Wireless Interface for the "DANI" (Dynamic Automated Nutrition Innovations) Diet Aid Weight Scale

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Introduction

Obesity in the United States is on the rise – according to data from the Centers for Disease Control and Prevention, in 2009, all states but Colorado and the District of Columbia had obesity rates of 20% or more. To help curtail this trend, a team of Cornell students have been designing a revolutionary diet aid: a weight scale that reports the nutritional value of the weighed item and transmits it wirelessly to a smartphone or computer for viewing and logging. This project entails the development of a complete prototype of the "DANI" (Dynamic Automated Nutrition Innovations) weight scale.

Methods

The working prototype consists of three parts – the circuitry to capture weight data as electrical signals and amplify them, the microprocessor and wireless module software to process and transmit the collected data, and the computer software to receive, further process, and appropriately display the data.

1. Obtaining Weight Data

Weight data is obtained using a strain gauge mounted on a metal cantilever. Any weight on the metal cantilever causes it to bend and deflect a very tiny amount; this strain changes the resistance across the strain gauge, allowing a weight-dependent voltage signal to be extracted. This electrical signal is also tiny, requiring amplification using a low-noise high-accuracy instrumentation amplifier built using three op-amps and resistors.

2. Processing and Transmitting Weight Data

The amplified voltage is fed into an analog-to-digital converter (ADC) inside an ATmega microprocessor.

Methods, cont.

To improve the accuracy of the measurement and to prevent the measurement from fluctuating up and down from noise, 4096 samples of the weight data are collected and averaged (to fit all these sampled data, a 32-bit variable was constructed from available 8-bit variables, along with rudimentary 32-bit math functions). Once the weight data is digitized, it can be sent out using emulated serial (COM) port communication via a commercially available Bluetooth module.

3. Receiving and Further Processing Weight Data

A Bluetooth-enabled computer connects to the remote Bluetooth module via an emulated serial (COM) port. The computer requests weight data or recalibration (taring) by sending signals to the remote microprocessor and Bluetooth module, which obliges by sending the appropriate data signals back. The locally downloaded USDA SR23 national nutrient database is paired with the weight data to generate the detailed nutritional value of the food item weighed.

Schematics

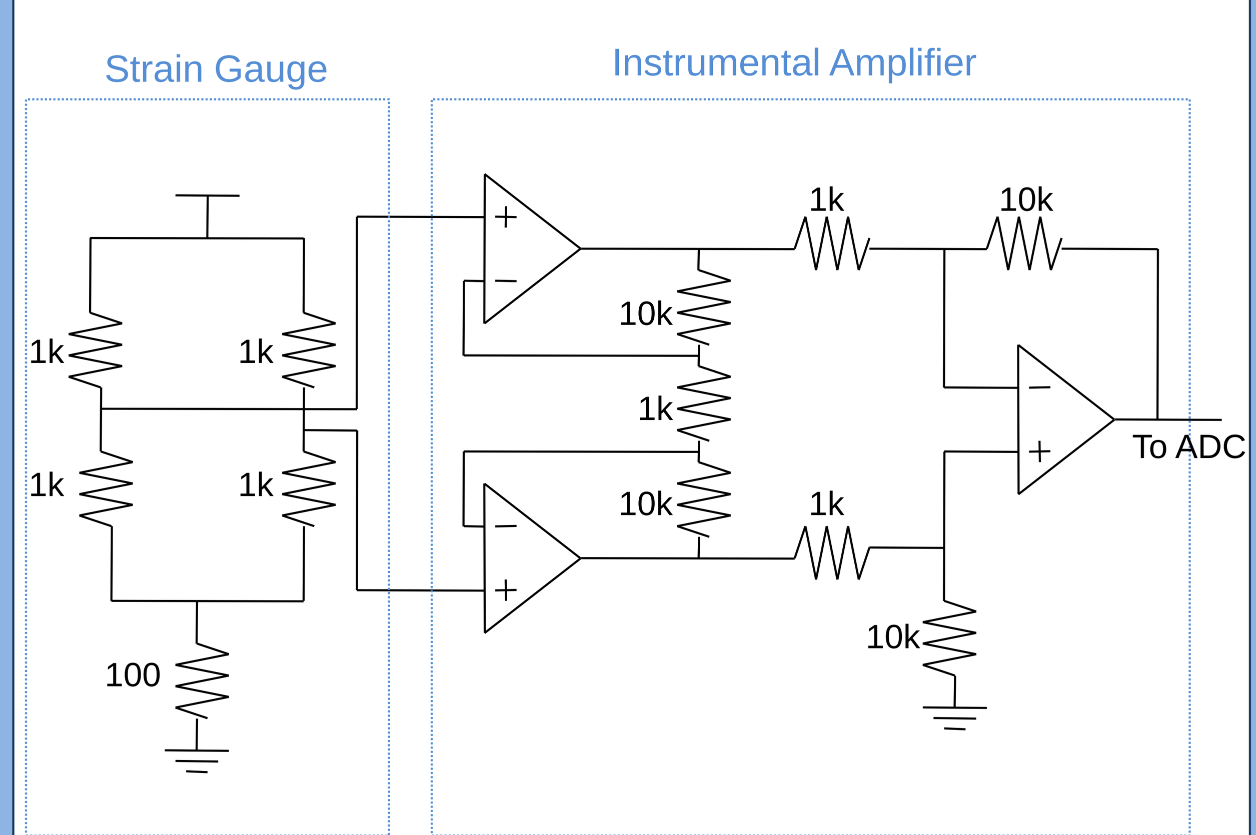

Figure 1: Schematics for stage 1, obtaining weight data.

Schematics, cont.

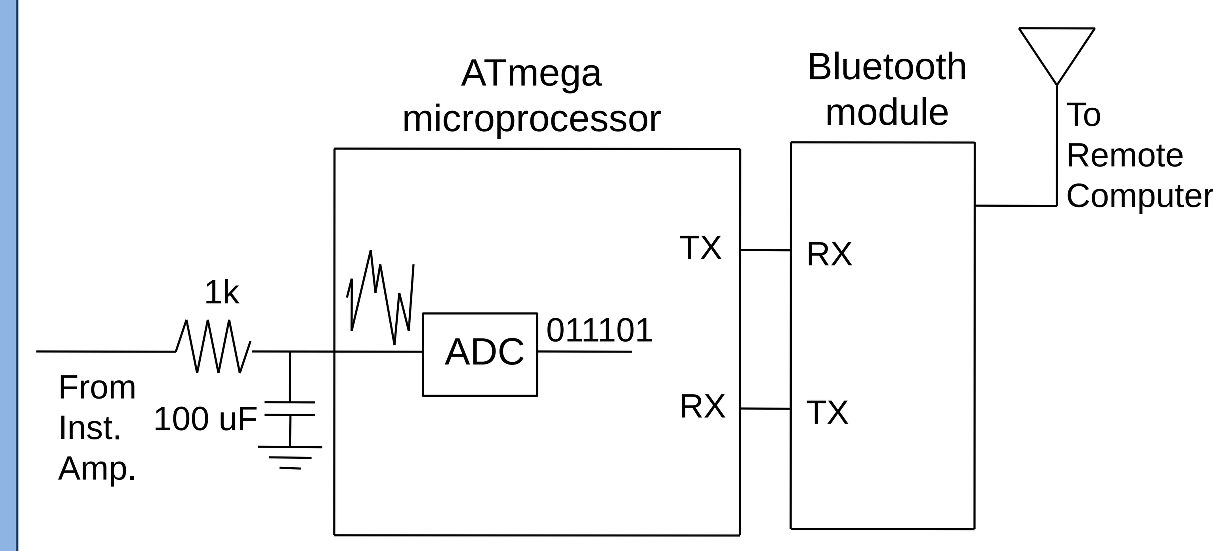

Figure 2: Schematics for stage 2, processing and transmitting weight data.

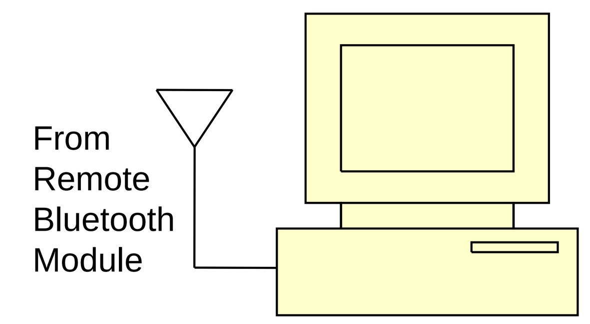

Figure 3: "Schematics" for stage 3, receiving and further processing weight data.

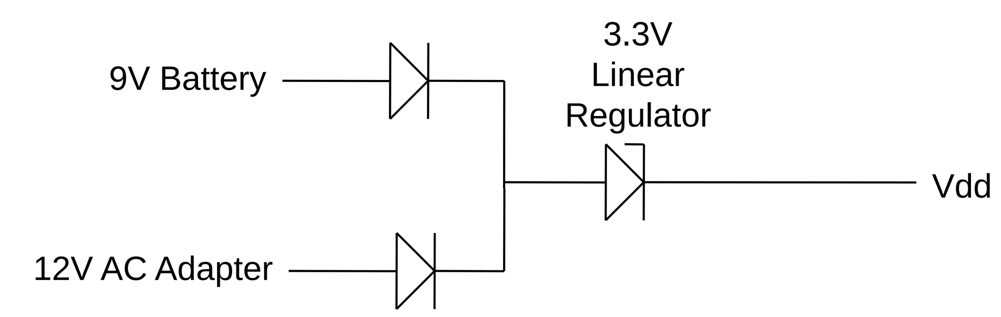

Figure 4: Schematics for battery-backed up power supply.

Results

The result of this project was a fully functional prototype of a wireless weight scale, complete with a user interface program running on a Windows computer. Resolution was approximately ±1 grams, with a current consumption of ~50 mA during active transmission and ~10 mA during idle, in this case mostly consumed through the power indicator LED. Transmission was on the order of hundreds of milliseconds. Using compatible cheaper parts, the unit cost was calculated at $24.63 plus ~$20 for the cost of PCB manufacturing, strain gauge, and enclosure. A PCB layout for the design was also completed in both PCB123 and ExpressPCB.

Appendix

Table 1: Part Costs

Part	Cost
RN-42 Bluetooth module	17.65
ATmega 48 microcontroller	2.30
3.6864 MHz clock oscillator	1.60
3.3V linear regulator	0.42
9V battery snap	0.38
28-DIP socket	0.31
Power slide switch	0.29
Quad op-amps	0.22
2-pin male headers	0.09 * 3
Green LED	0.09
Diodes	0.02 * 3
100 Ohm resistors	0.05 * 4
1 kOhm resistors	0.05 * 4
10 kOhm resistors	0.05 * 4
100 kOhm resistor	0.05
0.1 uF ceramic capacitor	0.07 * 5
100 uF electrolytic capacitor	0.04
PCB Manufacturing	Varies
Strain Gauge	Varies

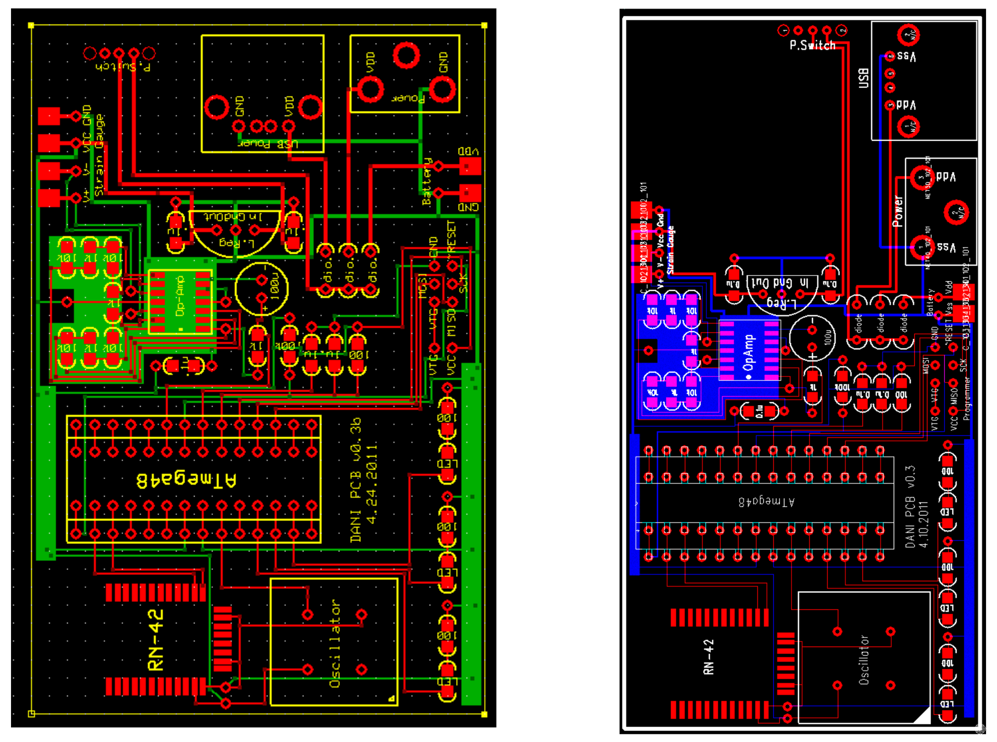

Figure 5: PCB layouts

Acknowledgments/Contact

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Further comments/questions can be sent to jk459@cornell.edu