Team 13 - SmartRack

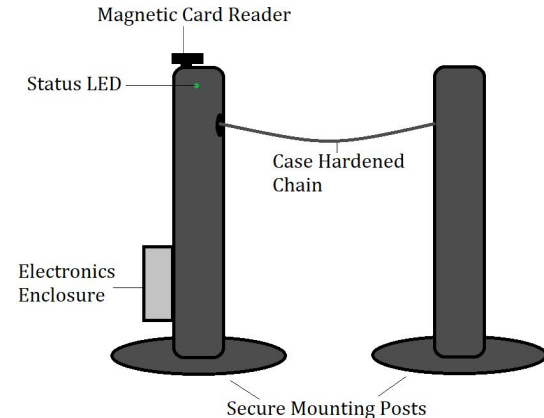Preliminary Design Review

October 11th, 2019

Problem Statement

- Bike racks are typically full and unorganized
- No guarantee of a spot

Problem Statement: Solution

- SmartRack!
- Reserve bike rack ahead of time
- Real-time feedback on bike rack availability
- Lock and unlock with UCard

Magnetic Card Reader

Status LED

Case Hardened Chain

Electronics Enclosure

Secure Mounting Posts

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Team Roles

Arthur, CSE, Mobile Application Development

Alessy, EE, Manager, MagSwipe & Raspberry Pi Development

Fedor, EE, PCB Lead, PCB Development

Andrew, EE, Hardware Fabrication

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Current Alternatives

Bikeep

Pros:

- Solar Powered (Optional)
- Secure Bar Locking

Cons:

- Expensive (>$100 per individual spot + shipping)
- No reservations
- Must buy RFID card to use without phone

vadeBike

Pros:

- Chain Lock
- Small Storage Space

Cons:

- No Mobile App
  - No Reservations
- Pay for Spot
- Geographical Limitation

Bikeep

vadeBike

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System Specifications

- Mobile application reservation w/ map view
- 15 minute grace period
- Embedded Locking System
- UCard Compatibility (Stripe Reader)
- Raspberry Pi
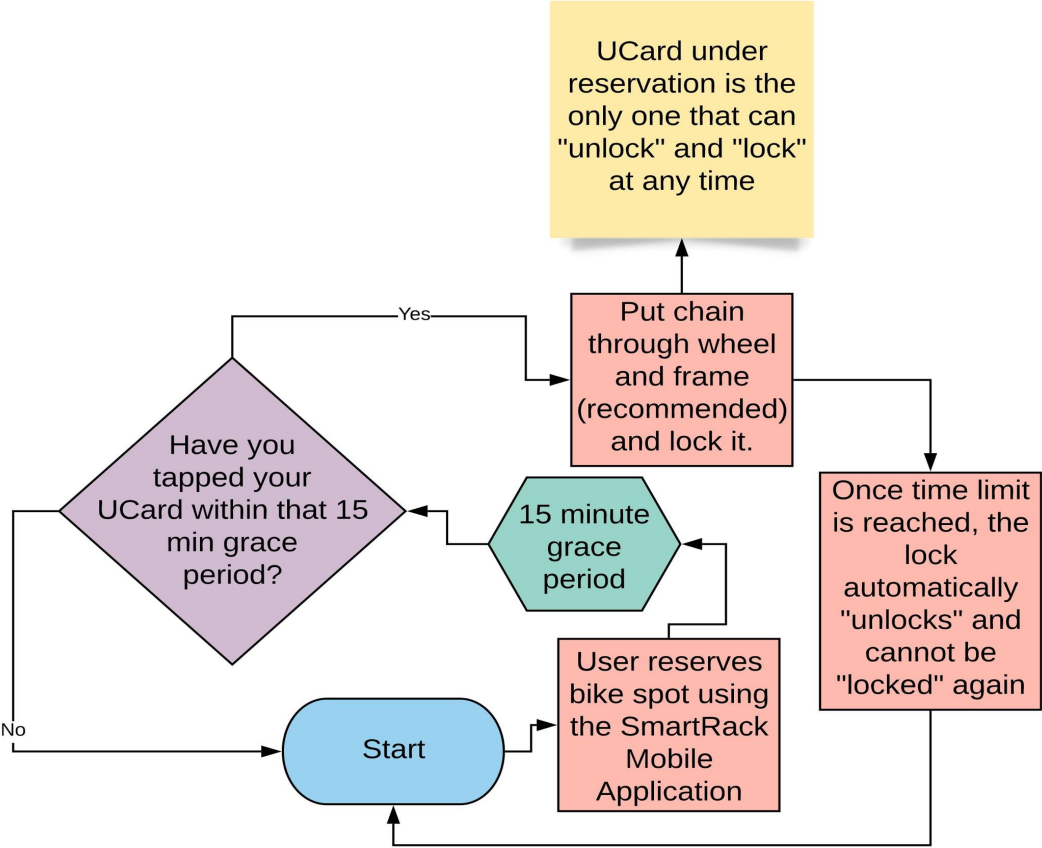- Time Permits: Screen (on-site reservations)

Current Alternatives Comparison

	Bikeep	vadeBike	SmartRack
Mobile App	YES	NO	YES
Reservations	NO	NO	YES
Free for User	NO	NO	YES
Power Source	Solar or AC Power (220V/24V)	AC Power (220V/24V)	AC Power (120V)

Block Diagram
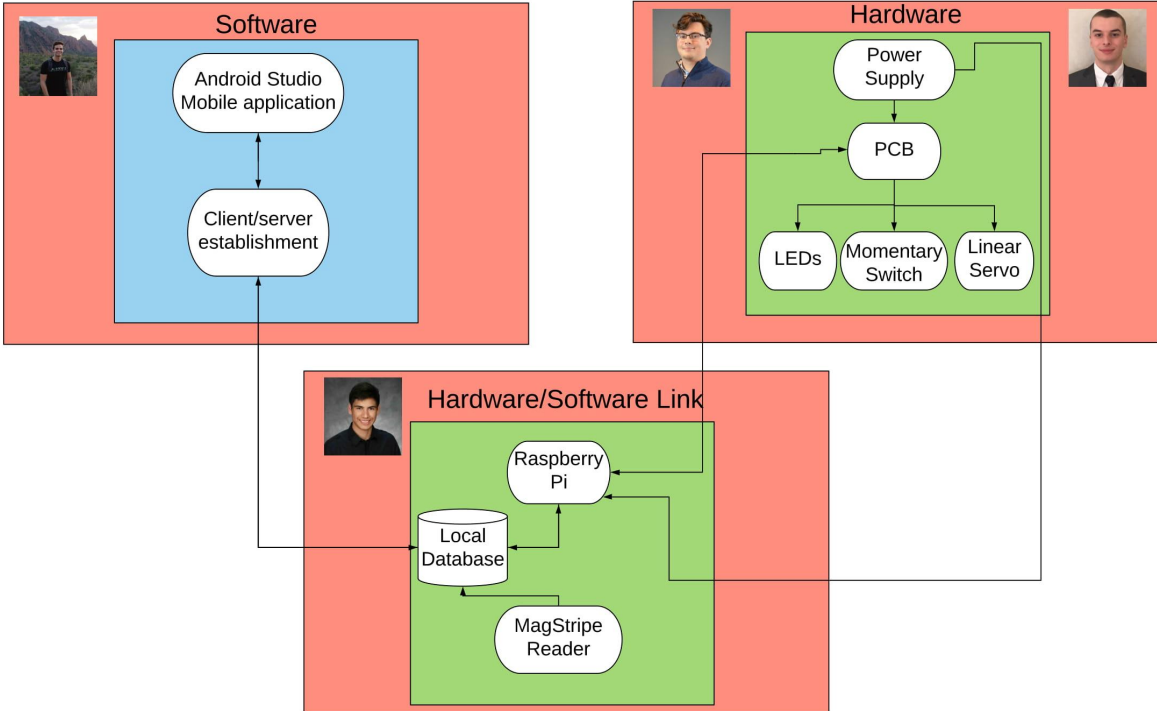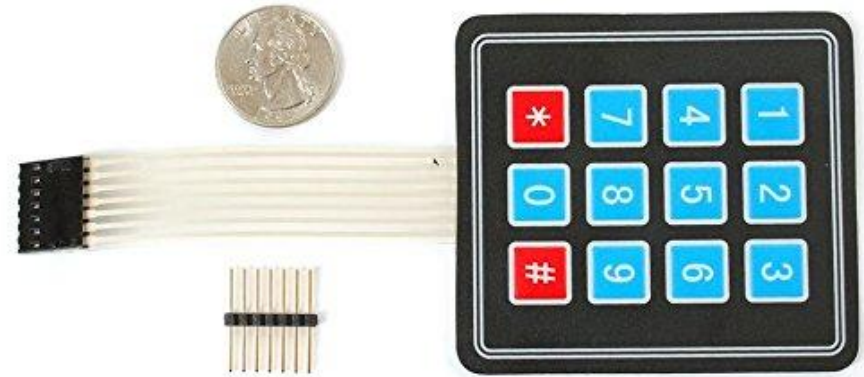
State Machine Diagram

Plan A: Mini MagStripe Reader

- 16 Digit ISO Number + 8 Digit Student ID (Track 2)

- Parsing done with configuration tool

Plan B: Digital Passcode

- 3 x 4 Keypad
- 4 digit, single-use password
- Connects easily with any Raspberry Pi model
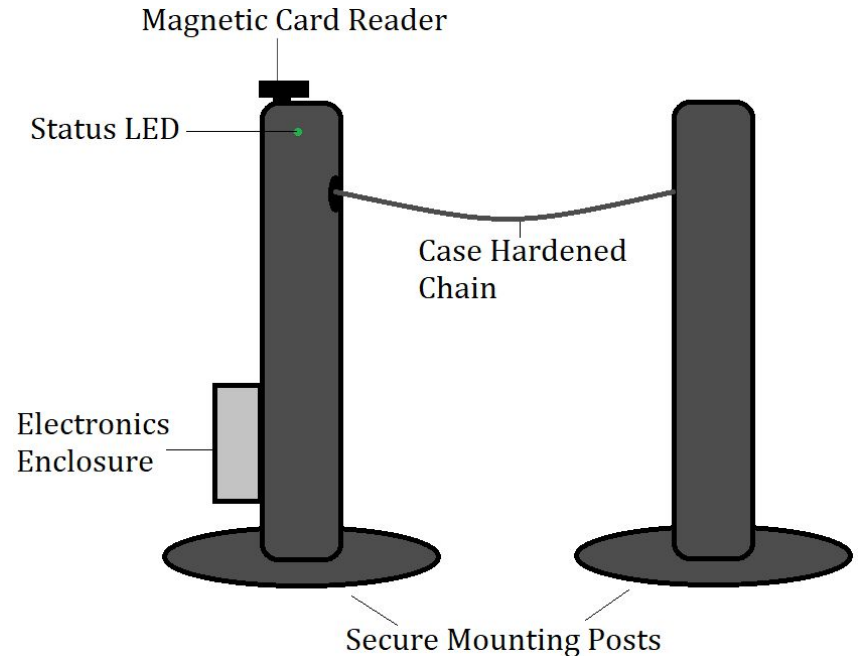- Code displayed through Mobile Application

Raspberry Pi

- Raspberry Pi 3 B+
- Raspberry Pi Universal Power Supply (5V, 2.5 Amps)
- 1GB of local data
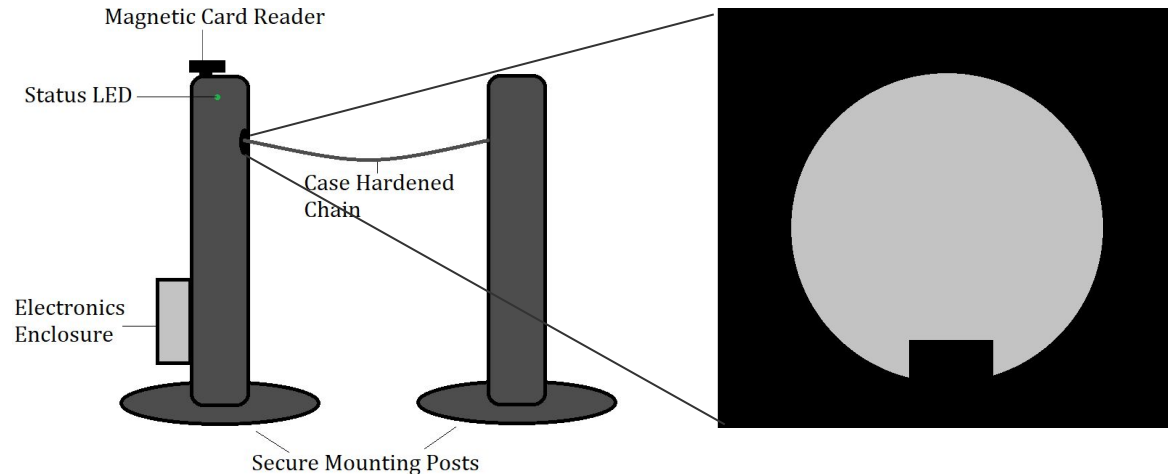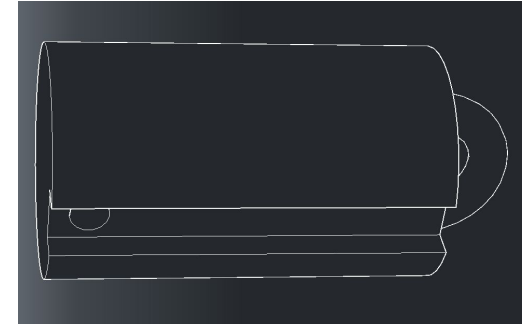- Python Programming Language

Frame Design

- Implement UMass single bike rack
- Compact and replicable
- Design discourages unauthorized use

Magnetic Card Reader

Status LED

Case Hardened Chain

Electronics Enclosure
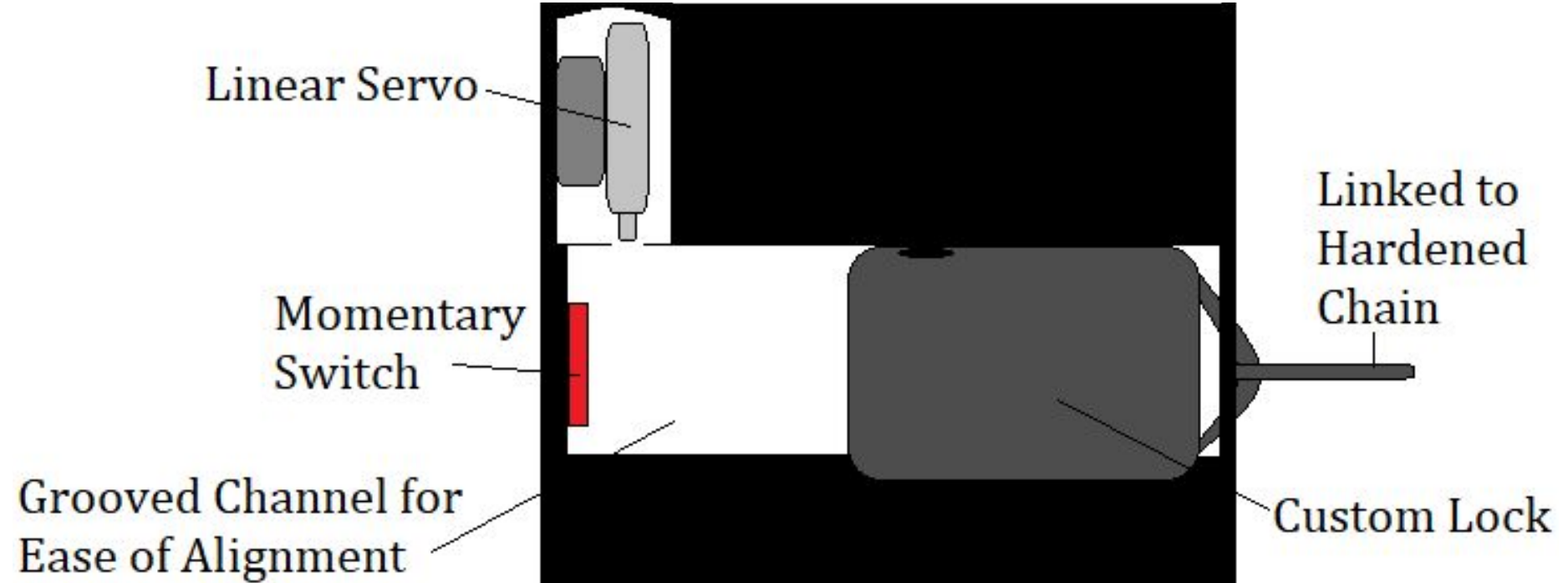
Secure Mounting Posts

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Lock Design

- Custom fabricated steel cylinder at the end of the chain
- User-friendly - grooved channel to make locking simple
- Rack will not lock unless card is swiped

Magnetic Card Reader

Status LED

Case Hardened Chain

Electronics Enclosure

Secure Mounting Posts

Lock Operation

Linear Servo

Momentary Switch

Grooved Channel for Ease of Alignment

Linked to Hardened Chain

Custom Lock

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Chain Design

- Utilizing chain allows for universal design
- Traditional round steel chain is susceptible to tampering
- Two ways to improve security:
  - Case hardening
  - Hexagonal Links

Identifying Occupancy

- LED used as status indicator for each rack
- Utilize servo resistance reading to indicate status of a rack
- Can also be used to identify availability of spots on rack in conjunction with reservation system in software
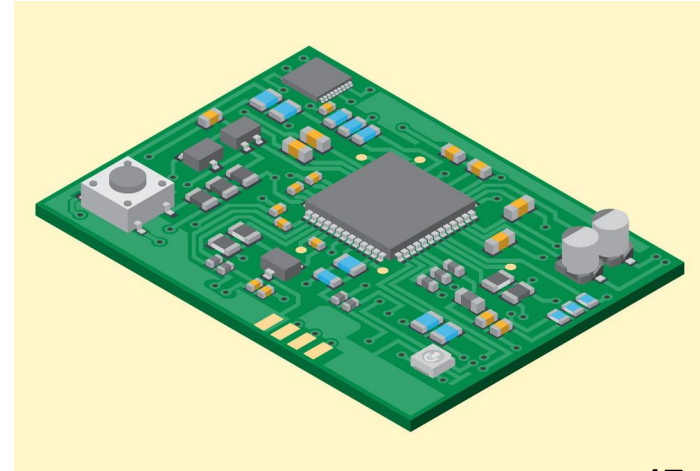
PCBA Design

- Will be designed in Altium
- Interactions with all electrical components
  - LEDs
  - MagStripe
  - Actuator
- Controls Distribution of Power

ALTIUM
DESIGNER

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Power Options

- Low Power Consumption
- Several Options
  - Solar
  - USB
  - External Power Supply
 - Batteries
  - **AC to DC Adapter**

Connecting to Raspberry Pi

- Receives Information from Pi
- Transmits Information to sensors
  - States for LEDs
  - States for Actuator
  - Is the lock in place
- Transmits sensor data to Pi

App Development

- Android Studio
  - UI
  - Map view
  - Prompts user to specify their student ID
  - Transmission of ID and timestamp
- Socket programming - Raspberry Pi listening for signals from Android app
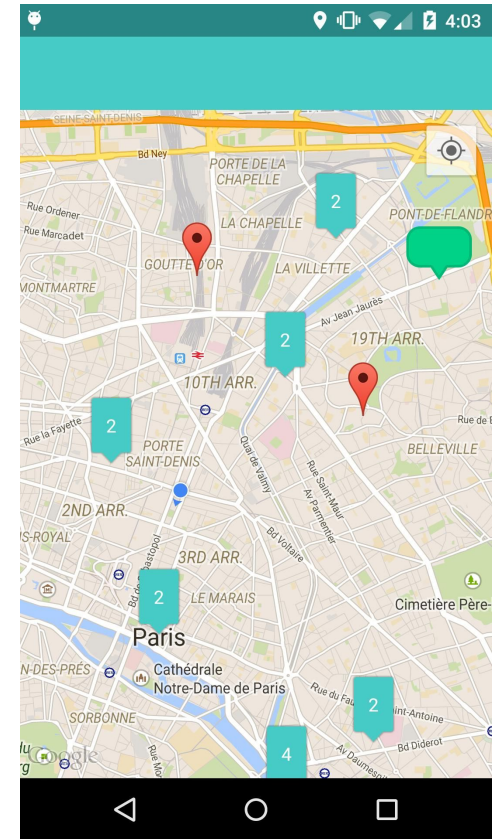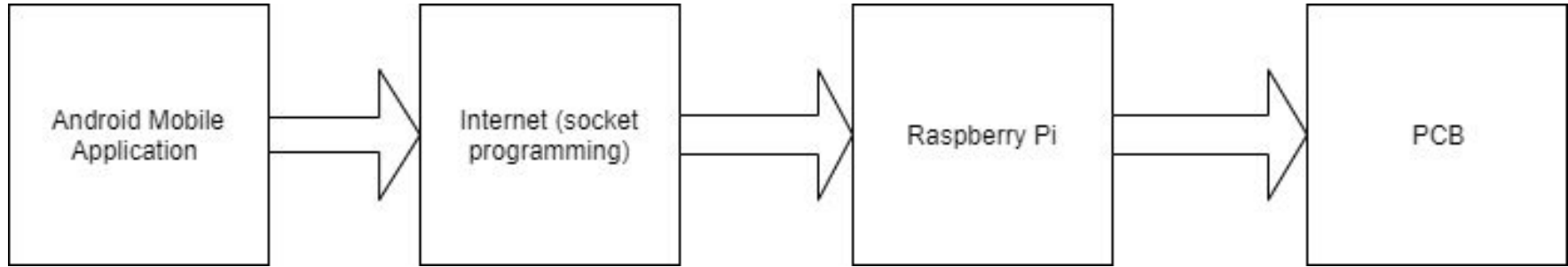
Raspberry Pi Network Capabilities

- 2.4 / 5 GHz Dual-band wireless LAN
- Problem: Raspberry Pi may be slightly out of range of eduroam
- Solution: ModMyPi Long-range WiFi dongle
  - 100m straight line range

Networking Infrastructure

- UMass student ID/timestamp sent through network
  - Int and Time data types (4 bytes, 8 bytes respectively)

Cost

Electronics Enclosure (IP-67)	$30
MagSwipe Reader	$40 - $50
Plan B: Key Pad	$7-$10
Raspberry Pi 3 B+	$30 - $40
Frame and Lock Materials	$50
Power Supply	$25
Linear Servo	$89

Total: $270 - $294

MDR Deliverables - Arthur

- Basic Android Studio application
  - Ability to transmit 8-digit integer/timestamp

MDR Deliverables - Andrew

- Prototype model of the rack with custom components 3D printed
- Lock mechanism operating time < 3 sec (Based on 50:1 gearing servo speed)

MDR Deliverables - Alessy

- Communication link between the Raspberry Pi and the Mobile Application
- Configuration tool setup
  - MagStripe Reader data can be manipulated
- Set up local database to support all incoming data

MDR Deliverables - Fedor

- ● PCB prototype on a breadboard
  - ○ Working interaction between components
    - ■ LEDs
    - ■ Actuator
    - ■ Momentary Switch
  - ○ Ability to regulate power between components

Thank you

Questions and/or comments?

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