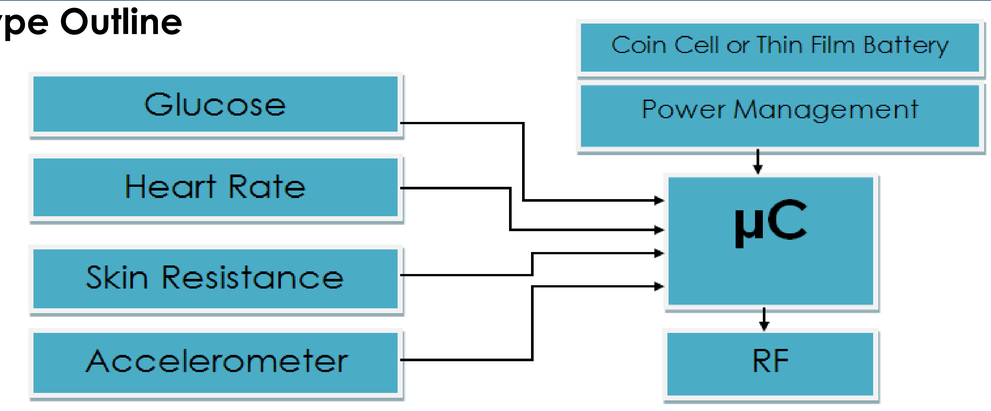
Our Goal

- Wirelessly transmit data to a computer for physician analysis
- Give insulin pump the ability to deliver insulin anytime level is low

HOW?

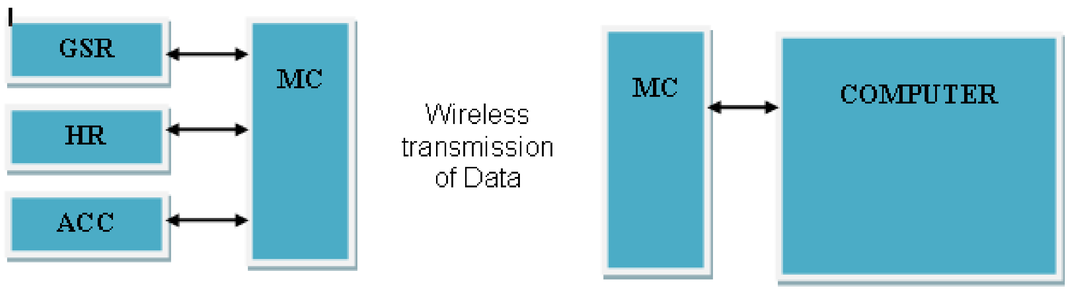
- Wireless transmission of data using Freeduino JeeNode with RF modules to transmit and receive data
- Allow insulin pump to deliver insulin more accurately (Artificial pancreas):
  - Sense skin resistance
  - Sense motion
  - Sense heart rate
  - Sense temperature
  - Sense blood pressure

Prototype Outline



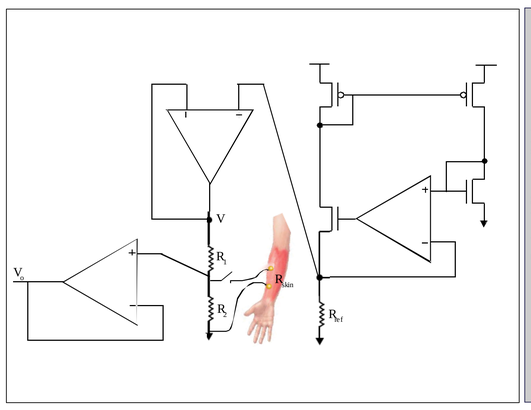
Wireless Transfer of Data

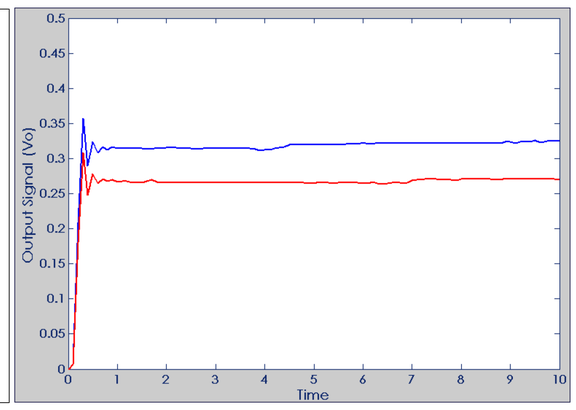
- Used to transmit data wirelessly from each sensor to the computer
- Operation in an unlicensed ISM (Industrial, Scientific, Medical) frequency band
- Relatively simple programming in WIRE language (Arduino language)
- Low power: below 100µW in sleep or active modes



Galvanic Skin Resistance

- Highly Robust-Invariant to device variation due to aging
- Low Power





Vo=V x (R2 | | Rs) / [(R2 | | Rs)+R1]

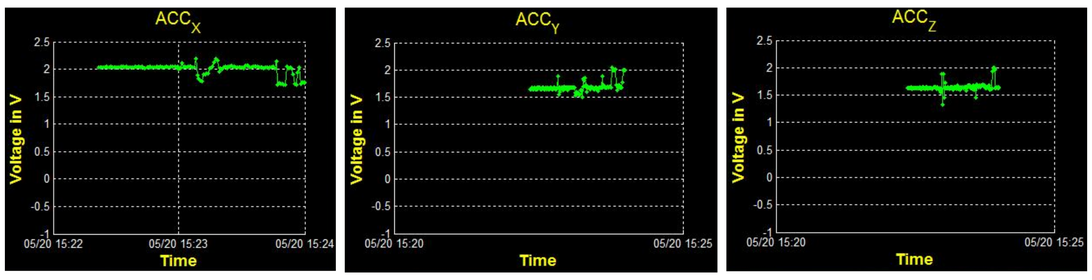
Normal Conditions: Rskin ≈ 0.763 MΩ

Some Exercise: Rskin ≈ 0.494 MΩ

Accelerometer

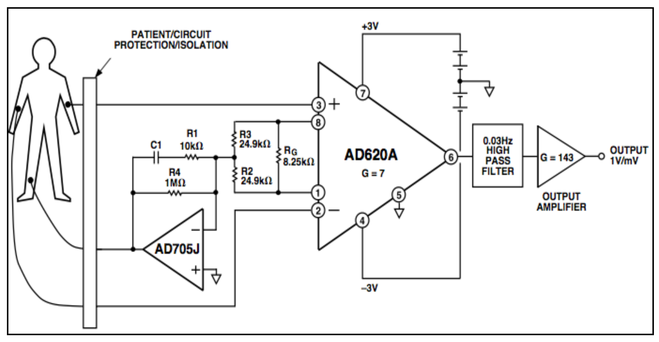
Accelerometer (ADXL325) Sensor:

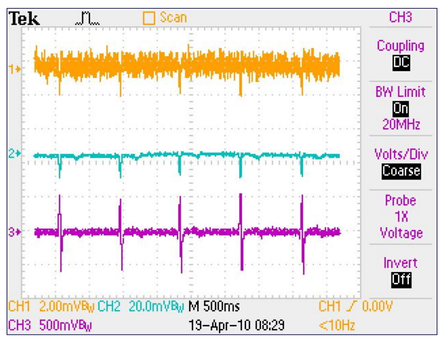
- 3-axis accelerometer
- Low Power Consumption—40µA in measurement mode at Vs=2.5V
- Small—3mm X 5mm X 1mm



Heart Rate Monitor

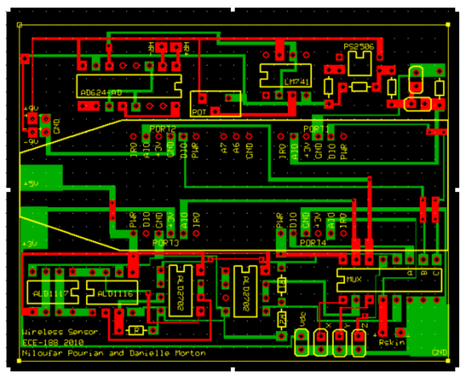
- EKG-accurate heart rate measurement
- Sensitive in the mV range
- Requires high pass filtering for low frequency noise
- Low power consumption 2.5mA with Vs=6V

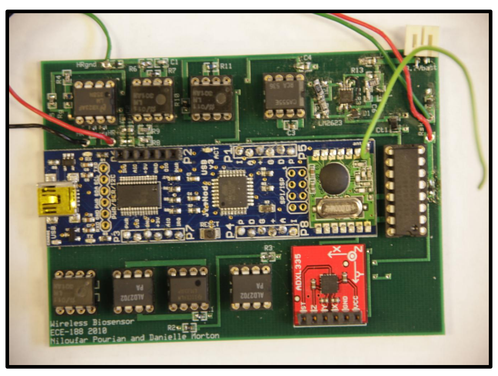




Board Layout

- Dimension: 3.8 x 2.5 inches
- Overall power consumption less than 30mA static current at 5V supply (~3 days of continuous operation between recharges)





Future Work

- Enable the wireless transmission of data to cell phone
- Enable sensors to trigger each other upon abnormal conditions

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