

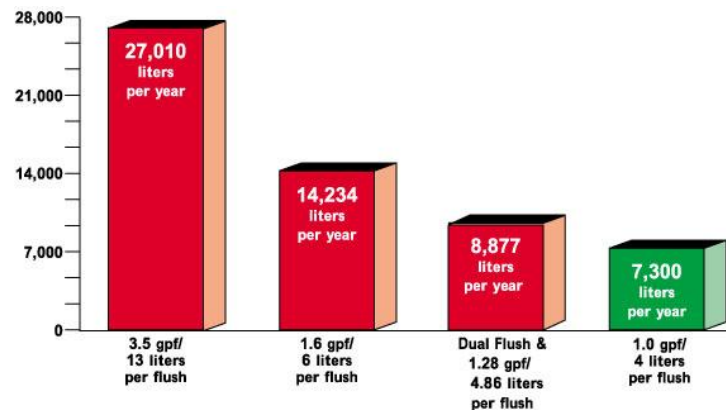


Sustainable Hi Traffic Toilet Redesign

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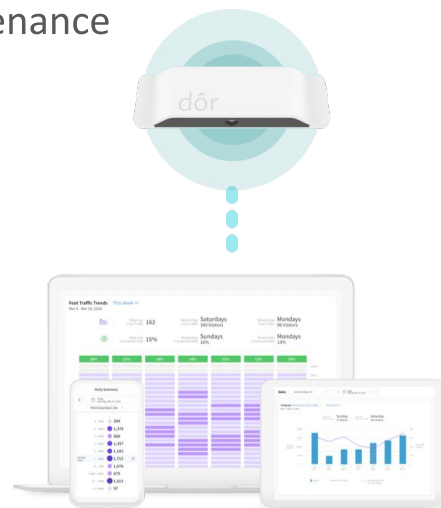
The Problem

- The average person uses a toilet 2,500 times a year
- Commercial automatic flush toilets are convenient, but they pose a problem with wastewater usage
- Most automatic toilets do not implement dual-flushing
- Millions of dollars are wasted annually in redundant sanitation maintenance

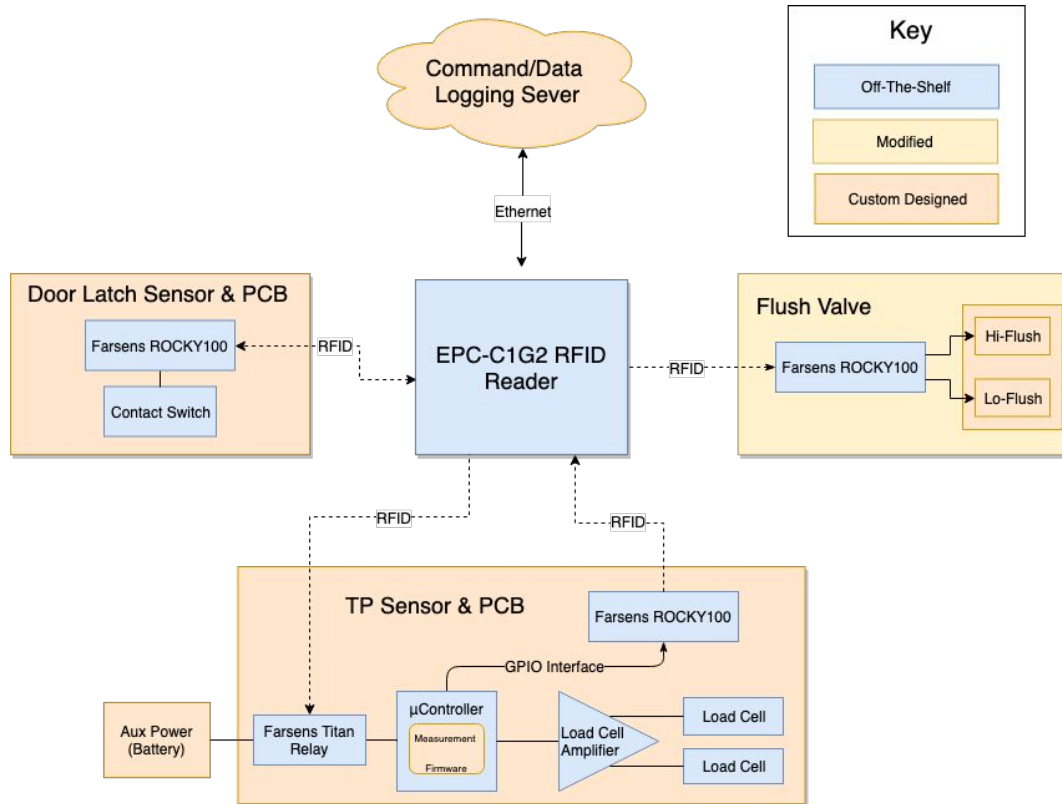


Proposed Solution

- Toilet paper sensing
 - Toilet paper is the most frequently clogging item in toilets
 - Detecting how much has been used would allow toilets to implement variable volume flushes, further conserving water and reducing clogs/maintenance
- Occupancy Data Logging
 - Once a sensor network is in place, all data from it can be gathered and used to make informed janitorial decisions
 - This improves upon current systems that track traffic externally

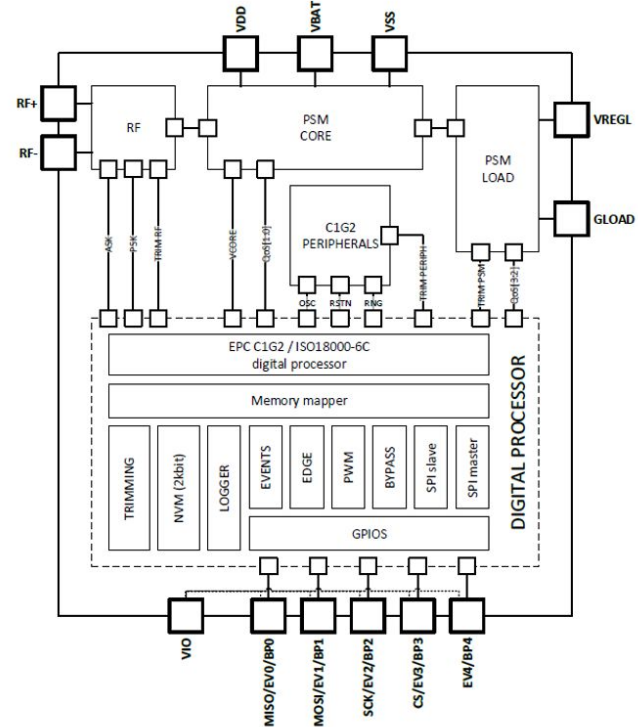


System Design/Implementation Plan



The Rocky100

- Standard UHF RFID communication (EPC C1G2/iso 18000-6c)
- Wireless power harvesting
- 5m passive/20m battery-assisted range
- GPIO/SPI capability
- No custom command interface



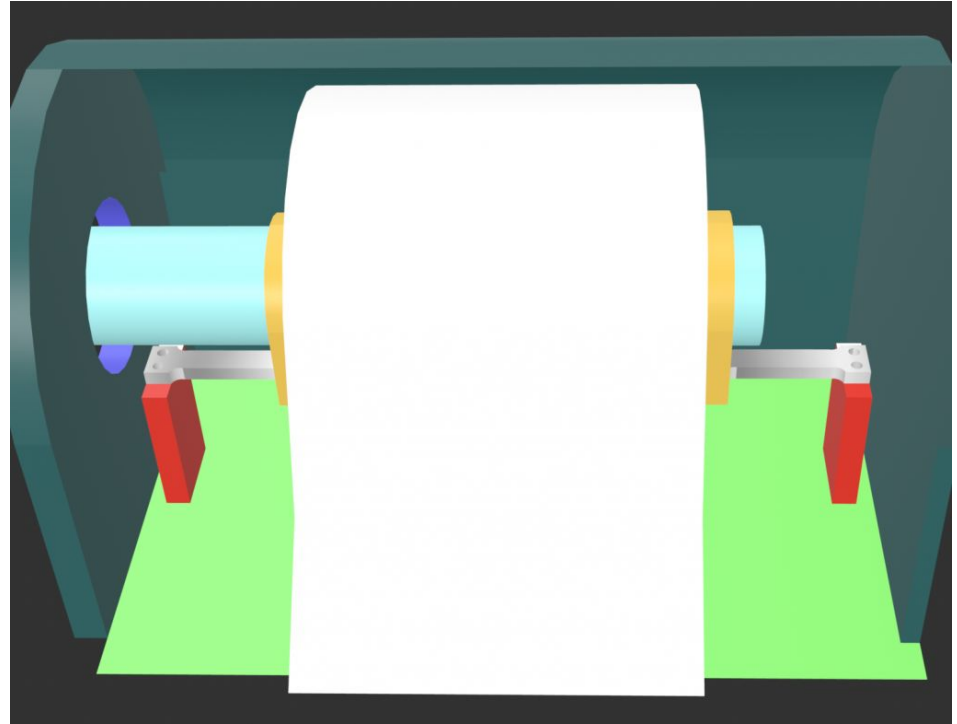
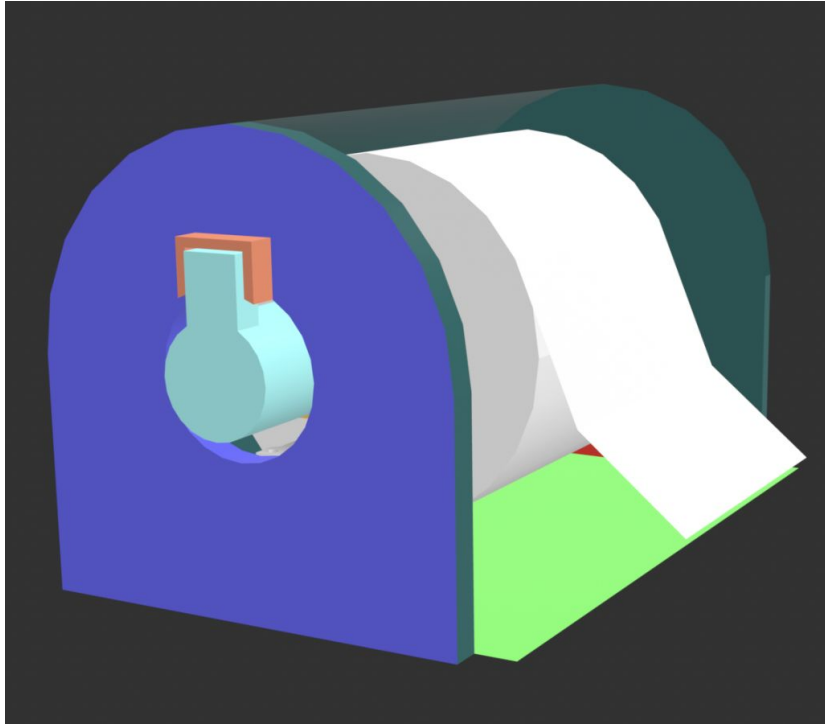
Control Flow

- Door latch detects the start of occupancy
- Triggers the relay to activate the load cell microcontroller
 - Conserves auxiliary battery power by reducing powered-on time
- Flush volume is determined one of two metrics (to be tested):
 - Amount of time pulling force is exerted vs the pulling force
 - Weight of TP roll before and after usage
- Flush volume is sent to flush valve tag and either a Hi or Lo flush is triggered

Important Data Points

- How often each stall is used
- How often does a Hi-flush occur
- How often does a Lo-flush occur
- How much TP is left
 - Alert at ~10% of roll remaining
- System Errors

Preliminary Sensor Design

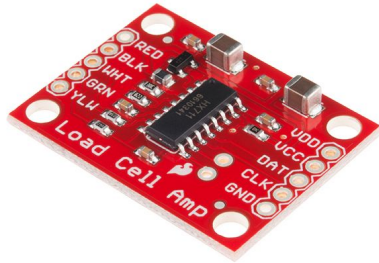


Testing & Verification

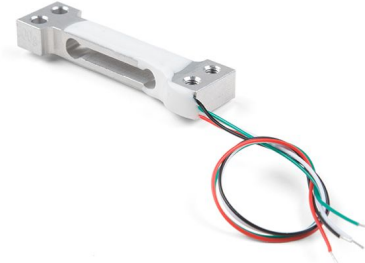
- Testing TP Sensor
 - Test accuracy of load cell measurement
 - If precise to $< +/- 5$ sheets we can use before and after weight measurements to determine TP usage
 - Otherwise determine a ratio of pulling force to time force is applied to determine TP usage.
- Testing Door Latch Sensor
 - Attach the sensor to a mock door and ensure stable communication with the reader for open and closed readings. (Precise to 5s of occupancy)

Calculating Scale Resolution

$$\textit{Resolution} = \frac{\textit{Load Cell Max Weight (g)}}{\textit{ADC Resolution * ADC Gain * Load Cell Sensitivity (mV/V)}}$$



HX711



TAL221

$$\textit{Resolution} = \frac{500\text{g}}{2^{16} \textit{ bits} * 0.128 * 0.7\text{mV/V}} = \pm 0.085\text{g}$$

Schedule Update

Task Name	Duration	Start	Finish	Precedence	Feb			Mar				Apr			
					Feb 10	Feb 17	Feb 24	Mar 3	Mar 10	Mar 17	Mar 24	Mar 31	Apr 7	Apr 14	Apr 21
Research Stage	5d	02/11/19	02/15/19		█										
Prototype TP Load Sensor	12d	02/16/19	03/04/19			█	█	█							
Prototype TP Sensor and Latch Casing	4d	03/05/19	03/08/19					█							
Spring Break	6d	03/09/19	03/15/19						█	█					
Integrate Farsens Tags	7d	03/18/19	03/26/19							█	█				
Final prototype, testing	7d	03/27/19	04/04/19									█	█		
Design PCB	7d	04/05/19	04/15/19										█	█	
Final Design, stretch goals	6d	04/16/19	04/23/19											█	█
In Lab Demo	1d	04/24/19	04/24/19												█

- David - TP Load Sensor Design, Farsens Integration, PCB Design
- Brian - Data Logging and Visualization, RFID Network Control
- James - TP Sensor and Latch Sensor Physical Design, Flush Valve Integration
- All - Testing and Integration