Wireless Weight Distribution Scale

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Presentation Outline

- Purpose
- Individual Roles
- System Overview
- High Level System Design
- Business Approach
- Timeline and Budget
- Individual Achievements
- Conclusions and Future Work
- Sources of Information and Acknowledgements

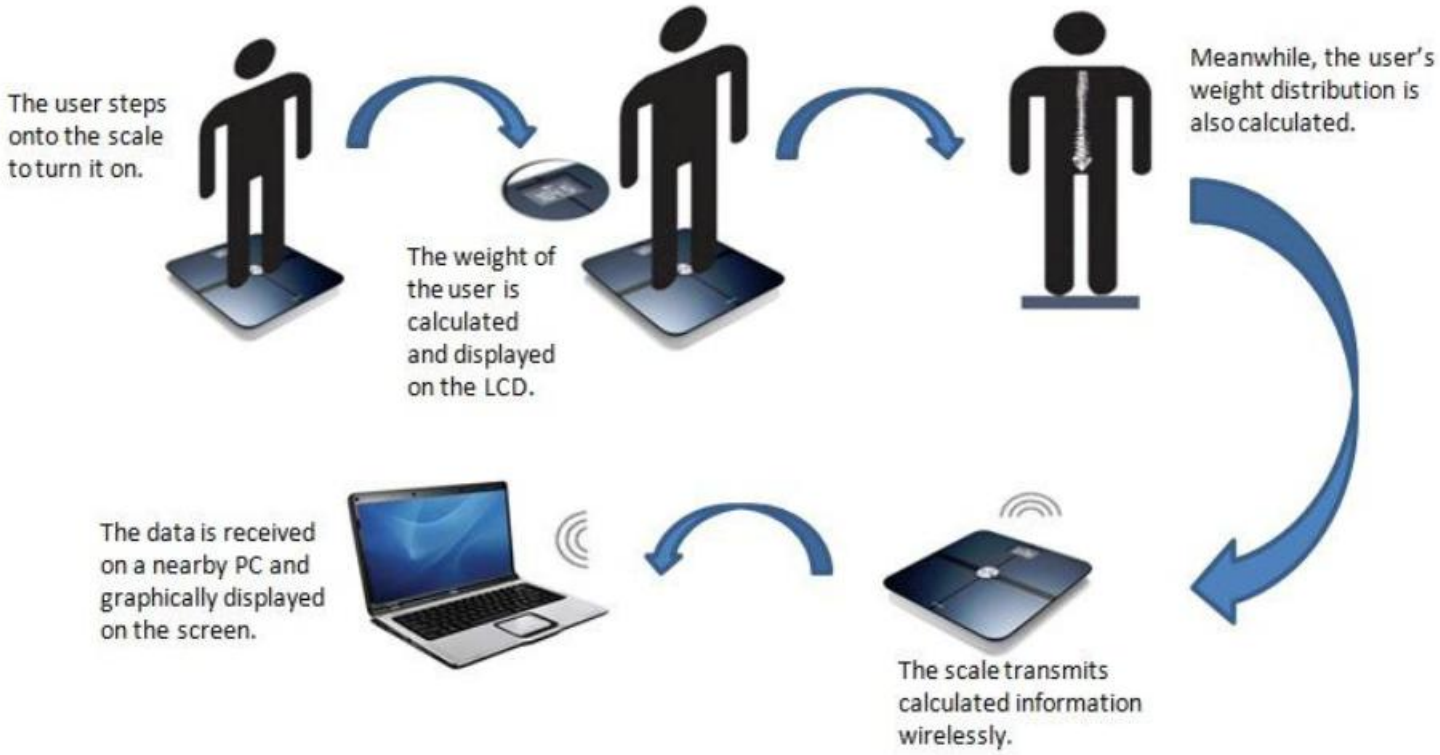
Purpose and Benefits

- The Wireless Weight Distribution Scale is designed to log the progress of an individual's weight while monitoring weight distribution in a standing position.
- Beneficial in monitoring
  - Stroke patient recovery
  - Scoliosis
  - Short leg syndrome
  - Muscular atrophy
  - General posture
  - Overall weight

Roles in Project

- Sam Leung – Chief Executive Officer
  - Project manager
  - PC application development
- Wil Gomez – Chief Technical Officer
  - Microcontroller application development and testing
  - LCD implementation
- Sasan Naderi – Chief Financial Officer
  - Allocated funds
  - Component research and hardware design
- Gurpal Sandhu – Chief Operations Officer
  - Wireless communications
  - Hardware design and testing

System Overview



High Level System Design

Differential Pressure Sensors

- Determines pressure applied across liquid or gas
- Measure weight by taking the difference between two pressures applied to unit
- Accurate but temperature dependent and difficult to integrate

Linear Variable Differential Transformer Sensors (LVDT)

- Electrical transformers used to measure linear displacement
- Displacement determined by movement of armature – magnetic coil in-between primary and secondary transformer
- High precision and accuracy but only suitable for lower mass measurements

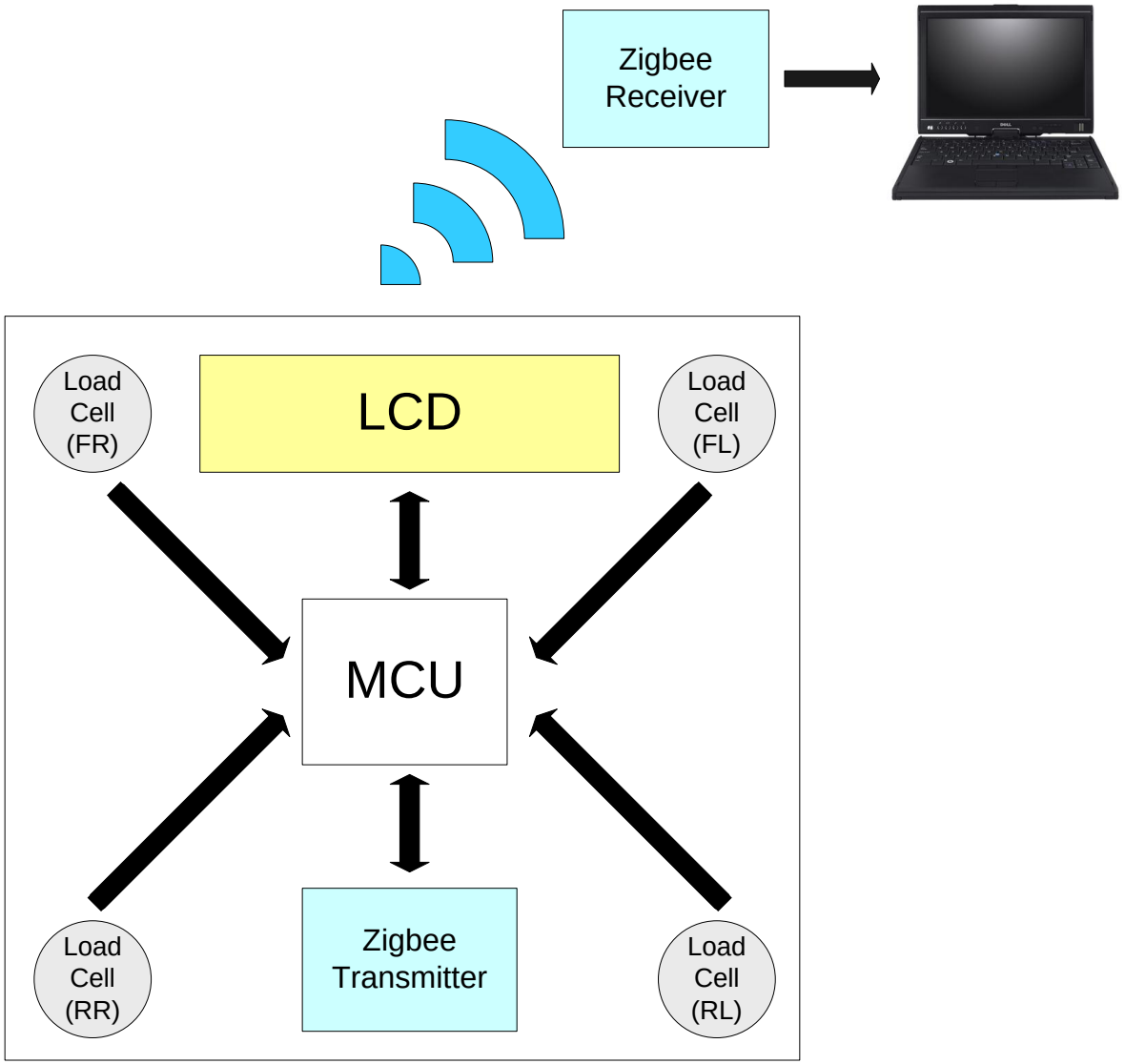
Load Cell Sensors

Measures changes in electrical resistance when external force is applied.

A load cell consists of a wheatstone bridge and a strain gauge sensor.

Our implementation requires four load cells – located in each corner of the scale.

Sufficiently accurate and reasonably priced.



Business Approach

- Competition
  - Nothing exactly
  - Withings Internet connected body scale
  - Nintendo Wii Balance Board
  - Professional force platforms
    - Measures ground reaction forces generated by a body standing or moving on it
- Marketing
  - Health-conscious individuals
  - Constant access to technology
  - Professional use
    - Physiotherapists
    - Kinesiology research
  - Personal use

Business Approach (cont'd)

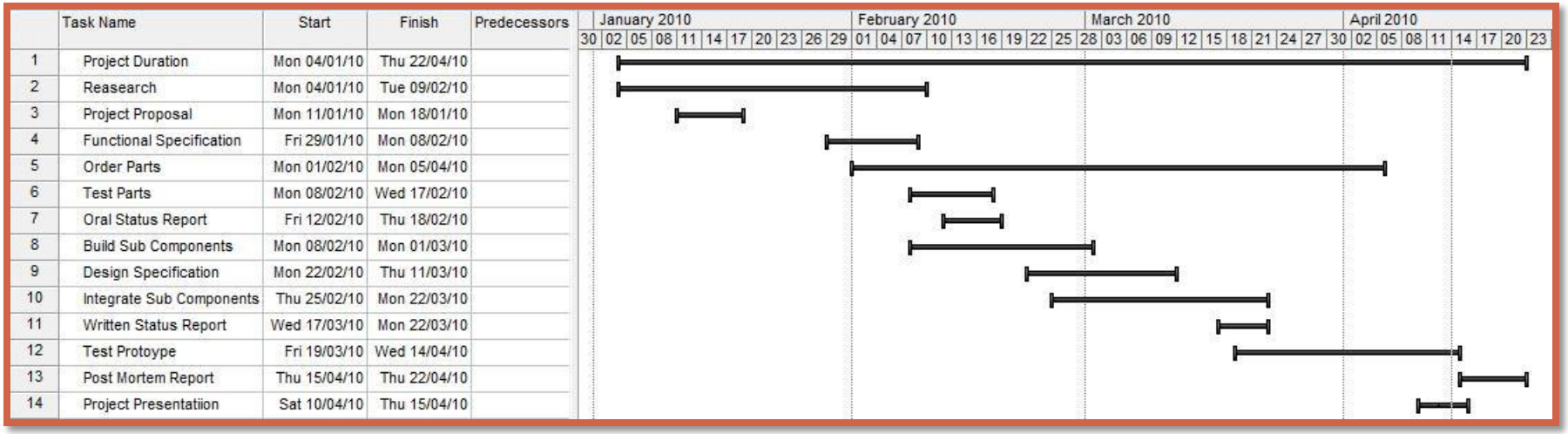
- Cost
  - Prototype cost: $549.55

100 Units	1,000 Units	10,000 Units
$101.76	$82.24	$72.11

Component	Quantity
RF radio transceiver	2
Load cell	4
Relay	2
Microcontroller	1
USB Microcontroller	1
Graphic Serial LCD	1
Variable Voltage Regulator	1
Operational Amplifier	4
5V Voltage Regulator	1

- Financing
  - Funding from venture capitalist company
  - Private investors
  - Relevant companies interested in our product

Project Timeline



	Task Name	Start	Finish	Predecessors
1	Project Duration	Mon 04/01/10	Thu 22/04/10	
2	Reasearch	Mon 04/01/10	Tue 09/02/10	
3	Project Proposal	Mon 11/01/10	Mon 18/01/10	
4	Functional Specification	Fri 29/01/10	Mon 08/02/10	
5	Order Parts	Mon 01/02/10	Mon 05/04/10	
6	Test Parts	Mon 08/02/10	Wed 17/02/10	
7	Oral Status Report	Fri 12/02/10	Thu 18/02/10	
8	Build Sub Components	Mon 08/02/10	Mon 01/03/10	
9	Design Specification	Mon 22/02/10	Thu 11/03/10	
10	Integrate Sub Components	Thu 25/02/10	Mon 22/03/10	
11	Written Status Report	Wed 17/03/10	Mon 22/03/10	
12	Test Protoype	Fri 19/03/10	Wed 14/04/10	
13	Post Mortem Report	Thu 15/04/10	Thu 22/04/10	
14	Project Presentatiion	Sat 10/04/10	Thu 15/04/10	

- Revised Gantt chart
- Project schedule maintained

Project Budget

Item Name	Description	Quantity	Total Cost ($CAD)
Anyload ES300 Digital Scale	Digital Scale consisting of 4 load cells and aluminum housing	1	115.50
Arduino Duemilanove	Development board with Atmel ATmega328P	2	67.92
Toshiba LCD	LCD with serial backpack	1	76.62
Xbee Wireless Module	Zigbee 802.15.4 with wire antenna	2	46.21
Arduino Xbee Shield	Expansion board for Xbee module on Arduino development board	1	27.33
Maxstream Board	Zigbee development board (used)	1	40.00
Atmel RZUSBSTICK	USB powered Zigbee transceiver	1	47.50
Shipping	All shipping charges on ordered components	5	55.21
Miscellaneous	Small items	n/a	56.55
		Total:	549.55
		Total amount awarded through ESSEF:	425.00
		Unfunded project cost:	124.55

Individual Achievements

- Sam Leung
  - Project management
  - Development in C#
- Wil Gomez
  - Embedded software development
  - Testing and troubleshooting
- Sasan Naderi
  - Reliability hardware design
  - Research and development
- Gurpal Sandhu
  - Wireless communications
  - Testing and troubleshooting

Conclusions and Future Work

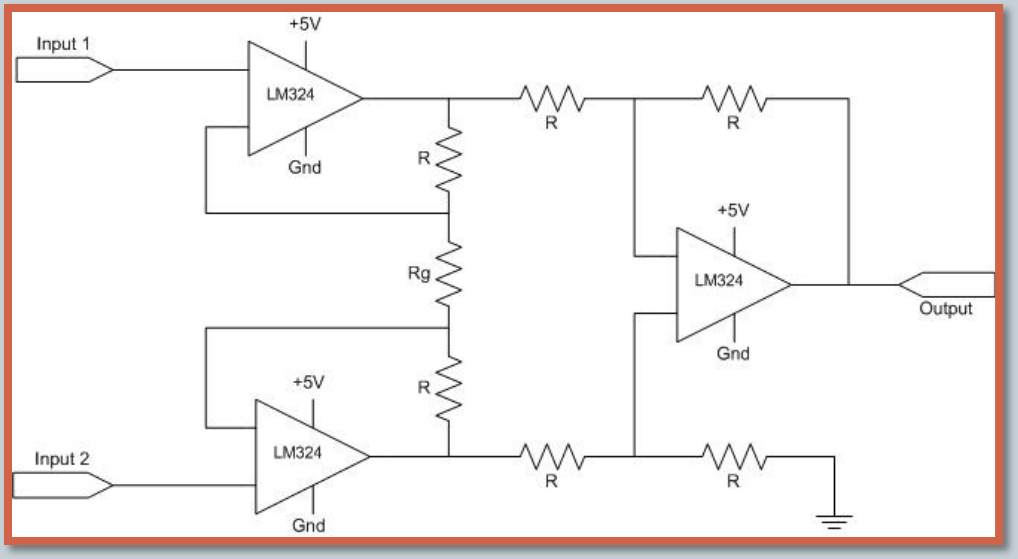
- Encase everything into the scale chassis
- Use a more compact receiver on the PC side
- Create a website so the data can be accessed remotely
- Refine power consumption
- Show more data on the LCD
  - Weight distribution percentage
- Percent body fat measurement
- Real-time data measurement and transmission

Information Sources/Acknowledgements

- Edwin Leung – Anyload
  - Customer Service Manager
- Mehrdad Rastan – SFU Physics
  - Teaching Assistant, Network Administrator
- Dr. Ash Parameswaran – SFU Engineering
  - Professor
- Tony Leyland – SFU Kinesiology
  - Senior Lecturer
- ESSEF for project funding

Questions?

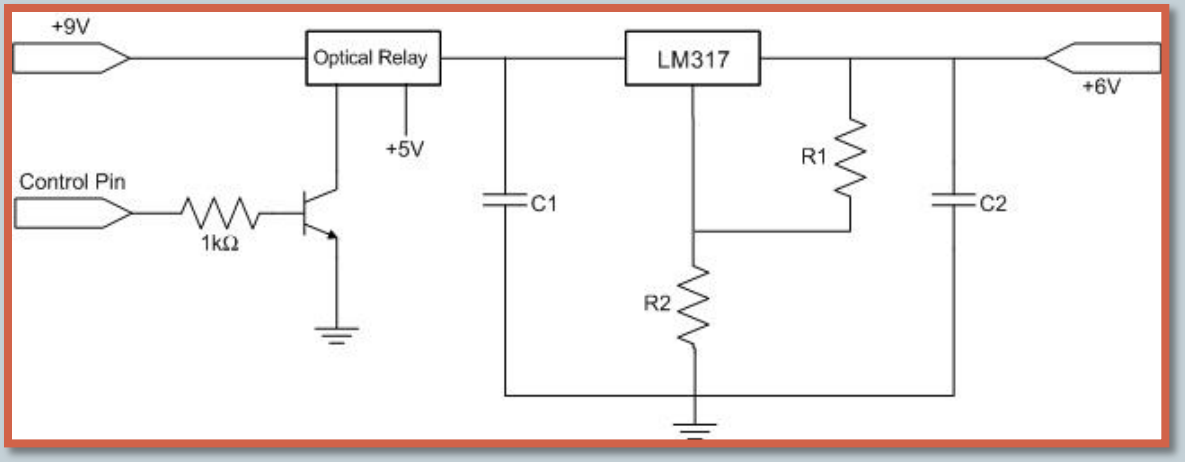
Hardware Implementation



- Instrumentation Amplifier
  - Buffered differential amplifier
  - Attached to each load cell
  - Provides total voltage gain of 201

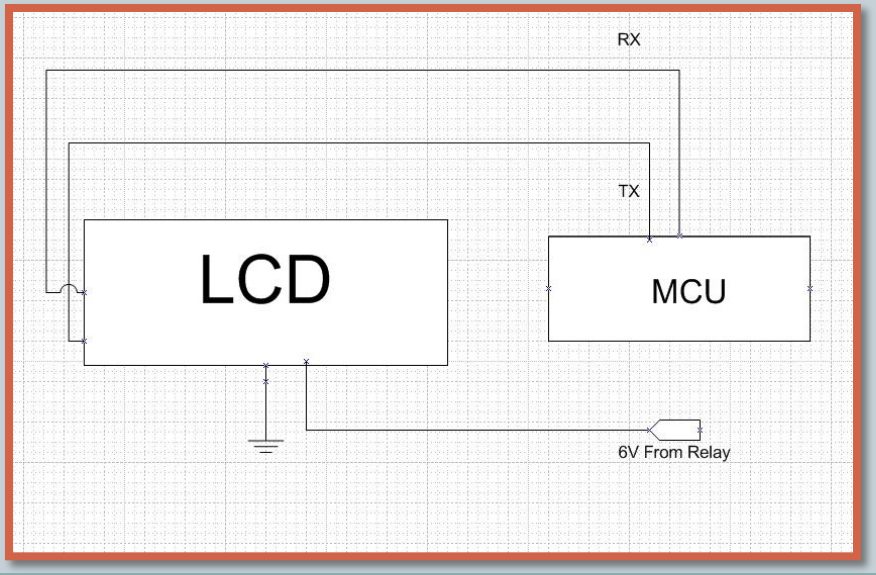
Hardware Implementation (cont'd)

- Variable Voltage Regulator
  - Regulates 9V to 6V to power LCD
  - Controlled by digital pin of microcontroller through optical relay



LCD Implementation

- 160x128 Serial Graphic LCD
  - Connected to MCU via Digital pins
  - Custom font was created to show weight value
  - Power was controlled via Relay connected to MCU
  - Baud rate of 115200 was used



Wireless Implementation

- Xbee 802.15.4 Transmitter/Receiver:
  - Low-cost and low-power RF modules that operates within the ISM 2.4 GHz frequency
  - UART interface for serial communication
- XBee Setup:
  - Unique address pairing
    - PAN ID
    - Source ID
    - Destination ID
    - Channel ID

Parameter	Value
Indoor/Urban	Up to 100' (30 m)
Outdoor line-of-sight	Up to 300' (100 m)
Transmit Power	1 mW (0 dBm)
Receiver Sensitivity	-92 dBm
TX Current	45 mA @ 3.3 V
RX Current	50 mA @ 3.3 V

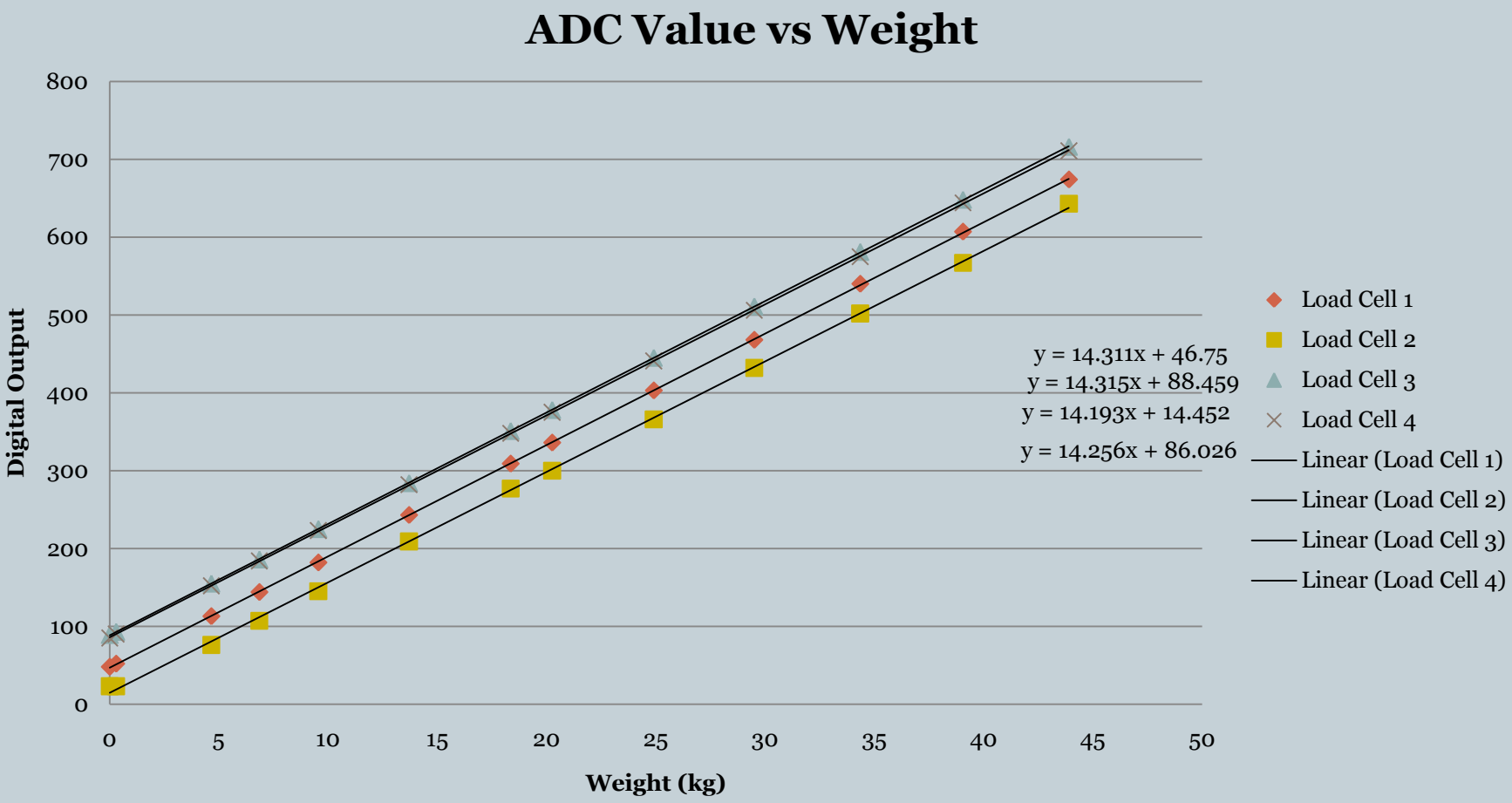
Wireless Implementation (cont'd)

- Transmitter Protocol:
  - Arduino serial API to establish communication and send data
  - Transmits a finished packet after transmitting data
- Receiver Protocol:
  - C# serial API to establish communication and receive data
  - Receives and verifies the finished packet
  - Received data captured on the serial port is written to a text file for post analysis

Weight Calculations

- Load cell characterization
  - Created a table of ADC values corresponding to a known weight
  - Plotted the data to obtain the line of best fit
  - Obtain the line equation to gather a ADC to weight relationship
- Weight distribution
  - Weight distribution is measured by keeping individual load cell measurement values
  - Weight from each corner's load cell is totaled in the MCU to produce the total weight

Weight Calculations (cont'd)



GUI Implementation

- Developed using C#
  - Microsoft Visual Studios 2008
  - Weight distribution graph done using ZedGraph
    - Free charting class library
  - Editable fields for name and comment only
- Microsoft Access Database
  - Used to store and organize all data entries
- Code was frequently backed up using Perforce

Questions?