
ENGINEERING
TEXAS A&M UNIVERSITY
Autonomous Lawnmower
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ECEN 404-904 Team 30

Project Summary

Problem Statement: *“You will start with a lawn mower shell, add motors to propel the wheels, microcontroller to control everything, comms to a wifi network where area to be covered and route will be entered, and a power mechanism (docking station or other)”*

- Use lawn mower body and reconfigure for our needs
  - Electric motors for wheel and blade
  - Solar and grid tied charging
  - Docking station
  - Navigate autonomously using various sensors
  - Receive user information about area to mow and scheduling through app

Integration Problems

- Front Sensor Array Errors
  - Returns out of range value
  - Array tested and works on Bench, so likely connection issue
  - **Solution: Troubleshoot array connections one at a time**
- Navigation Problems
  - Insufficient torque for motors
    - Doesn't allow for proper turns
    - has issues moving on grass
    - **Solution: slow down mower to reduce momentum**
  - Wheel problems
    - Caster wheels not stable enough
    - original wheels don’t allow for tight turns
    - **Solution: Ordered Mecanum Wheels (pick up from Grainger tomorrow)**

Blade Drive

- Blade Detached for testing
- Need to transfer control to Nav-MCU, interface is “plug and play” ready

Integration

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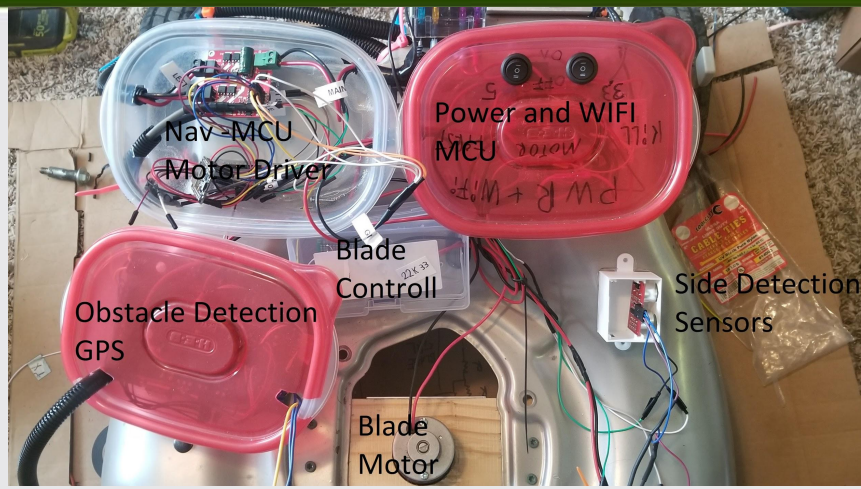
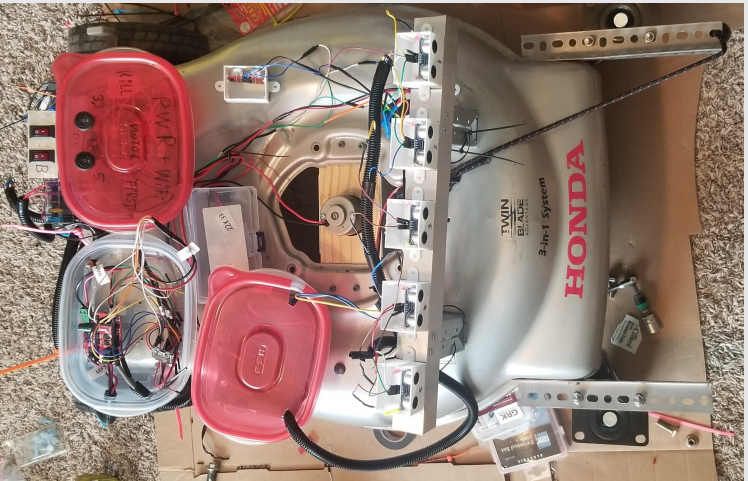
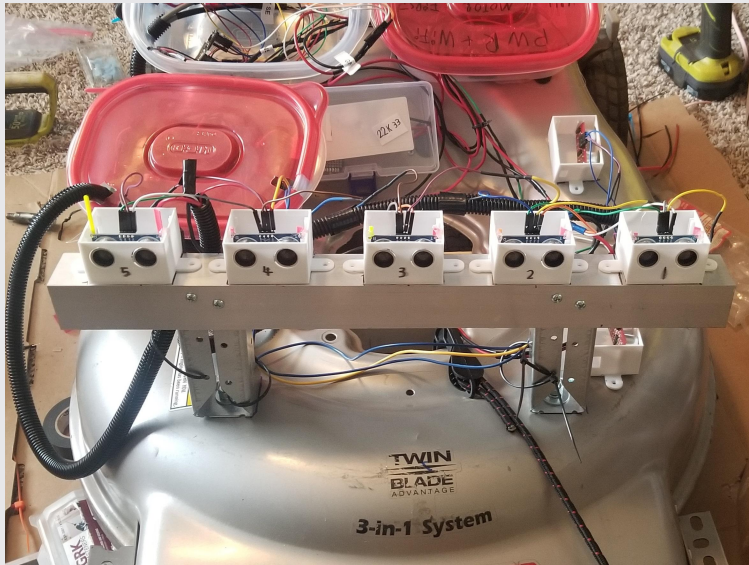
- All Components Mounted
  - Motors
  - MCUs
  - Sensors
  - Blade drive components
    - (Blade detached for testing)
- All Components Connected
- Need to Replace front Wheels
  - **Part Arrives tomorrow**
- Need to clean up wiring
- Need to mount Blade Shroud.
  -

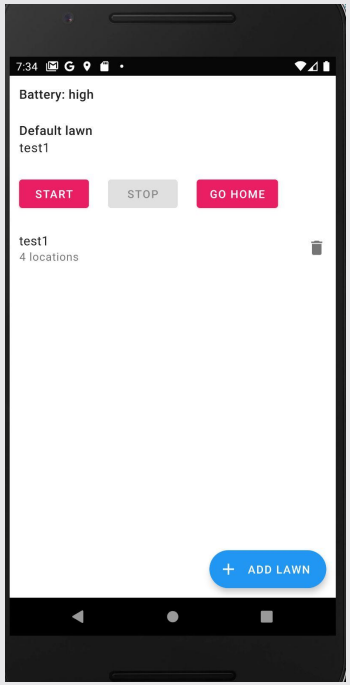


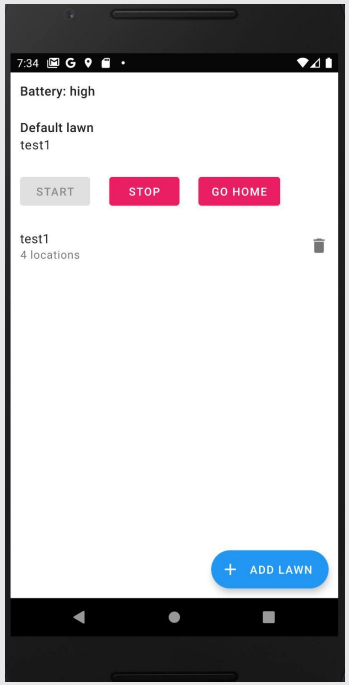




User Interface/Server Update

- Android application runs smoothly
- Added stop button that corresponds with start status in server





WiFi & Navigation MCU Integration

- Android application
  - Can be used to turn on/off mower
- Server with WiFi MCU integration
  - Communicating through WiFi
  - Server receives battery statistics from WiFi MCU & Nav MCU
  - WiFi MCU receives start_status and and coordinate information from server
- WiFi MCU & Navigation MCU integration
  - Both MCU's have been integrated
  - Bug has been fixed
  - Navigation code is still being worked on

Navigation

- This is our first mower test with the navigation code
- We were able to make a rectangular pattern (somewhat)
- Some directional issues occurred on the first leg
- This is due to the unstable caster wheels in the front, new wheels have been purchased

Schedule for the Semester

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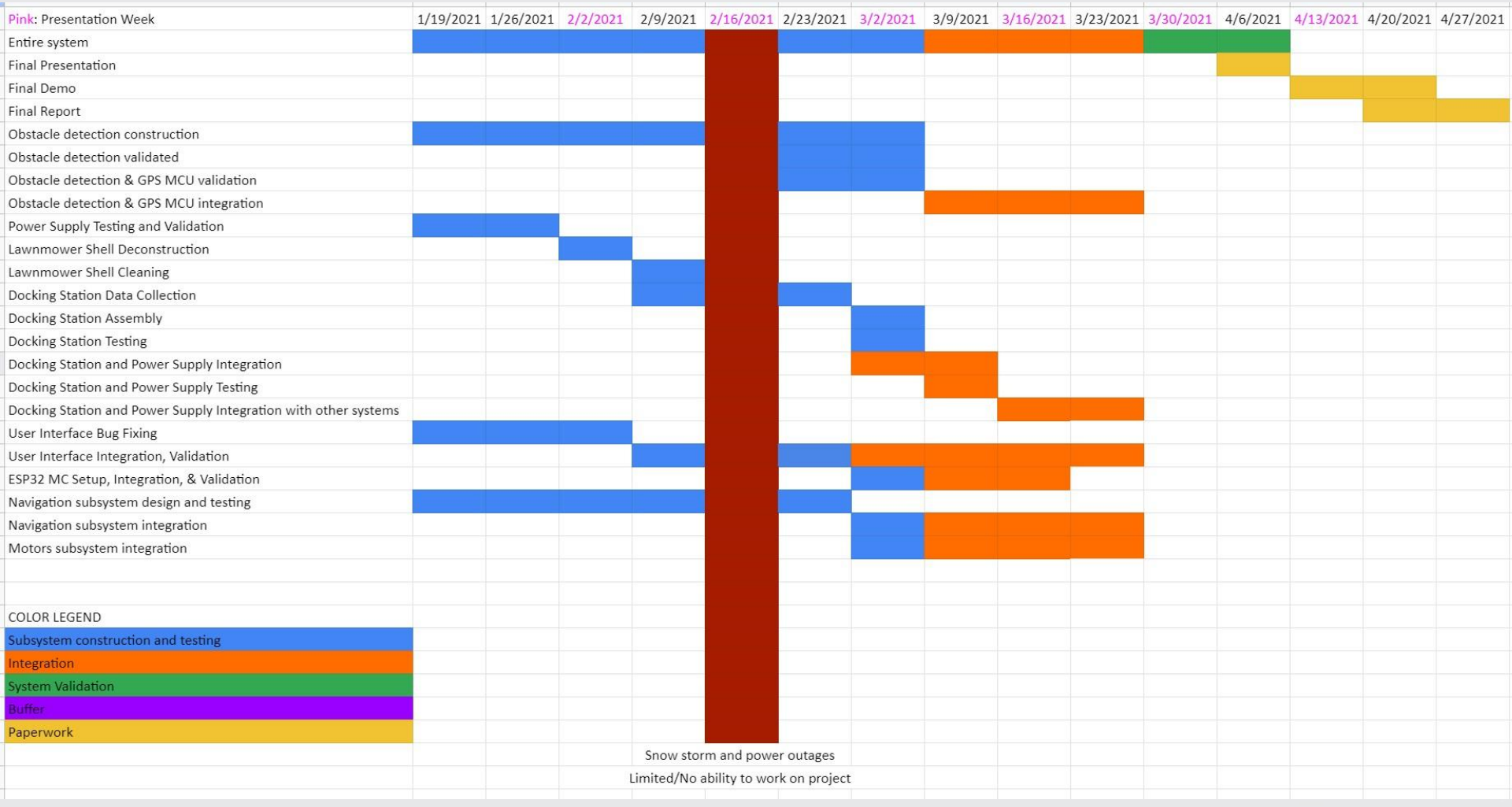

Validation Plan

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	Requirement title and heading, as found in the FSR	Abridged text of requirement (see FSR for full text)	Methodology	Status	Responsible team member	Validated By
3	**3.2.1 Functional/Performance requirements**	Performance requirements for the compelates system				
4	3.2.2.1 Operational Stamina	The system shall mow grass continuously for no less than 1 hour in flat, obstacle free terrain	Time operation of system under normal conditions		All	
5	3.2.1.2 Duty cycle	The system shall perform operations at least every 7 days.	Validate Solar/grid charging rate against power consumption in above test		All	
6	3.2.1.3 Obstacle Avoidance	The system shall avoid all obstacles that are harmful to the overall system, running over small obstacles that only impact blade sharpness or appearance is acceptable	Individual evaluation of obstacle detection and navigation function under realistic input. Full system validation in Realistic terrain		J. Samaniego & M. Lesser	
7	3.2.1.4 Navigation	The system shall use internal sensors to follow a spiral pattern within the boundaries outlined by the user	Simulation of Nav-code, Full system test under realistic conditions		J. Samaniego	
8	3.2.1.5 Obstacle detection Range and Threshold	The system shall be aware of any obstacle in the hypothetical box extending forward from the front of the mower to 2M, as wide as the widest point of the mower	Individual test of Obstacle detection function, in final configuration		M. Lesser	
10	**3.2.2 Physical characteristics**	Physical Requirements on the completed system				
11	3.2.2.1 Mass	The mowing unit shall not exceed a maximum weight of 70lbs	Weigh final system		All	M. Lesser
12	3.2.2.2 Volume Envelope	The volume envelope of the Lawnmower shall be less than or equal to 30 inches in height, 25 inches in width, and 40 inches in length.	Measure final system		All	M. Lesser
13	3.2.2.3 Mounting	All components shall be mounted in a fashion to resist vibration incidental to lawnmowing, with service once every 6 months when used weekly	Test connection manually, not able to perform full test, will have to extrapolate results gained from other tests		All	M. Lesser
15	**3.2.3 Electrical Characteristics**	Definitions of expected external inputs and outputs				
16	3.2.3.1 Inputs	The system shall not be damaged by any possible inputs or signals produced by the system, No user input shall result in the system engaging in unsafe or damaging operations	Provide mower with all possible input signals and observe performance		All	
17	3.2.3.1.1 Power Consumption	The power consumption of the lawnmower unit shall not exceed 200 Watts.	Measure battery discharge level after use		V. McMasters	
18	3.2.3.1.2 Input Voltage Level	The input voltage level for the Lawnmower shall be 14.2 VDC to 14.4 VDC.	Measure input voltage to battery from charging station		V. McMasters	
19	3.2.3.1.3 External Commands	The Lawnmower system shall receive external commands from the User Interface via a WIFI connection. Details will be outlined in the ICD.	Attempt to transmit Nav/Schedule commands from app and see if mower responds		J. Poulose	J. Poulose
20	3.2.3.2.1 Data Output	The mowing unit shall inform the user of problems and fault conditions through the UI app via WIFI.	Generate Fault conditions on mower and see if reports to user		J. Poulose	
21	3.2.3.2.2 Diagnostic Output	The MCU shall include a hardware debugging port that may be interfaced to a computer for Diagnostics.	Physical validation of hardware access ports		M. Lesser	M. Lesser
22	3.2.3.3 Connectors	(Electrical) Connectors shall be resistant to vibration incidental in lawnmowing, with service no more than once per 6 months when used weekly	Extrapolate from other physical trials		All	
23	3.2.3.4 Wiring	The wiring for signal and power interfaces shall be routed clear of any moving internal parts, and clear of all possible outside interference. And protected as appropriate	Visual inspection of completed system		All	
25	**3.2.4 Environmental Requirements**	The Lawn mowing system shall operate in all environmental conditions that traditional residential lawn mowers operate and lawn care activities take place.	Test in as many environmental conditions as possible and extrapolate			
26	3.2.4.1 Thermal	The Lawnmower shall operate in temperatures ranging from 40°F to 120°F.	see 3.2.4		All	
27	3.2.4.2 External Contamination	The Lawn mower shall be immune to dust and debris. The Lawn mower systems shall either be protected from, or insensitive to ingress of debriess 1mm or larger, as well as dust.	see 3.2.4		All	
28	3.2.4.3 Rain and extreme weather	The Lawn mower shall not operate in rain. It shall be able to withstand exposure to the elements when parked in the docking station.	see 3.2.4		All	
29	3.2.4.4 Humidity	The Lawnmower shall function temporarily in conditions of up to 100% humidity, but requires lower humidity or higher maintenance for long term storage and performance.	see 3.2.4		All	
30	3.2.4.5 Soil Moisture	The Lawn mower shall be able to operate on moist, but not wet solid, on level terrain.	see 3.2.4		All	
31	3.2.4.6 Distance from Router (WIFI connection distance)	The Lawnmower shall be able to communicate with the network at the operating site from at least 100 ft and through at least 1 wall of wood/drywall construction	see if mower responds when specified distance from WIFI router		J. Poulose	
32	3.2.4.7 Sky clearance	The Lawnmower shall be able to operate with light to medium foliage overhead	test GPS unit in mounting configuration under specified overhead cover		M. Lesser	
33	3.2.4.8 Vibration	The Lawnmower system shall operate without failure, under vibration incidental to lawn mowing for at least 6 months, when operated once weekly for 1 hour.	see 3.2.4		All	
35	**3.2.5 Failure Propagation and protocols**	No failure shall cause to mower to endanger bystanders				
36	3.2.5.1 Blade error	The lawnmower's user interface will notify the user if the blade is stuck on an obstacle. In this case the blade will shut down automatically	Simulate stuck blade and validate mower sends error message and disabled blade drive		J. Samaniego & J. Poulose	
37	3.2.5.2 Mower stuck	If the mower becomes stuck in terrain it shall power down, disabling the blade and alert the user.	simulate/force mower to become stuck and monitor response		J. Samaniego & J. Poulose	
38	3.2.5.3 Lost Wifi connection	In cases where the WIFI connection to the user device is lost the mower will continue on its planned route and return to the rest position.	disable WIFI router and monitor response		All	J. Poulose
39	3.2.5.4 Lost GPS connection	If the mower loses GPS connection it shall attempt to follow the planned route to the best ability.	disable GPS module and monitor response		M. Lesser & J. Samaniego	
40	3.2.5.5 System Failure	In cases of system failure the mower shall alert the user through the UI, disable the main blade and return to the start position, if possible	Simulate system failure, (f.e. by disconnecting sensors O.S.) and monitor response		All	
41	3.2.5.6 Critical System Failure	In Critical Failure cases, that is situations in which the MCU loses all ability to control the mower or it's subsystems the lawnmower blade will shut off.	Power down MCU during operation and monitor response		All	M. Lesser

Legend	
Not Yet Validated	
Falied	
Passed	
Revised/adjusted	