



# Autonomous Lawnmower

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*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



## Problems (looking towards interfacing):

- Front Mower wheels 0-degree turn
- Rear Mower wheels
  - Geared connection/transmission
  - Solid axle
- Blade drive attachment
  - How to mount blade motor
- MCU interface
- US sensors have issues detecting object with fabric
  - Readings for objects covered in fabric (f.e. person wearing sweatshirt) extremely inaccurate and unreliable

## Solutions:

- Caster wheels in the front
  - Allows 0-degree turn
- Several Options for rear
  - Cut axel in 2 parts and mount motors to that, adjust for gearing ratio in code
  - Manufacture shaft and mount directly to wheels and motors for 1:1 ratio. (Need to ensure sufficient torque, but ratio stays the same, possibly easier motor mounting because the old shaft won't be in the way)
- Several Options for Blade also
  - Disassemble motor and reuse its driveshaft
  - Manufacture our own driveshaft
- MCU interface
  - Need to finalize format
- Person detection
  - Include Bump/contact sensor in front
  - More extensive tests with full array, may be possible to determine fabric with multiple sensors.



# MCU Subsystem (Obstacle detection)



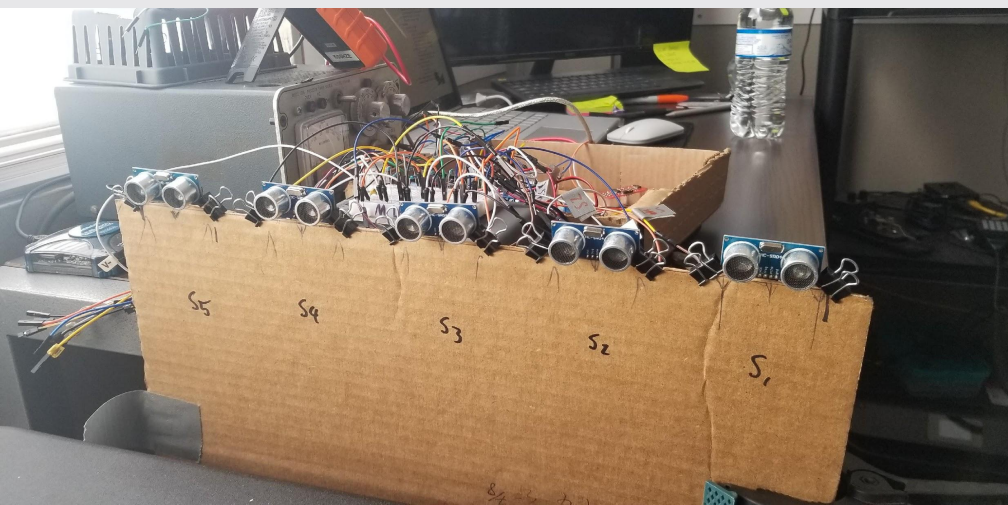
**Object: Cardboard Box (11.4x13.4x31.75) cm (WxDxH)  
presenting 11.4x31.75cm side**

- Test 1: approx. 70deg @ 40.6cm (resolved by 2 sensors)

<input checked="" type="checkbox"/>		distance1	float	...	0x8007FF60	...	289.93024
<input checked="" type="checkbox"/>		distance2	float	...	0x8007FF64	...	129.46112
<input checked="" type="checkbox"/>		distance3	float	...	0x8007FF68	...	18.224
<input checked="" type="checkbox"/>		distance4	float	...	0x8007FF6C	...	41.33312
<input checked="" type="checkbox"/>		distance5	float	...	0x8007FF70	...	38.4608
<input checked="" type="checkbox"/>		angleNormal	float	...	0x8007FD64	...	54.951046
<input checked="" type="checkbox"/>		Dist	float	...	0x8007FD60	...	37.373196

- Test 2: Directly in front of Array @ 42.5cm (resolved by all sensors)

<input checked="" type="checkbox"/>		angleNormal	float	...	0x8007FD64	...	-90.01698
<input checked="" type="checkbox"/>		Dist	float	...	0x8007FD60	...	40.059673



## Status and Plans

- **Right Now**

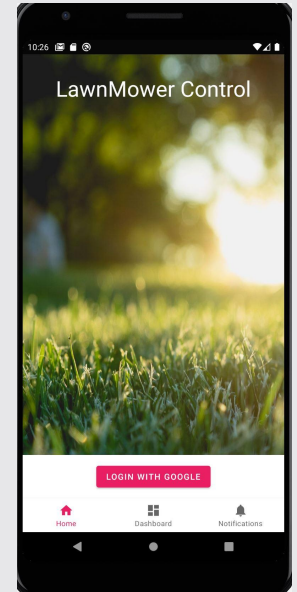
- Obstacle detection implemented on target platform
- Mock-up sensor array tested with Pic
- Construction plans for final assembly (unable to build due to weather)
- Side facing detection implemented on pic

- **Upcoming**

- Build Array module
- Refine thresholds
  - Can't fully test and refine until we have final assembly to ensure correct sensor layout
  - Real obstacles vs ideal obstacles (can't predict what part of obstacle reflects US signal)
- Side Facing obstacle detection function
  - Need power to test
  - Need assemble side array to fully implement (need dimensions)
- Clean Up & Interface PIC
  - Remove excess code
  - Time operations
  - Share data with Nav MCU

- **GOAL: Begin integration end of next week**

- Bugs all fixed
- Scheduling times
- Start & “Go home to docking station” successfully implemented through the firebase server
- Ready to receive statistics



- Using ESP32 DEVKIT V1
- Ran WiFiScan program
  - Set up as STA mode
- Ran WiFiAccessPoint Program
  - Set up as soft access point mode
- Started to write the code to be able to communicate with other ESP32

```
WiFiScan
#include "WiFi.h"

void setup()
{
  Serial.begin(115200);

  // Set WiFi to station mode and disconnect from an AP if it was previously connected
  WiFi.mode(WIFI_STA);
  WiFi.disconnect();
  delay(100);

  Serial.println("Setup done");
}

void loop()
{
  Serial.println("scan start");

  // WiFi.scanNetworks will return the number of networks found
  int n = WiFi.scanNetworks();
  Serial.println("scan done");
  if (n == 0) {
    Serial.println("no networks found");
  } else {
    Serial.print(n);
    Serial.println(" networks found");
    for (int i = 0; i < n; ++i) {
      // Print SSID and RSSI for each network found
      Serial.print(i + 1);
      Serial.print(": ");
      Serial.print(WiFi.SSID(i));
      Serial.print(" ");
      Serial.print(WiFi.RSSI(i));
      Serial.print(" ");
      Serial.print(WiFi.encryptionType(i) == WIFI_AUTH_OPEN ? " " : "");
      delay(10);
    }
  }
}
```

```
WiFiAccessPoint
#include <WiFi.h>
#include <WiFiClient.h>
#include <WiFiAP.h>

#define LED_BUILTIN 2 // Set the GPIO pin where you connected your test LED or comment this line out if your dev board has a built-in LED

// Set these to your desired credentials.
const char *ssid = "Tadpole";
const char *password = "214797902";

WiFiServer server(80);

void setup() {
  pinMode(LED_BUILTIN, OUTPUT);

  Serial.begin(115200);
  Serial.println();
  Serial.println("Configuring access point...");

  // You can remove the password parameter if you want the AP to be open.
  WiFi.softAP(ssid, password);
  IPAddress myIP = WiFi.softAPIP();
  Serial.print("IP address: ");
  Serial.println(myIP);
  server.begin();

  Serial.println("Server started");
}

void loop() {
  WiFiClient client = server.available(); // listen for incoming clients

  if (!client) {
    Serial.println("New Client."); // if you get a client,
    // print a message out the serial port
  }
}
```

Motors subsystem ready to integrate





- Transferred MATLAB simulation code to C
- Successfully created 32 file project to run on the MCU
- Working on inserting the code for it to work with real time signals from shaft encoders, PWM, and motors
- Should be ready to integrate on time in reference to our schedule
- Code on next slide





```
22 #include <stddef.h>
23
24 #include <stdlib.h>
25
26 #include "rtwtypes.h"
27
28 #include "mower_sim_types.h"
29
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31
32
33 /* Function Declarations */
34
35 extern void mower_sim(double mower_width, double D0, double MAX_LEGS, double
36
37     leg_number, double r_e, double dt, double wheel_diam,
38
39     double Cw, double shaft_encoder_levels, double
40
41     shaft_encoder_steps, double v_mow_normal_mph, double
42
43     v_mow_turn_mph, double mph_to_mps, double mps_to_rpm,
44
45     double rpm_to_mps, double deg_to_rad, double rad_to_deg,
46
47     const unsigned char a[524547], double lat_start_deg,
48
49     double lon_start_deg, double heading_deg[10000], double
50
51     L_rpm_desired[10000], double R_rpm_desired[10000],
52
53     double L_rpm_actual[10000], double R_rpm_actual[10000],
54
55     double v_left_actual_mps[10000], double
56
57     v_right_actual_mps[10000], double L_wheel_exact_deg,
58
59     double R_wheel_exact_deg, const double t[10000], double
60
61     next_heading_deg, const double L_shaft_enc[10000], const
62
63     double R_shaft_enc[10000], const double x[10000], const
64
65     double y[10000], double d[10000], const double lat_deg
66
67     [10000], const double lon_deg[10000], double frame_num);
68
```

mower\_sim.h (main function and  
variable initializations)

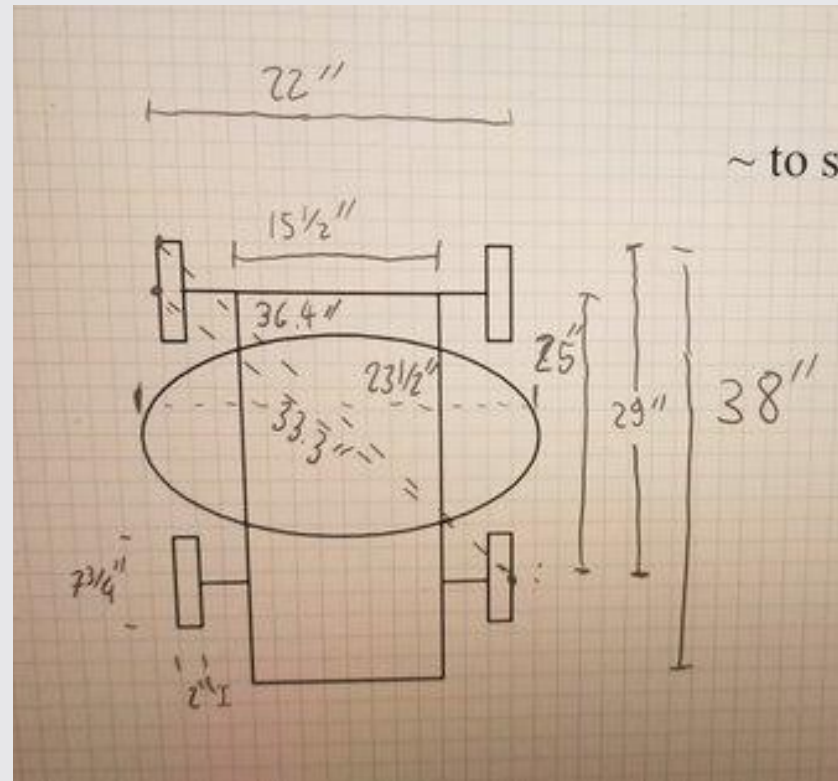
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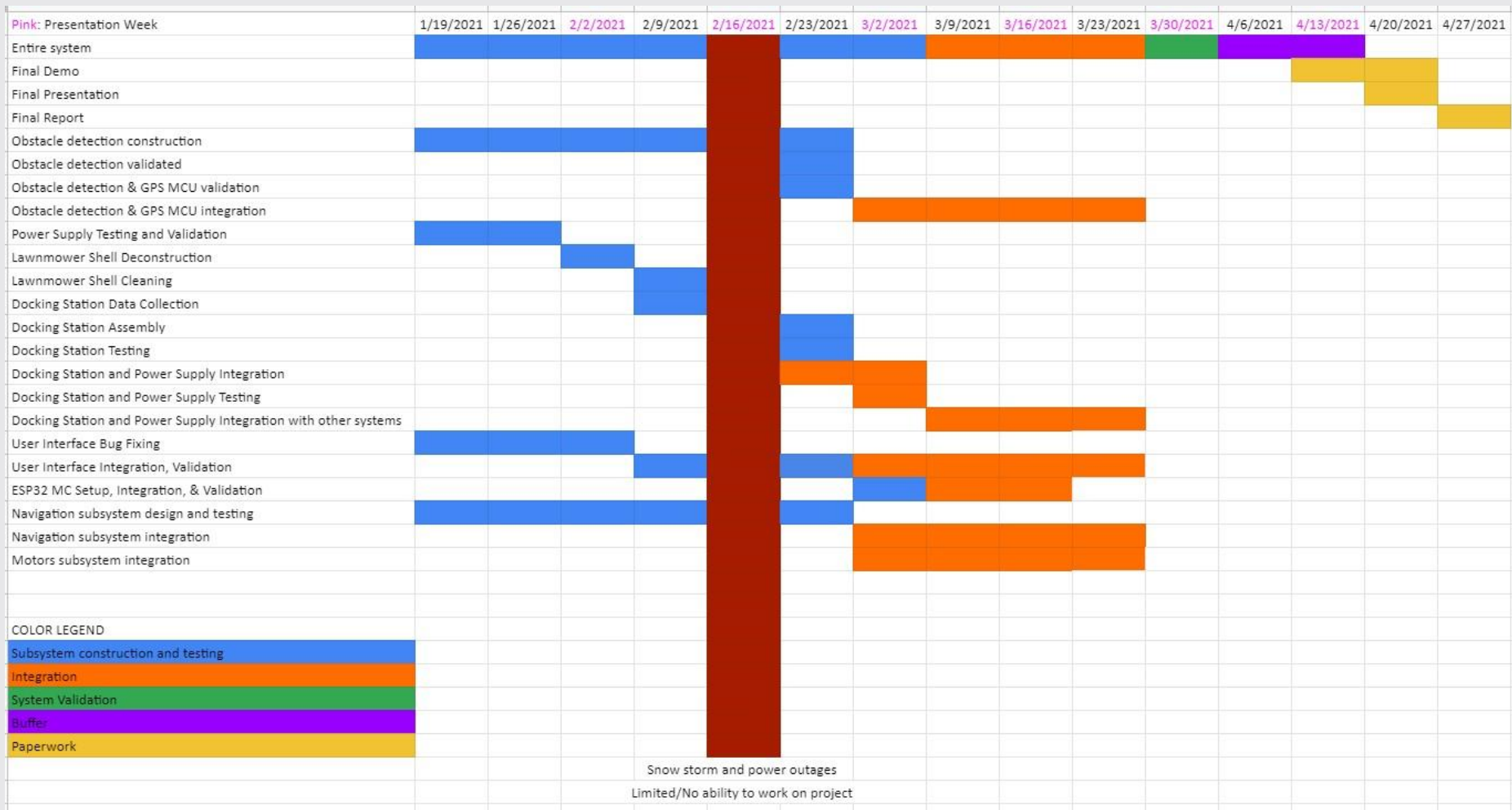
# Docking Station Update



Approximately to scale,  
each square represents 2  
inches by 2 inches

- Lawnmower has been disassembled and cleaned
  - Need to figure out when it can be brought to the FEDC
- Next step is to assemble the docking station







[illegible]



Attached here is the link to the video of our presentation:

<https://youtu.be/IHkTR2UbbH4>

