Institute of Electrical and Electronics Engineers Stony Brook Chapter

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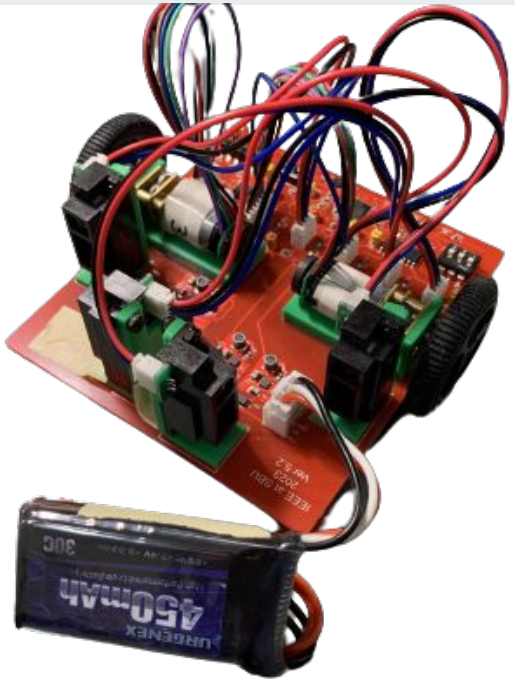
Hardware Key Details

- 2S 30C 7.4V LiPo Battery
  - Switching regulators
- AT32UC3L0256
  - 50MHz max speed
  - Ultra-low power consumption, 165µA/MHz
- Sharp Sensors
  - 2cm to 15cm
  - Linear output over the sensor's usable range
- IMU, LSM6DSV16X
  - 3-axis digital accelerometer and 3-axis digital gyroscope



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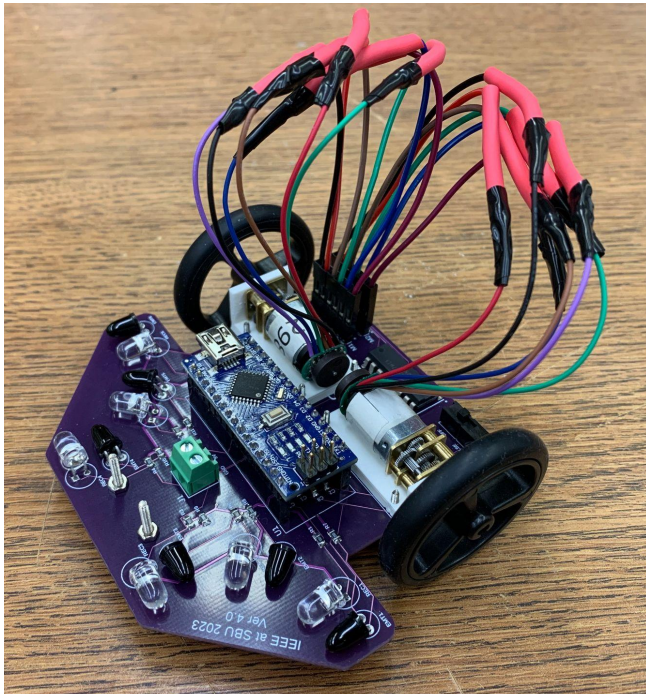
Old versus New

- Current Revision: V 5.2
- Changes Made:
  - All components are surface mount devices
  - Sharp IR Sensors
  - 3D Printed Castor Wheel
  - JTAG Connector can now reset
  - Added test points
- Previous (Winning) Revision: V 4.0
  - Microcontroller: Arduino nano
  - Bare IR Sensors
  - All components are through hole technology devices



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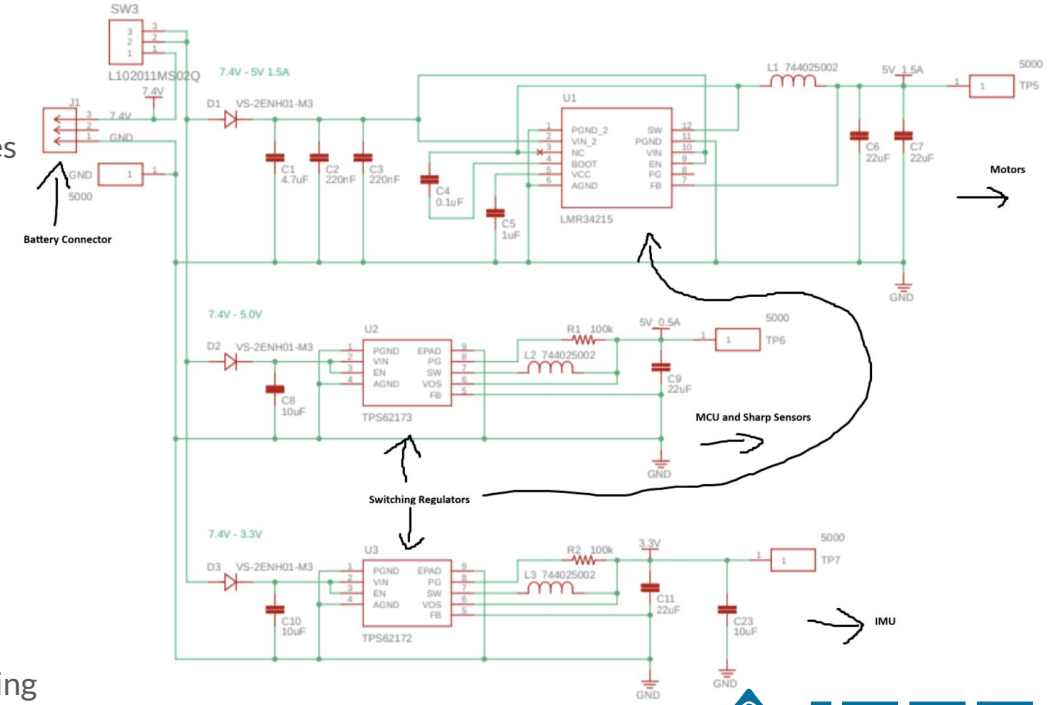
Power

- Three switching regulators the buck down the voltages
  - 7.4V -> 3.3V, 500mA
  - 7.4V -> 5V, 500mA
  - 7.4V -> 5V, 1.5A
- LiPo Battery
  - Lighter than a NiMH battery and maintain the voltage longer as it depletes
  - 30C means it can run for 3 minutes while drawing 13.5 Amps



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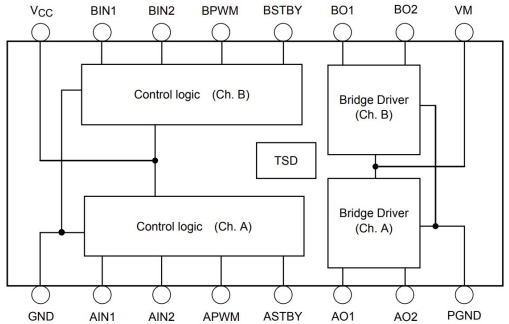
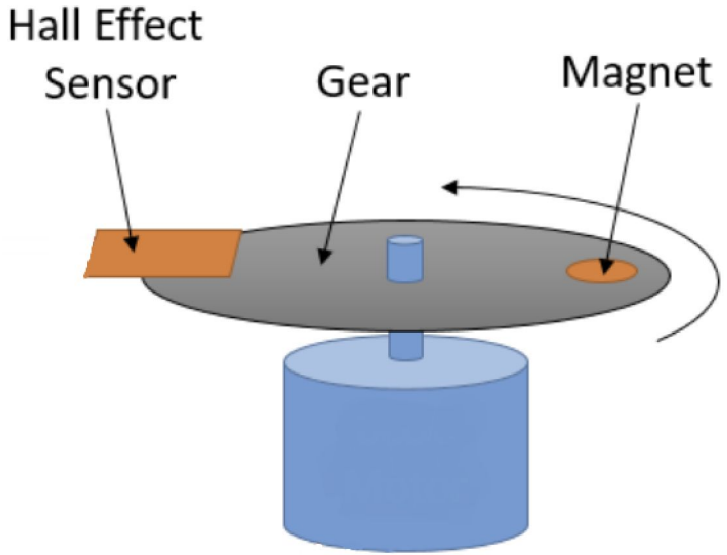
Motors

- Two wheel drive
  - Motors with encoders, relative using hall sensors
  - 900 rpm, 359.72 events per revolution
- Motor Controller
  - Used an Dual-bridge driver to control the motors
  - Built-in thermal shutdown circuit





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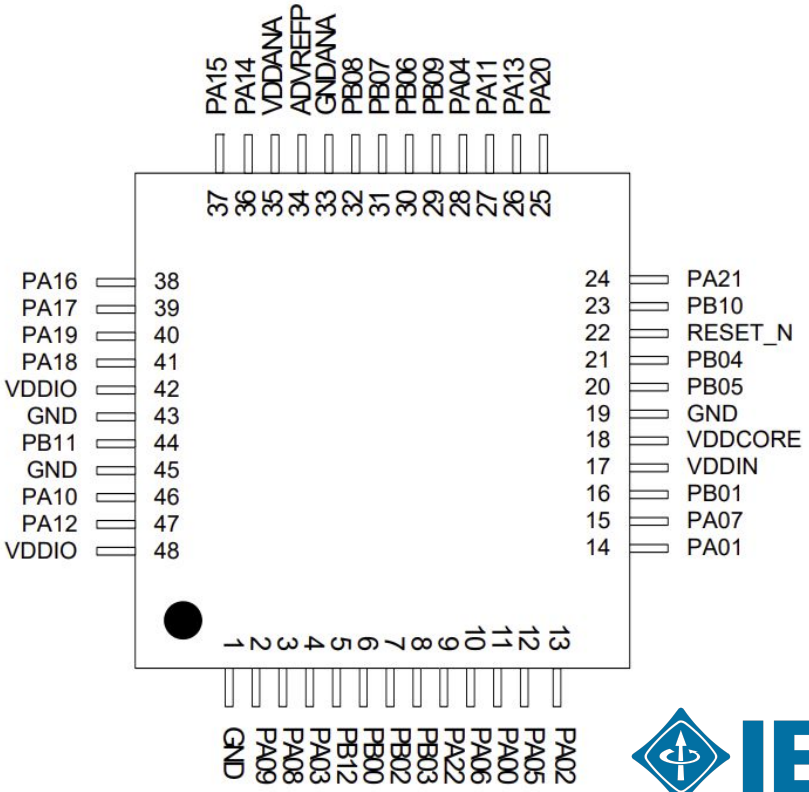
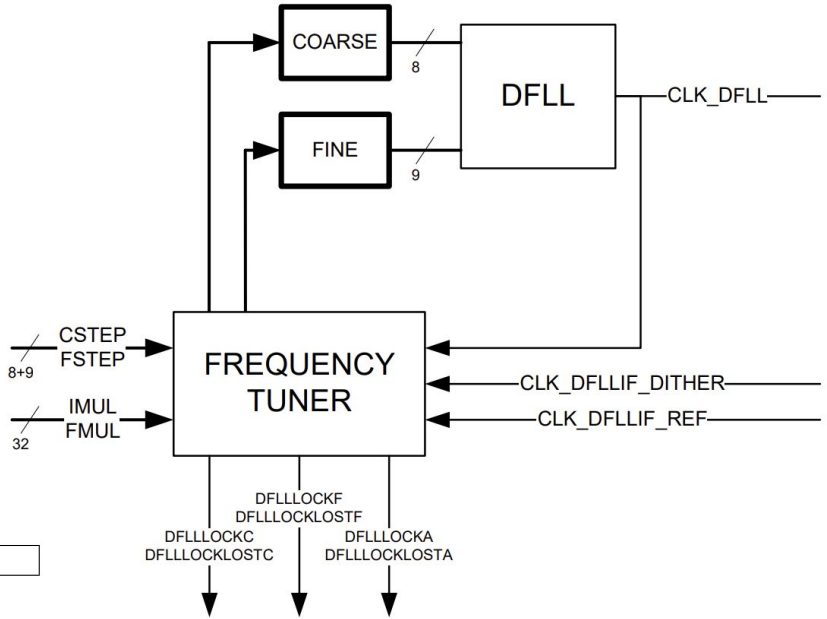
Microcontroller

- PWM
  - 36 PWM channels
    - Two PWM channels are used
- ADC
  - 8-channel 12-bit
    - 4-channels 10 bits are used
- JTAG
  - Programmable via JTAG and aWire
- Interrupts
  - 6 External Interrupts
    - 2 External Interrupts are used



Microcontroller DFLL

- Digital Frequency-locked Loop
  - Control system that synchronizes the output frequency with a reference signal;
  - Digitally manipulating the phase and frequency
- Our microcontroller will run at 35MHz



31	30	29	28	27	26	25	24
COARSE[7:0]							

23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	FINE[8]

15	14	13	12	11	10	9	8
FINE[7:0]							

7	6	5	4	3	2	1	0
-	QLEN	CCEN	-	LLAW	DITHER	MODE	EN

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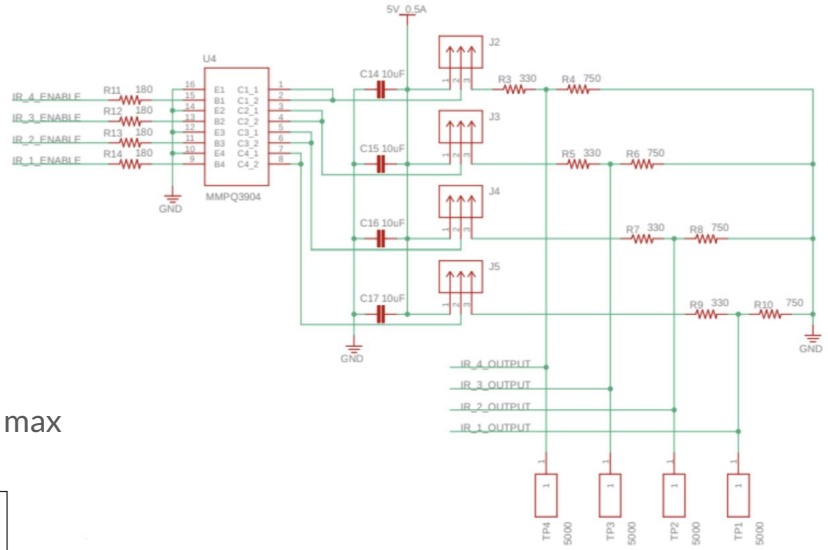
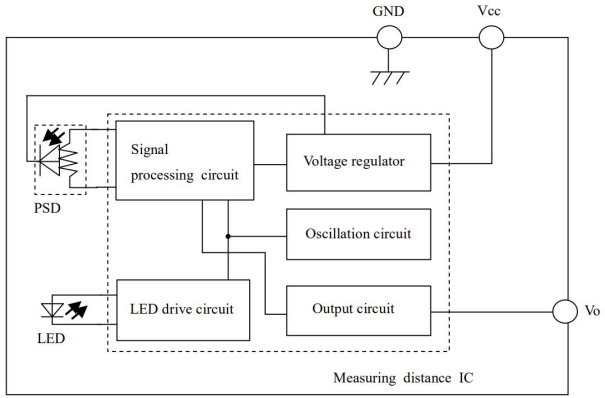
Sharp Sensors

- Voltage Outputs
  - Minimum Voltage Output of .55V
  - Maximum Voltage Output of 2.5V
  - ADC max value is 1.98V
    - Voltage Divider can drop it down to 1.736V max





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Inertial Measurement Unit

- Triple-channel architecture
- Sensor fusion low power
- SPI serial interface with main processor data synchronization

Figure 18. **Block diagram of filters**

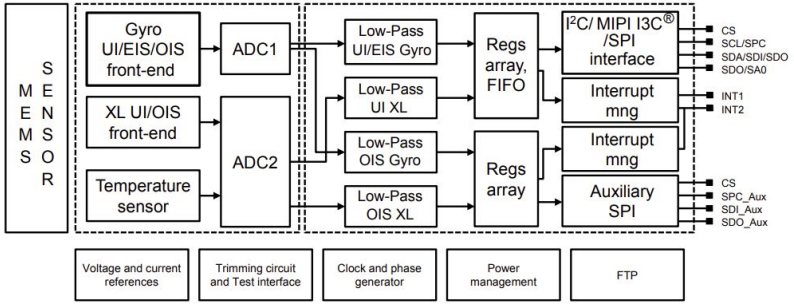
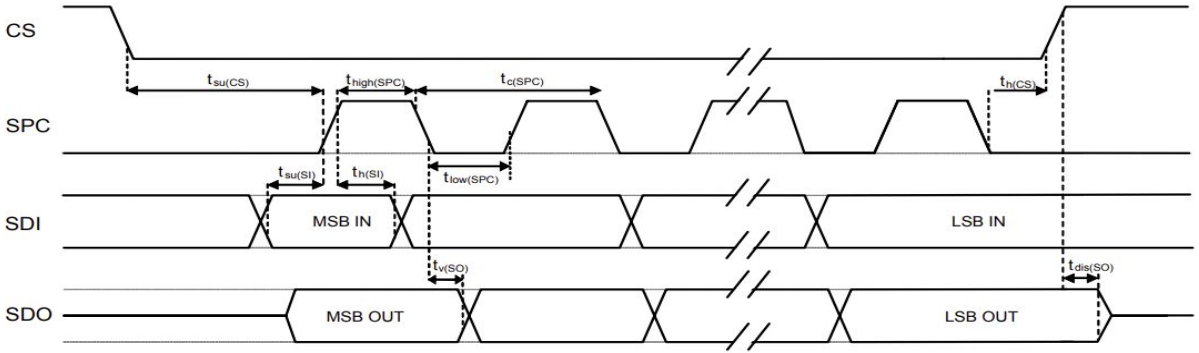


Figure 7. **SPI slave timing in mode 0**



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Embedded C PWM

- 30:1 Ratio, 900 RPM brushed motor controlled with MCU PWM
- Integrated PWM circuit on AT32UC3L0256 (PWMA)
    - Set Control Register (CR) to activate
- 2 motors - 2 PWMs
    - Set IMDUTY register to control Pulse Width
    - IMDUTY is continuously updated to match PID loop

23.7 User Interface

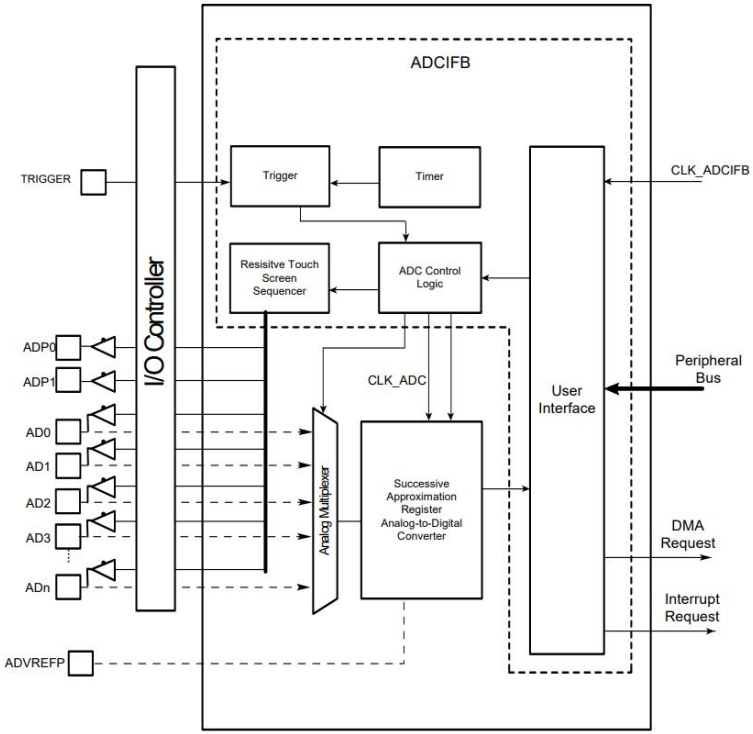
Table 23-3. PWMA Register Memory Map

Offset	Register	Register Name	Access	Reset
0x00	Control Register	CR	Read/Write	0x00000000
0x04	Interlinked Single Value Duty Register	ISDUTY	Write-only	0x00000000
0x08	Interlinked Multiple Value Duty Register	IMDUTY	Write-only	0x00000000
0x0C	Interlinked Multiple Value Channel Select	IMCHSEL	Write-only	0x00000000
0x10	Interrupt Enable Register	IER	Write-only	0x00000000
0x14	Interrupt Disable Register	IDR	Write-only	0x00000000
0x18	Interrupt Mask Register	IMR	Read-only	0x00000000
0x1C	Status Register	SR	Read-only	0x00000000
0x20	Status Clear Register	SCR	Write-only	0x00000000
0x24	Parameter Register	PARAMETER	Read-only	- (1)
0x28	Version Register	VERSION	Read-only	- (1)
0x2C	Top Value Register	TVR	Read/Write	0x00000000
0x30+m*0x10	Interlinked Single Value Channel Set m	ISCHSETm	Write-only	0x00000000
0x34+m*0x10	Channel Event Response Register m	CHERRm	Read/Write	0x00000000
0x38+m*0x10	Channel Event Enable Register m	CHEERm	Read/Write	0x00000000
0x3C+k*0x10	CWG Register	CWGk	Read/Write	0x00000000

Note: 1. The reset values are device specific. Please refer to the Module Configuration section at the end of this chapter.

Embedded C ADC

Figure 26-1. ADCIFB Block Diagram



- The ADC interprets data from the Sharp IR Sensors
  - The IR sensors take turns to output
  - When enabled, voltage (And therefore distance) is measured off the walls
  - Register to call: **adcifb**

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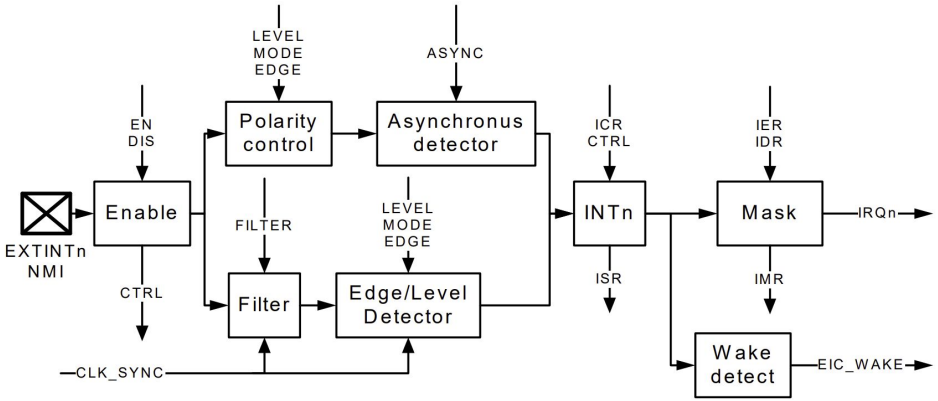
Embedded C Interrupts

- External Interrupts Controller(EIC)
- Used for the motors encoders
- Setup required to config the external interrupt
- Interrupt Service Routine(ISR) is used to see what interrupts got flagged and update internal variables

Table 16-2. EIC Register Memory Map

Offset	Register	Register Name	Access	Reset
0x000	Interrupt Enable Register	IER	Write-only	0x00000000
0x004	Interrupt Disable Register	IDR	Write-only	0x00000000
0x008	Interrupt Mask Register	IMR	Read-only	0x00000000
0x00C	Interrupt Status Register	ISR	Read-only	0x00000000
0x010	Interrupt Clear Register	ICR	Write-only	0x00000000
0x014	Mode Register	MODE	Read/Write	0x00000000
0x018	Edge Register	EDGE	Read/Write	0x00000000
0x01C	Level Register	LEVEL	Read/Write	0x00000000
0x020	Filter Register	FILTER	Read/Write	0x00000000
0x024	Test Register	TEST	Read/Write	0x00000000
0x028	Asynchronous Register	ASYNC	Read/Write	0x00000000
0x030	Enable Register	EN	Write-only	0x00000000
0x034	Disable Register	DIS	Write-only	0x00000000
0x038	Control Register	CTRL	Read-only	0x00000000
0x3FC	Version Register	VERSION	Read-only	- (1)



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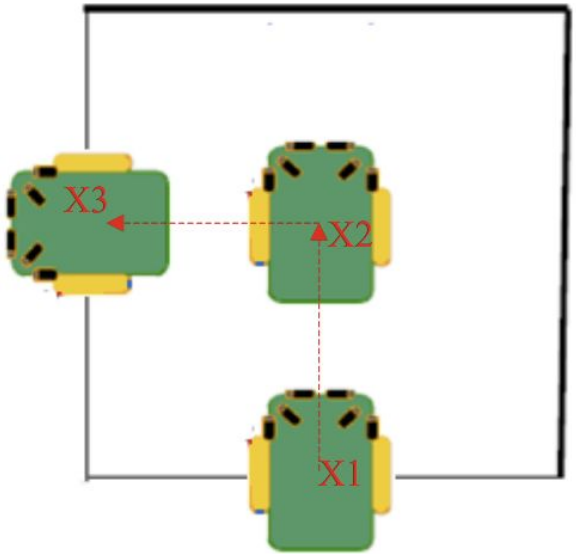
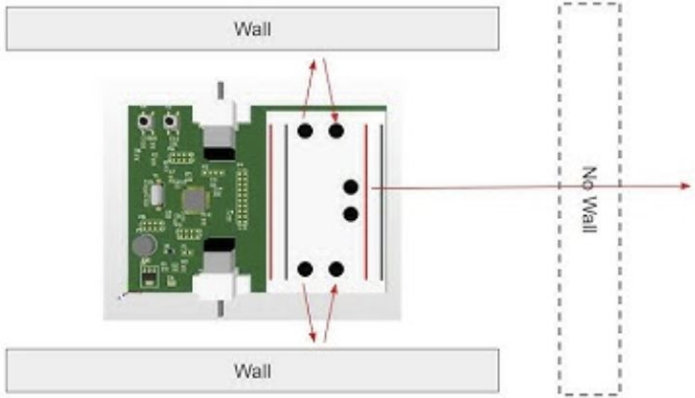
Sensor Algorithm

- The mouse moves one grid square at a time, using the encoders values and a PID control loop
- The mouse automatically adjusts to be in the middle of the grid
- At each turn is adjusts before moving 90 degrees for a turn





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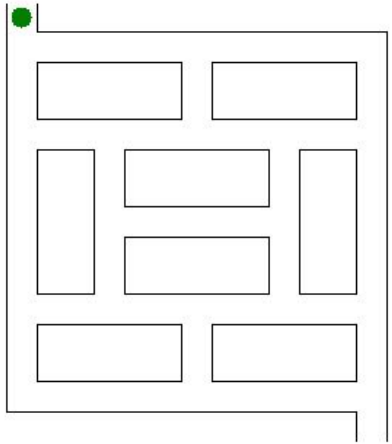
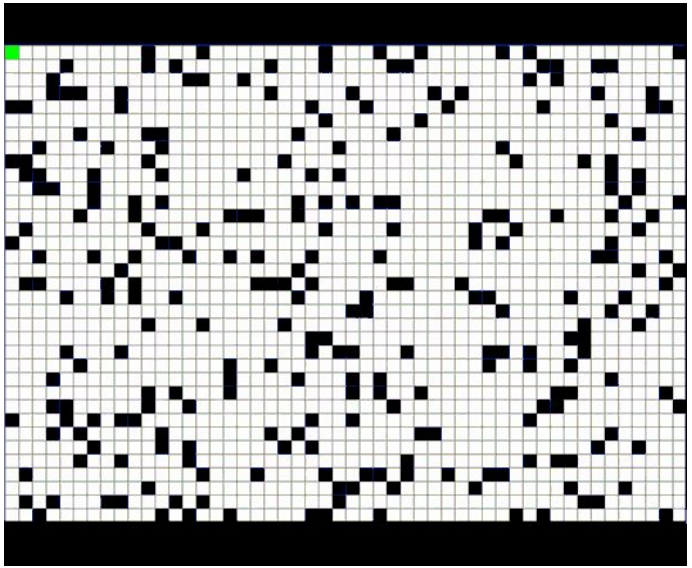
Tremaux Algorithm

- Maze traversal
- Whenever you pass through an entrance of a passage, whether it is to enter or exit a junction, leave a mark at the entrance as you pass.
- When at a junction:
    - If only the entrance you just came from is marked, pick an arbitrary unmarked entrance, if any
    - Pick the entrance you just came from, unless it is marked twice
    - Pick any entrance with the fewest marks



A* Algorithm

- Informed search algorithm
  - Formulated in terms of weighted graphs
- f(n) = g(n) + h(n)
  - n is the next node
  - g(n) is the cost of path from the start node to n
  - h(n) is a heuristic function that estimates the cost of the cheapest path from n to the goal
- Priority queue, each node with the lowest value removed from the queue



Questions?