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

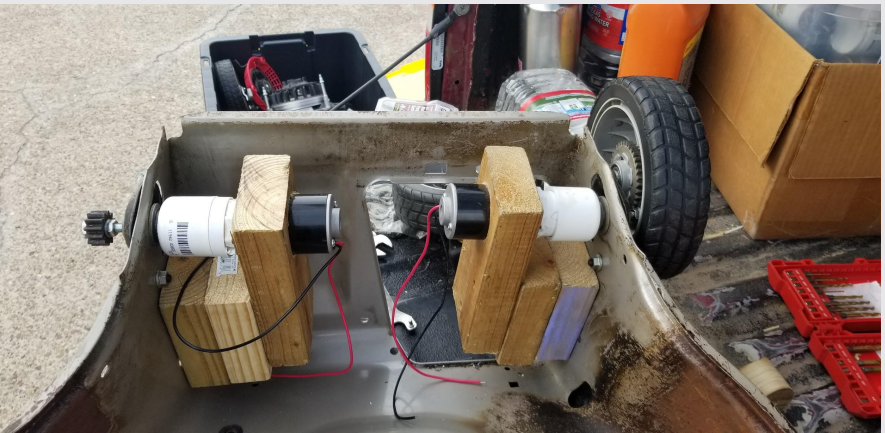
Project Summary

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

Mechanical integration

- Rear Wheels mounted
- Front Wheels mounted
- Motor and Shaft encoder assembly
  - Previous shaft encoders failed
- Replacement part arriving Thursday
  - Can modify existing assembly to fit new part



Electrical Integration

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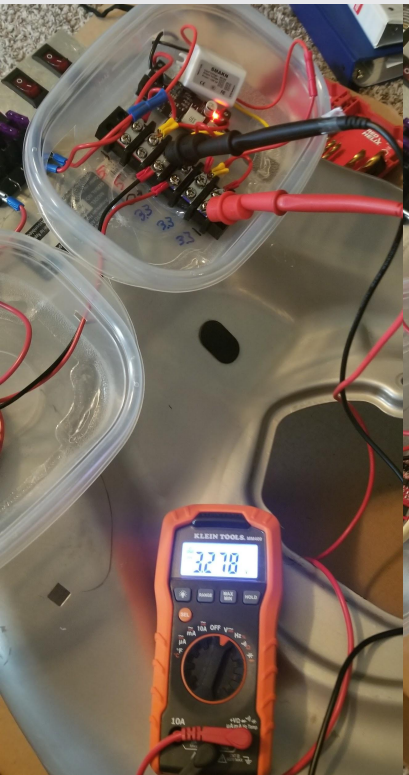
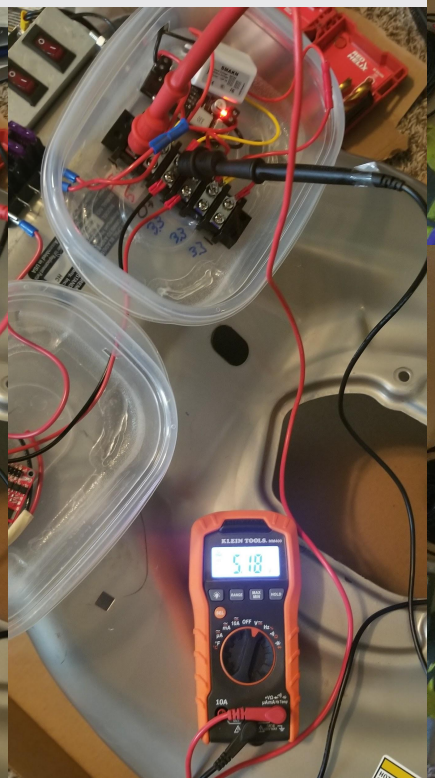
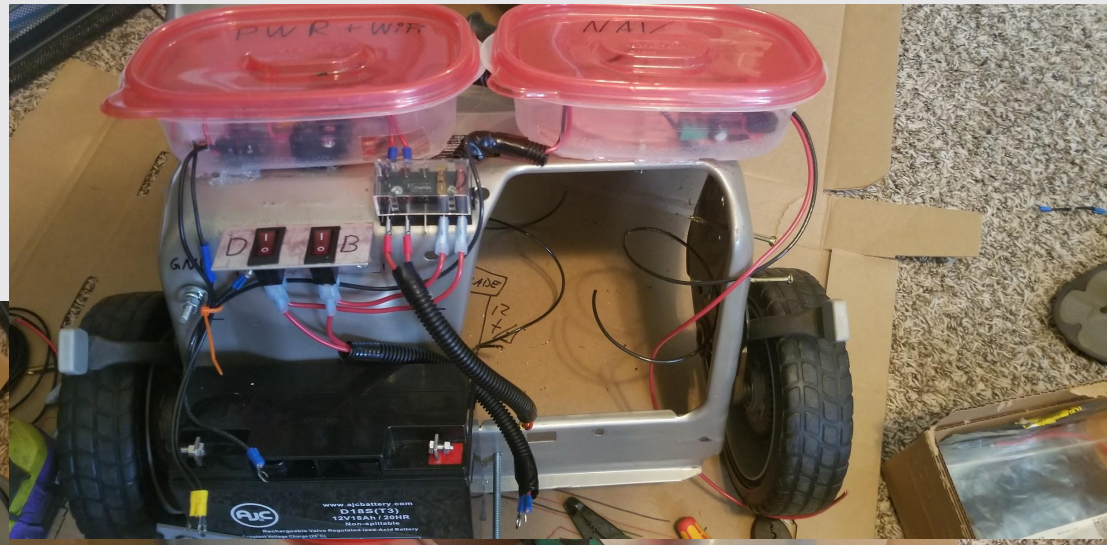
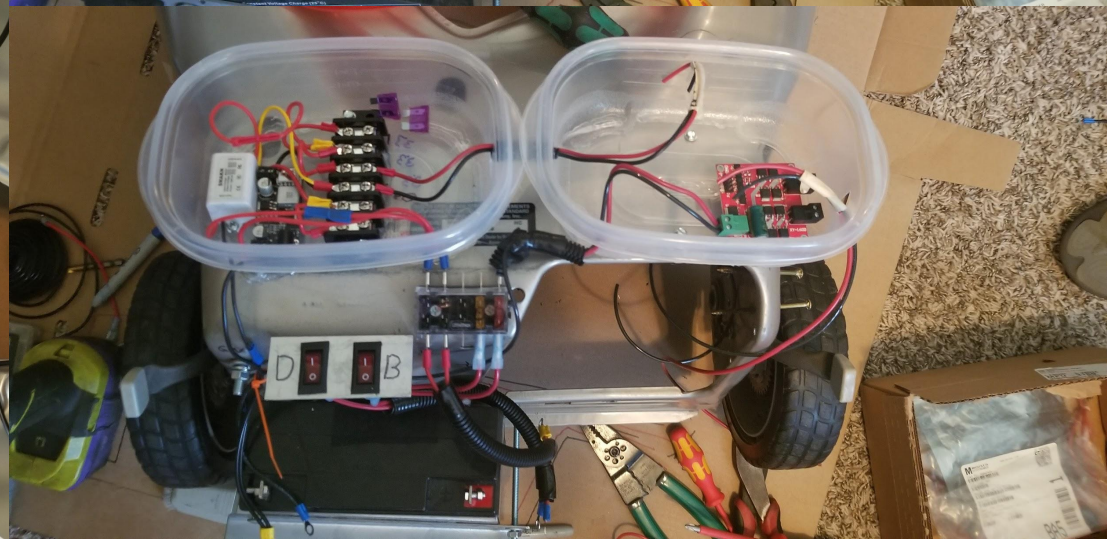
- Power Supply (12V, 5V, 3.3V) integrated
- Fuse block and distribution bar integrated
- Housing for N-MCU and W-MCU as well as Motor Driver board
- Kill Switch for Blade and drive motors
- Needs MCU mounts
- Wiring cleaned up









Blade Drive

- Reuse Drive shaft from motor
  - Is free (and here!)
  - Includes shaft bearings
  - Easy to mount to mower
- Old motor disassembled and stripped
- Still very much a problem to solve, but it's a well defined problem now.
- Have 12V relay, driven by 5V, since MCUs only output up to 3.3V we need to upconvert
  - Comparator based Relay driver driven by N-MCU

Possible Options to attach motor

- on top via Gears
  - + Torque advantage & easier to mount
  - - Need gears
- on top directly to shaft
  - + Couling likely easier to make/find than gears
  - -harder to mount & no Torque advantage
- Drive Shaft via crank bearing
  - - Complicated mechanics & need to lubricate crank bearing

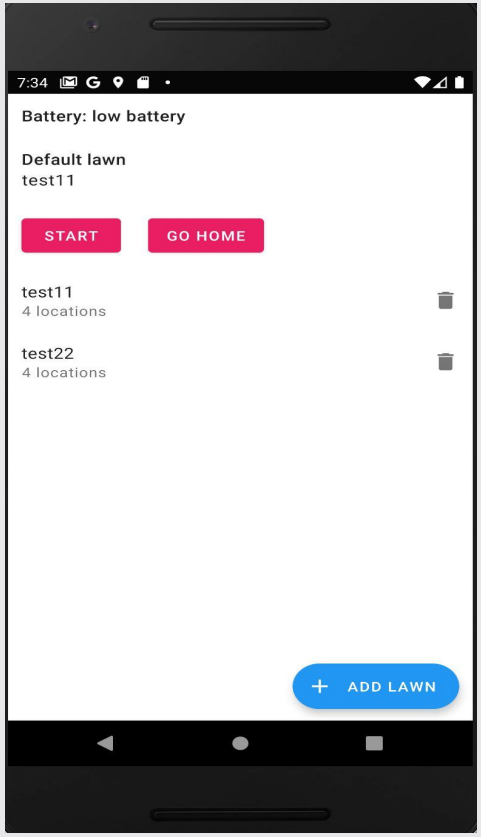
Obstacle detection

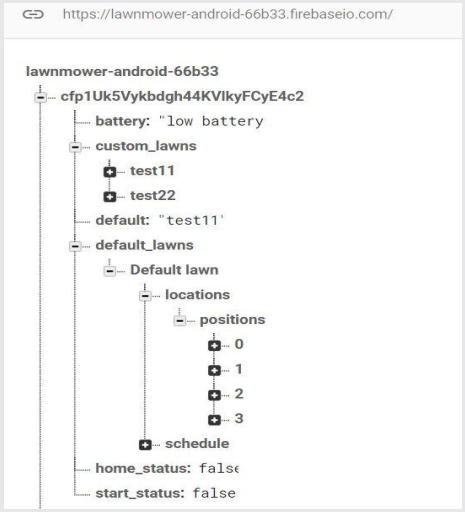
- All parts on hand
  - Mounts
  - Mounting rail
  - Sensors
  - Wire
- Starting construction while waiting for new encoders to arrive
  - Mount Laid out
  - Wiring up sensors today
  - Hope to confirm working order today
- Continue work after Navigation test this weekend

User Interface/Server Update

-Added a default lawn feature to the application

-Fixed bug that made application crash





WiFi & Navigation MCU Integration

- Integrated Server with WiFi MCU successfully
  - Communicating through WiFi
  - Server receives battery statistics from WiFi MCU & Nav MCU
  - WiFi MCU receives start_status and and coordinate information from server
- Wrote Navigation MCU .ino file to test and receive coordinates
  - Communicating through WiFi
  - Navigation MCU successfully received coordinates & start_status from WiFi MCU
- Added Navigation code to .ino file
  - Information still received from WiFi MCU
  - Running into rebooting issues

Serial Monitor Error


```
receiveData :[{"start_status":"   ","_0_latitude":" 30.621404 ","_0_longitude":" -96.334650 ","_1_latitude":" 30.622638 ","_1_longitude":" -96.335838 ","_
receiveData :[{"start_status":"   ","_0_latitude":" 30.621404 ","_0_longitude":" -96.334650 ","_1_latitude":" 30.622638 ","_1_longitude":" -96.335838 ","_


Waiting for WiFi...
WiFi connected
IP address:
192.168.4.2
30.6214
 30.621404
 -96.334650
/home/runner/work/esp32-arduino-lib-builder/esp32-arduino-lib-builder/esp-idf/components/freertos/queue.c:1442 (xQueueGenericReceive)- assert failed!
abort() was called at PC 0x40088869 on core 0

Backtrace: 0x4008c434:0x3ffcfa30 0x4008c665:0x3ffcfa50 0x40088869:0x3ffcfa70 0x400d6023:0x3ffcfab0 0x400d1a32:0x3ffcfad0 0x40088b7d:0x3ffcfb60

Rebooting...
ets Jun  8 2016 00:22:57

rst:0xc (SW_CPU_RESET),boot:0x13 (SPI_FAST_FLASH_BOOT)
configsip: 0, SPIWP:0xee
clk_drv:0x00,q_drv:0x00,d_drv:0x00,cs0_drv:0x00,hd_drv:0x00,wp_drv:0x00
mode:DIO, clock div:1
load:0x3fff0018,len:4
load:0x3fff001c,len:1044
load:0x40078000,len:8896
load:0x40080400,len:5816
entry 0x400806ac
receiveData :[{"start_status":"   ","_0_latitude":" 30.621404 ","_0_longitude":" -96.334650 ","_1_latitude":" 30.622638 ","_1_longitude":" -96.335838 ","_
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Waiting for WiFi...
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abort() was called at PC 0x40088869 on core 0

Backtrace: 0x4008c434:0x3ffcf160 0x4008c665:0x3ffcf180 0x40088869:0x3ffcf1a0 0x400d6023:0x3ffcf1e0 0x400d1a32:0x3ffcf200 0x40088b7d:0x3ffcf290

Rebooting...
ets Jun  8 2016 00:22:57
```

Navigation

- Navigation MCU is ready to integrate with mower to try a test run (needs to be mounted)
- Wifi communication has been integrated but not fully
- MCU is rebooting every time it receives Jonathans GPS coordinates
- I hard coded the GPS coordinates for now so the team can run a mower test with my current NAV code
- Once mower is functional, obstacle detection will be added

```
lat_input_deg[0] = 30.62355;
lon_input_deg[0] = -96.33255;
lat_input_deg[1] = 30.62371;
lon_input_deg[1] = -96.33255;
lat_input_deg[2] = 30.62371;
lon_input_deg[2] = -96.33224;
lat_input_deg[3] = 30.62355;
lon_input_deg[3] = -96.33225;
```

Docking Station Update

Electrical components contained in a box

Still need to determine direct docking mechanism

Schedule for the Semester

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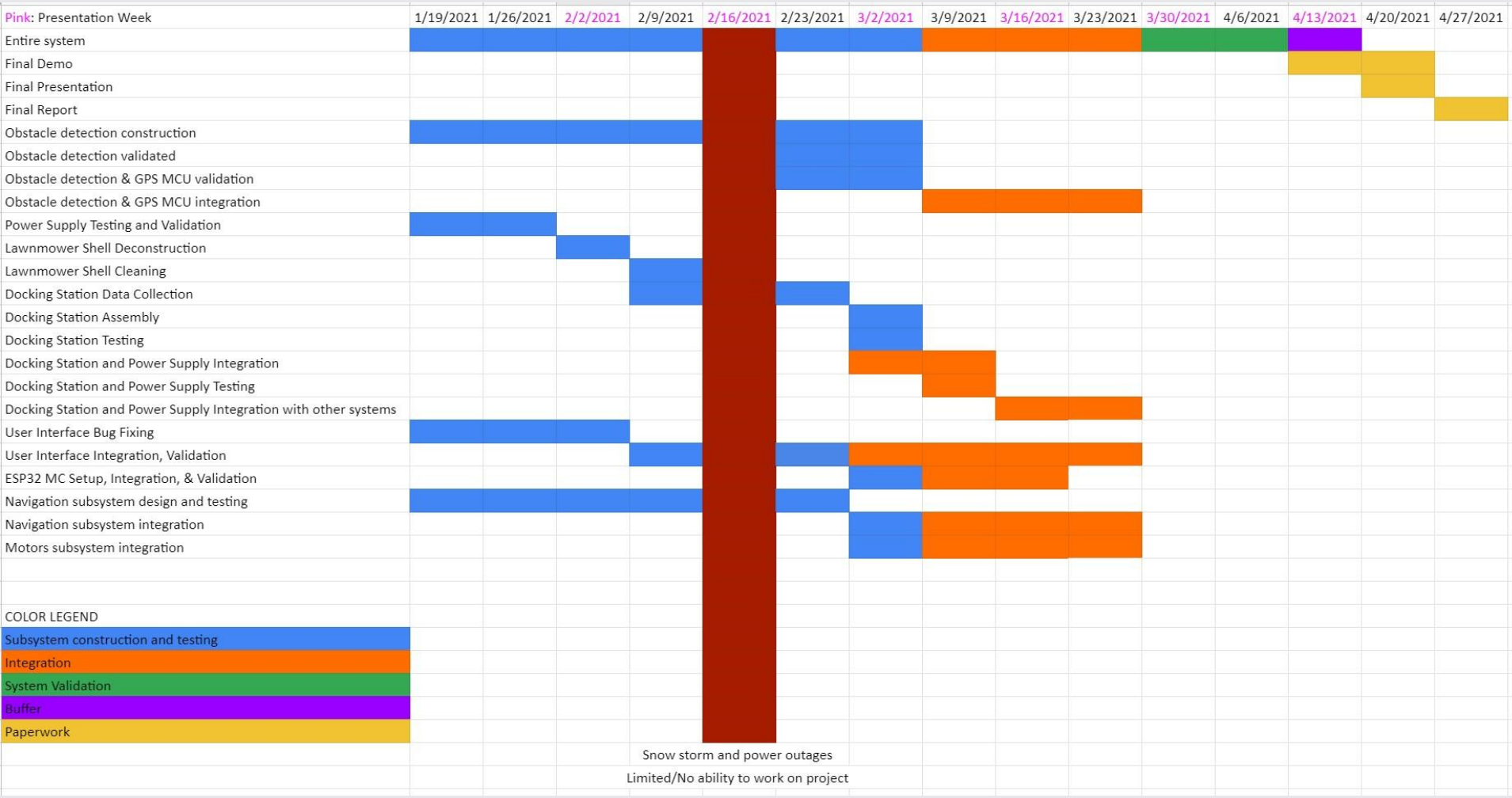

Validation Plan

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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
3.2.1 Functional/Performance requirements	Performance requirements for the compelates system				
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	
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	
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	
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	
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	
3.2.2 Physical characteristics	Physical Requirements on the completed system				
3.2.2.1 Mass	The mowing unit shall not exceed a maximum weight of 70lbs	Weigh final system		All	
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	
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	
3.2.3 Electrical Characteristics	Definitions of expected external inputs and outputs				
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	
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	
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	
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	
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	
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
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	
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	
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			
3.2.4.1 Thermal	The Lawnmower shall operate in temperatures ranging from 40°F to 120°F.	see 3.2.4		All	
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	
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	
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	
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	
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	
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	
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	
3.2.5 Failure Propagation and protocols	No failure shall cause to mower to endanger bystanders				
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	
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	
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	
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	
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	
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	

Legend
Not Yet Validated
Falied
Passed
Revised/adjusted