Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

ECEN 403 Final Presentation
Project Name: WIZARD-Team 72

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Sponsor: Dr. Markus Zink

German Team: Leon Jaksch, Michael Dachender, Lisa Krug

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Problem Statement

- Organic farming practices face significant challenges in controlling weeds within crop fields and need an ecological method of eliminating weeds with minimal time investment and labor use.

Solution Proposal

- Develop an autonomous robot system equipped with machine learning camera recognition and a targeted high voltage impulse zapper to effectively identify and eliminate weeds.

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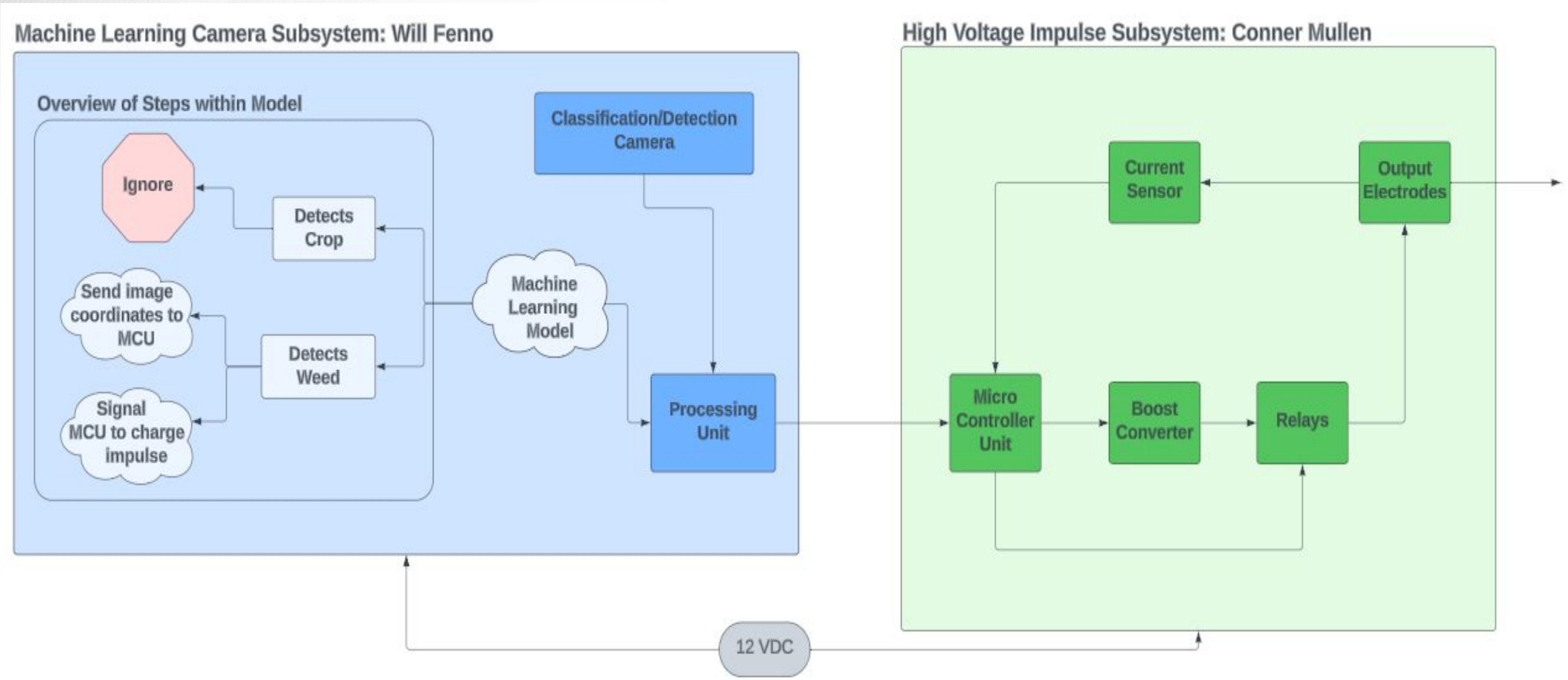
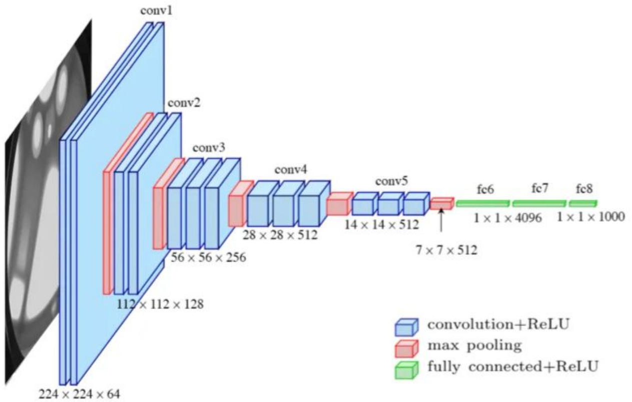
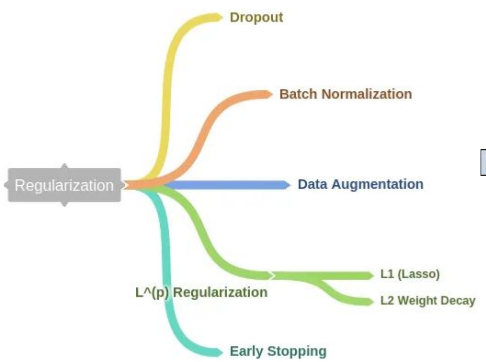
Diagram of Subsystems & Interface

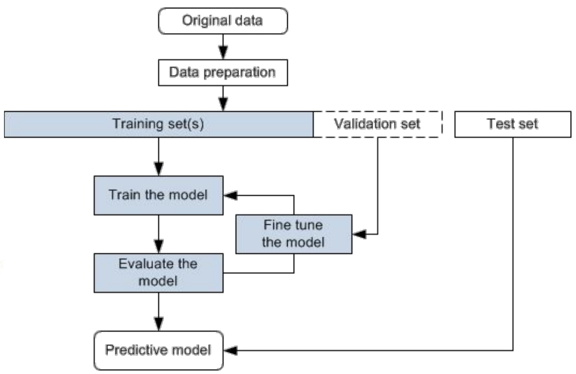


ML Computer Vision Accomplishments

- Created an augmented dataset of ~8,000 images and labels.
- Split data into Training, Testing, and Validation sets.
- Built the machine learning model with a modified VGG16 architecture.
- Applied regularization techniques and set hyperparameters.

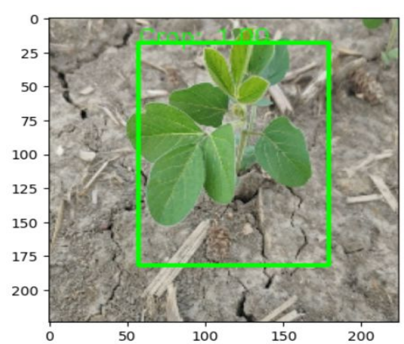


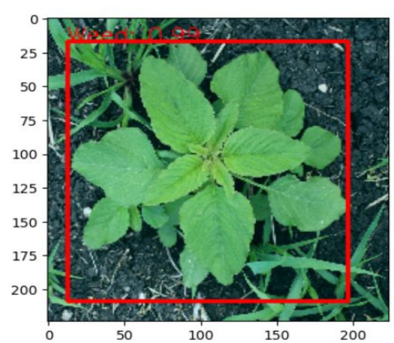


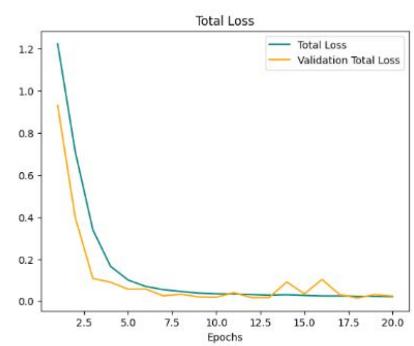


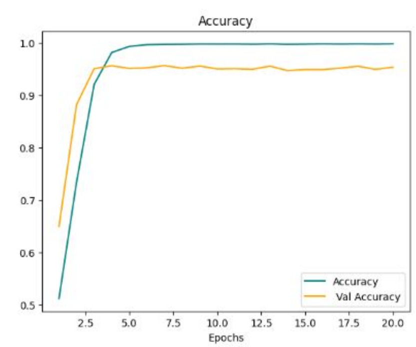
ML Computer Vision Accomplishments

- Selected best performing model configuration through iterative testing.
- Conducted classification and regression predictions on test images.
- Beginning real time detection tests with current model.









Remaining Tasks for ML Subsystem

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- Continue editing hyperparameters and model structure to achieve maximum accuracy and minimal losses.
- Conduct real time detection testing.

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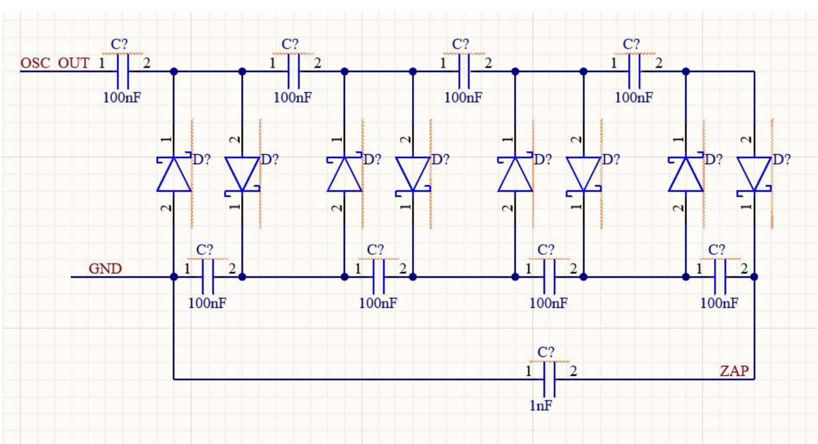
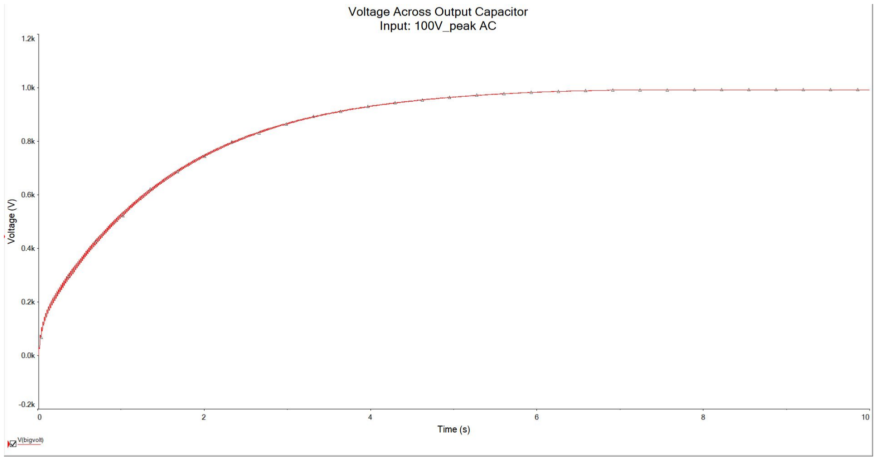
- Transfer the machine learning model and augmented dataset to the processing unit during system integration.
- Implement code to trigger the impulse charge and send coordinates upon confident weed detection over a set amount of time.
- Develop Built-In Test (BIT) in the case of camera error or failure.

High Voltage Accomplishments

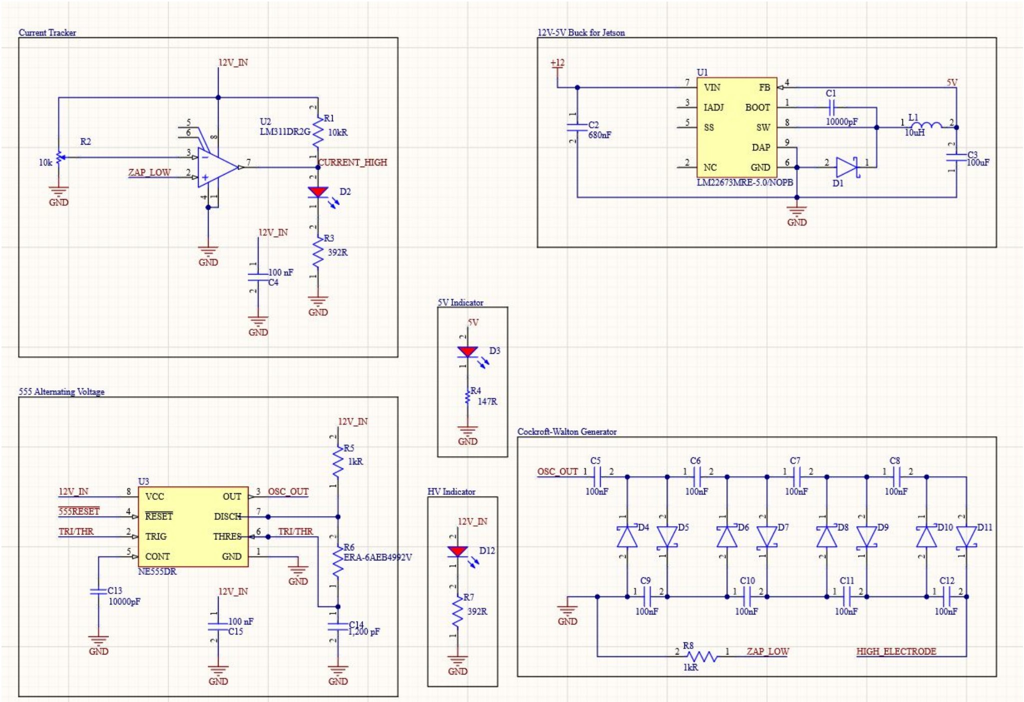
- Performed preliminary research on electrical weed control.
- Selected and simulated Cockroft-Walton Generator.
- Identified I^2C as communication between subsystems and prepared Arduino to send proper signals for validation.
- Designed high current sensor using comparator.

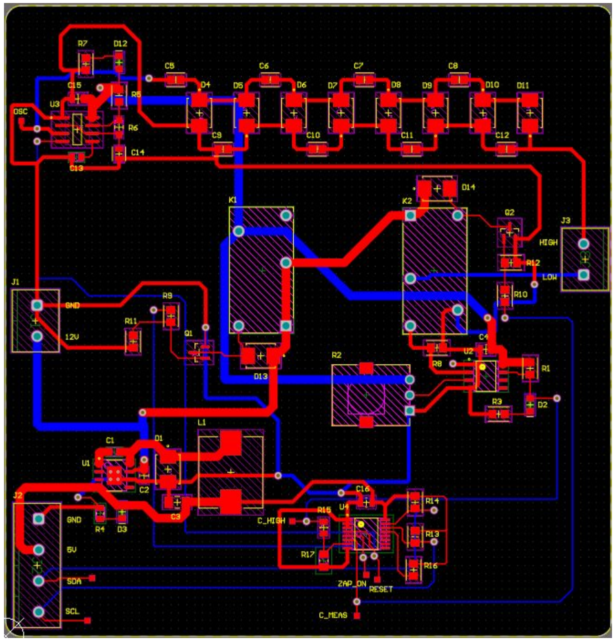




High Voltage Accomplishments

- PCB schematic, layout, and routing.
- Assembly is in progress.





Remaining Tasks for High Voltage Subsystem

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- Finish assembly and perform validation.

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- Coordinate with German students' research to determine exact parameters of high voltage impulse and electrodes.

- Design and produce casing for electronics.

- Update schematics to reach actual high voltage and make final PCB(s).

Execution Plan Status

WIZARD Project Schedule

Deliverable/Task	AUG		SEP				OCT					NOV				DEC
	8/20	8/27	9/3	9/10	9/17	9/24	10/1	10/8	10/15	10/22	10/29	11/5	11/12	11/19	11/26	12/3
Project Assigned 08/20																
Meet With Sponsor, German Team																
Preliminary Research																
Assign Subsystems																
Power Conversion Research																
Software Installation & Virtual Environment Setup																
Identify Species of Both Crop and Weed																
Create Image Dataset for Crops / Weeds																
ConOps First Draft, Send to Sponsor																
ConOps Revisions																
ConOps Report Due 09/15																
High Voltage Schematics and Simulations																
Label Images and Clean Data																
Set Milestones for Rest of Semester																
FSR, ICD, Validation Plan First Draft, Send to Sponsor																
FSR, ICD, Validation Plan Revision																
Midterm Presentation 09/23																
FSR, ICD, Milestones, Validation Plan Due 09/26																
High Voltage Component Research and Selection																
Build Object Detection Model																
Train & Test Model																
High Voltage PCB Design																
Status Update Presentation 10/14																
High Voltage PCB Layout Review																
Order Parts and PCB																
PCB Assembly and Smoke Test																
PCB Validation																
Improve Model Accuracy & Edit Hyperparameters																
Real Time Detection Testing																
Final Presentation 11/11																
Final Report First Draft, Send to Sponsor																
Final Demo Due 11/26																
Final Report Revisions																
Final Report Due 12/05																

Annotations

- Not Started
- In Progress
- Completed
- Behind Schedule

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Validation Plan Status

Paragraph #	Test Name	Success Criteria	Methodology	Status	Owner
3.2.1.1.	Capacitor Charge and Discharge Time	Time between start of charge up and end of discharge is less than 8 seconds	Measure voltage across output electrodes throughout a charge and discharge cycle, calculate time delta	UNTESTED	Conner Mullen
3.2.1.2.	Electrode Discharge Mode	Electrodes are only connected to high voltage output after contact is detected	With no contact: confirm that the voltage across electrodes is low With contact: confirm that indicator LED is on, and that the voltage across electrodes is high	UNTESTED	Conner Mullen
3.2.1.3.	False Positive Rate	FPR of less than 5% to prevent unintended crop damage	Conduct image classification test using a validation set with known crop and weed labels. Track the number of images where crops are incorrectly identified and calculate results	IN PROGRESS	Will Fenno
3.2.1.4.	False Negative Rate	FNR of less than 5% to prevent missed weeds	Conduct image classification test using a validation set with known crop and weed labels. Track the number of images where weedes are incorrectly identified and calculate results	IN PROGRESS	Will Fenno
3.2.1.5.	Camera Field of View	System detects objects at a range of 62.2 degrees horizontally and 48.8 degrees vertically	Measure the system's response to objects placed inside and outside the specified field of view	COMPLETED	Will Fenno
3.2.2.1.	Electrode Placement	Arcing does not occur across electrodes	Charge system to maximum voltage, visually confirm that no arc forms	UNTESTED	Conner Mullen
3.2.2.2.	Mounting	All components are secured properly	Visually inspect all connections to the robot or other platform, then attempt to move mounted components around to test strength of mounts	UNTESTED	Full Team
3.2.4.1.	Power Source	12V DC is converted to correct input voltages (after components are selected, exact values will be provided)	Before powering on: Perform continuity test for all 12V points Power on board with 12V DC source and test voltage at output of power converters	UNTESTED	Conner Mullen
3.2.4.2.	Inputs	All buttons/switches work as expected, as indicated by LEDs	Power system on, set to each combination and confirm that the proper LED indicators are on, and test for necessary continuities	UNTESTED	Conner Mullen
3.2.4.3.	Outputs	LEDs all light up under correct circumstances Energy discharges through electrodes (Germany)	Verify that proper LEDs light up under proper circumstances Charged capacitor is discharged following contact with target plant	UNTESTED	Conner Mullen
3.2.4.4.	Interface Between Processor and Electronics	I2C signal sent from processor is received by MCU, correct output is observed (specific output and input signals will be updated as we finalize designs)	Send I2C commands from processor to microcontrollers, verifying that every necessary function is initiated properly	UNTESTED	Full Team
3.2.5.1.	Temperature (Thermal Resistance)	System functions in complete range of temperatures (10C to 45C)	Low end of temperature range exists outside in Texas, high end will be created with temperature chamber	UNTESTED	Full Team
3.2.5.2.	External Contamination	Large particles are kept out of the electronics casing	Bombard empty casing with dirt, grass, and other particles; open casing and visually inspect inside	UNTESTED	Full Team
3.2.6.1.	Built-In Test (BIT)	The system will activate a red LED in the case of camera failure during the startup process	Intentionally simulate camera failure via disconnection to verify LED activation response	UNTESTED	Will Fenno
3.2.6.2.	Isolation and Recovery	In the case of a BIT fault, the system will be reset and restore normal operations	Conduct a reset test in response to a camera detection failure	UNTESTED	Will Fenno
Note	Specific values and signals will be included as we continue to develop and finalize our designs				

High Voltage Generator

	Pros	Cons	Choice
Cockroft-Walton Generator	- Simple design - Multiplication, not addition - Each capacitor only holds 2x peak input voltage - Repeatable	- Requires alternating input; we are using DC power	Will Use This for Both Stages
DC-DC Boost Converter	- No need for DC-AC or AC-DC conversion	- Requires PWM signal - Needs multiple stages to reach viable voltage	Not Used for High Voltage
Op-Amp		- VCC sets upper limit for output	Not Viable

Alternating Voltage Source

	Pros	Cons	Choice
555 Timer (NE555DR)	- Well documented - Necessary components are readily available - Full customization	- Maximum output current of 200mA - Cannot achieve perfect 50% duty cycle	Best Option
H-Bridge	- Well documented - Fairly simple to construct	- Requires external control signal - Dead time and short considerations	Alternative
Signal from Jetson	- Simple	- 2mA current limit	Not Viable

Detailed PCB Validation

I/O continuity (pre and post-solder)	12V_in connects to 12V-5V buck and relay K?	UNTESTED
	I2C SDA and SCL connect from input to GPIO IC (U?)	UNTESTED
	Electrode outputs connect to end of Cockroft-Walton Generator and relay K?	UNTESTED
	5V output to Jetson connects to output of buck converter	UNTESTED
	Ground of all IC's and I/Os are connected	UNTESTED
I2C/GPIO	Using Arduino: Send I2C signal to GPIO to change each pin to input/output, then read that register using I2C	UNTESTED
	Set outputs to 0, test with test points, then repeat, setting outputs to 1	UNTESTED
High Current Sensor	Verify functionality of potentiometer (multimeter)	UNTESTED
	Using power supply, put voltages between 0 and 5 volts across resistor, record and verify correctness of comparator output	UNTESTED
	Ensure LED turns on when comparator output is high	UNTESTED
Power Up	Nothing blows up	UNTESTED
	LED indicator turns on (and doesn't blow up)	UNTESTED
	5V from buck converter is generated	UNTESTED
	Nothing blows up (this is really important)	UNTESTED
Relays	GPIO signals for each relay turned to 0 and 1 individually, listen for click and do continuity test	UNTESTED
High Voltage	Use voltmeter to verify output voltage is 12V * 8 - ~1V (8x boost minus 8 diode drops)	UNTESTED
	Put various resistances (500k+) across output electrodes, record voltage and current	UNTESTED