ECE 189A Senior Capstone
October 29, 2014
Team Leader: Will Miller
Charles Crain, Isaac Flores, Brian Phan, Sarah Pilkington

INFINITABLE
INITIAL DESIGN
REVIEW
InfiniTable is a fully interactive, multifunctional table made up of individual tiles that can be connected in any configuration desired by the user.

The system is controlled by an LCD touchscreen user interface, and also features Bluetooth capabilities so the user can play music through the speakers remotely from a cellular device.

Each tile consists of a complex array of force and optical sensors that measure the location and the force with which the ball or die hits the table, and LEDs that visually represent the same information.
Product Development Team

- **Will Miller**: Wifi Module, Processor, Power Requirements
- **Charles Crain**: Bluetooth Module, Speakers, MP3 Converter
- **Isaac Flores**: Tile Interfacing, LED/Sensor Addressing
- **Brian Phan**: Android Application, Pressure Sensors, Capacitive Overlay
- **Sarah Pilkington**: LCD Touchscreen, LED design/layout
Applications

- Current application: Platform for popular party games, but there are many more practical applications:
  - **Games**
    - Board and Card Games
  - **Flooring**
    - Light-Up/Pressure-sensitive tiling for homes and businesses
  - **Security**
    - Alerts to a change in pressure if something is moved or removed
Initial Specifications

- **Tiles**
  - Can be connected in any configuration

- **Sensors**
  - *Pressure sensors*: measure the force from the die when it hits the table
  - *Optical sensors*: monitor the boundary edges of the table

- **Capacitive Overlay**
  - Redundant path for the *Pressure Sensors*

- **LEDs**
  - Visual representation of the information gathered by sensors
  - Pulse/change color to the beat of the music
Initial Specifications (II)

- LCD Touchscreen
  - User interface used to control the system
- Android Application
  - Redundant path for the LCD user interface
- Bluetooth Module
  - Connect cellular device through Bluetooth in order to play music and to use the Android Application
- WiFi Module
  - Redundant path for the Bluetooth Module
Initial Specifications (III)

- **MP3 Decoder**
  - Enable system to play music through a Bluetooth connected cellular device

- **Speakers**
  - Play music from cellular device along with game sounds

- **SD Card Reader**
  - Storage for pre-recorded game sounds and music, and pre-configured game designs
**Block Diagram**

- **Processor**: NXP LPC 4088
- **Wifi Module**
- **SD Card Reader**
- **LEDs**
- **Sensors**: Pressure/Optical
- **Capacitive Overlay**
- **LCD Display/Touchscreen**
- **MP3 Decoder/Speakers**
- **Bluetooth Module**
- **App Control**
- **Tiles**
- **Analog**
- **4 pin JST SM**
- **SPI**
- **UART**
- **I2C**
- **PS/Serial**
# Development Plan

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Start Date</th>
<th>End Date</th>
<th>Task</th>
<th>Person Responsible</th>
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<tbody>
<tr>
<td>Initial Design Review</td>
<td>10/20/14</td>
<td>10/29/14</td>
<td>Create powerpoint for system level design, pick all parts to be used in system</td>
<td>Everyone</td>
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<td>Milestone #3: System Level Design Checklist</td>
<td>10/27/14</td>
<td>11/03/14</td>
<td>Subsystem Requirements/Component Selection</td>
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<td>Collection of Data Sheets</td>
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<td>LCD Touchscreen/LED Design</td>
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<td>Tile interfacing and addressing LEDs/Sensors on Tiles</td>
<td>Isaac</td>
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<td>MP3 Module, Speakers, Bluetooth</td>
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<td>Pressure sensor, tile design, android App</td>
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<td>Preliminary Design Review</td>
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<td>Provide details and proof that the job can be done and done by us</td>
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<td>Low level hardware implementation for logic on tiles</td>
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<tr>
<td>Critical Design Review</td>
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<td>12/16/14</td>
<td>Demonstrate that the design and all subcomponents is complete</td>
<td>Refer to milestone #3 for assignments of duty</td>
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<td>Milestone #5: Design Implementation</td>
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<td>Gerber files and drill database</td>
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<td></td>
<td></td>
<td>Final Schematic</td>
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</table>
Parts – Processor (LPC 4088)

- 512kB Flash
- 96kB RAM
- 120MHz Clock Speed
- Supply Voltage: 2.4-3.6 V
- UART, I2C, SPI, I2S, USB Interfaces
- 10 bit DAC
- 109 GPIO pins
- Cost: $13.53
Parts – Tiles

- Tile Connectors
- Array of LEDs
- CPLD
- ispMACH4000ZE
Parts – Tiles (II)

Tile Components:
- CPLD
- Serial Bus
- Single Interrupt Line
- LEDs
- Force Sensors
Parts – Tiles (III)

- **ispMACH 4000ZE CPLD**
  - Will provide tile intelligence:
    - I2C slave, LED and Sensor addressing
  - Possibly supported on ispLever 3.1 programmer in Capstone lab
  - Number of Macro Cells: 128
  - Max Delay time: 7.5 ns
  - Cost: $7.19
Parts – Tiles (IV)

- Lattice Semiconductors I2C slave module
  - Open source Reference Design 1054 based on I2C specifications
  - Verilog
  - Supported on ispMACH 4000ZE
    - Speed Grade: -5 ns
    - Utilizes 48 Macrocells
    - Max frequency: >15MHz
    - I/Os: 26
Parts – Force Sensors

- Interlink Electronics FSR® 400 series
  - Part of the single zone Force Sensing Resistor® family
  - Actuation Force as low as 0.2N and sensitivity range to 20N
  - Robust: up to 10M actuations
  - Cost: $143.91 for a full development kit
- LM358 Dual Op-amp to drive the sensor output
  - Cost: $0.55
Parts – Capacitive Overlay

- **3M™ MicroTouch™ System SCT3250EX**
  - All glass design with 3M™ ClearTek™ proprietary hard coat and a scratch-resistant top coat

- Requires the EXII-7720SC for interfacing
  - EX Serial Controller that uses the standard 3M MicroTouch™ RS-232 serial cable
    - Cost: $19.41
  - +5V DC power supply
    - Cost: $75.86

- Total Cost: $95.27
Parts – Android Application

- Android-based user interface that provides a redundancy check for the LCD Touchscreen
- Does not require any additional hardware other than an Android phone
- Will use either Bluetooth or WiFi to communicate with InfiniTable
  - Possibly used to stream music
Parts – LCD Touchscreen

- Capacitive Touchscreen:
  - 800 x 480 Pixels
  - 3.3V Liquid Crystal Display
  - 24-bit Parallel RGB Interface
  - White LED Backlight
  - Wide Temperature (-20°C to +70°C)
  - Capacitive Touch Panel with I2C Interface
  - Cost: $70.00
    - Already have one from previous project
Parts – LED Strip

- 16.5mm wide, 4mm thick
- 32 LEDs per meter
  - Can be cut to 2 LEDs (2.45” long per segment)
- Weatherproof casing
- 5V DC power requirement
- Each LED is individually controllable
- Connector: 4-pin JST SM
- Cost:
  - $24.95 per meter (Need 5 m)
  - Total: $124.75
Parts – WiFi Module

- **RN171XVW-I/RM**
  - Ultra-low power
    - 4 uA sleep, 35 mA Rx, 185 mA Tx at 12 dBm
    - Tx power configurable from -2 to 12 dBm
  - 2.4GHz IEEE 802.11 b/g transceiver
  - Configuration over UART interface using ASCII commands
  - Features Infrastructure, AdHoc, and AP modes
  - Secure WiFi authentication via WEP, WPA, and WPA2
  - Built-in networking applications
  - Cost: $38.45
Parts – Bluetooth Module

- Microchip Technology RN41-XVC
  - Low power (30 mA connected)
  - Small footprint 24.4mm x 29.9mm
  - Backwards-compatible with Bluetooth version 2.0, 1.2, and 1.1
  - UART Data Connection
  - 3 V Voltage Supply
  - Cost: $34.74
Parts – MP3 Decoder

- Decodes MPEG 1.0 & 2.0 audio layer III; layers I & II optional
- High-quality stereo DAC
- Data Connection: SPI
- Single-Supply Operation: 2.5 to 3.6 V
- 5.5 KiB On-chip RAM for user code / data
- Cost: $24.99
Parts – Speaker

- PUI Audio, Inc. AST-030C0MR-R
  - Magnetic Speaker with range of 1.2kHz ~ 10kHz
  - 80dB, 29.70mm Diameter, 12.70mm Tall
  - Power rated at 0.15 W and maxed at 0.3 W
  - Cost: $3.53
Parts – SD Card Reader

- Kyocera 5738 Series
  - Surface mounted, will work with generic SD Card
  - Cost:
    - $3.03 + $7.00(S&H) = $10.03
    - SD Card: ~$5.00
    - Total: $15.03
## Current Bill of Materials

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Technology Reuse

- Bluetooth Module
  - and reference design
- WiFi Module
  - and reference design
- LCD Display
  - Similar design used in previous Capstone projects
- LED Strip
  - Ample source code and tutorials provided, as well as previous experience
Critical Elements

- Accurate measurements from the pressure sensors
  - Redundant path: Capacitive overlay
- Capability for any tile configuration
  - Tile addressing
- Working user interface
  - LCD touchscreen or Android Application
Questions? Comments?

Thank you!