Project Plan

Senior Design 491: Soybean Parasitic Cyst Detector

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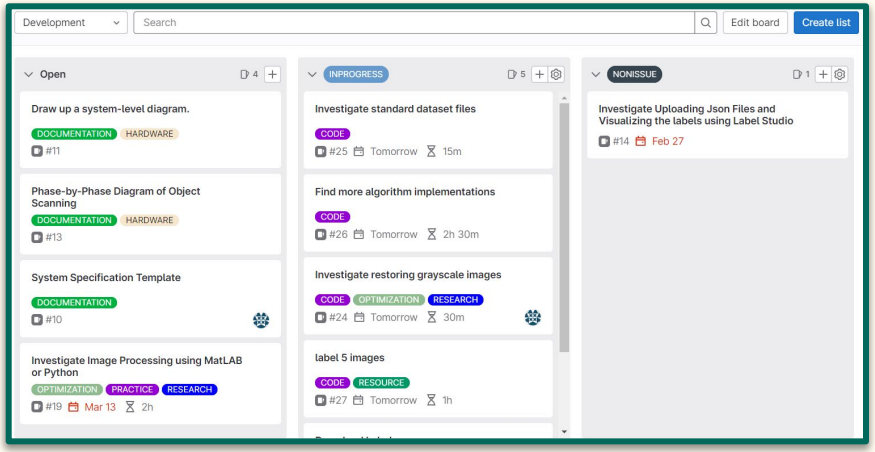
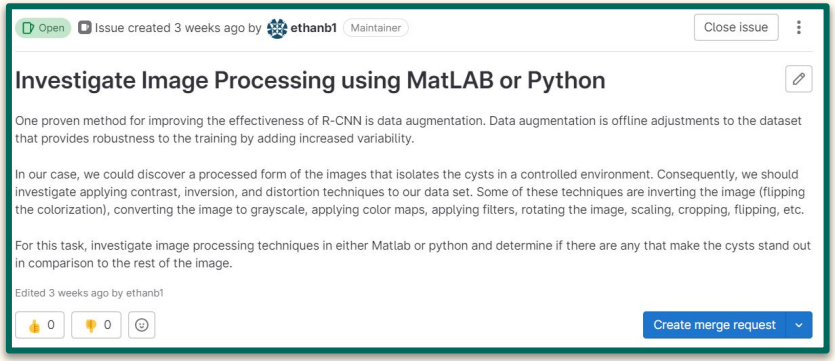
Problem Statement

- Develop a deep learning algorithm designed for small object detection to determine how many parasitic cysts are on the roots of soybean plants.
- Will also create a device to integrate image capturing with the machine learning algorithm.
- Increases productivity in farms.
- Reduces the amount of unnecessary pesticides.
- Helps farmers accurately fertilize their crops.

Project Management/Tracking Procedures

- Agile (SCRUM)
  - 1-week sprints
  - Use Gitlab to track issues
  - Weekly meetings to develop backlog & discuss work
- Use Gitlab repository for code and data set





Task Decomposition

- Task 1: Develop a Deep Learning Model
  - Research and choose a deep learning algorithm
  - Label our existing data
  - Implement our model in our environment
  - Train the model on our data
  - Validate & test the model
  - Optimize the code for enhanced improvement
  - Implement additional models for comparisons. (Optional)
- Task 2: Develop a Prototype Soybean Scanner
  - Set up a controlled environment for image capturing
  - Develop scanner that can scan all sides of the plant
  - Apply the machine learning detector to the scanned sides to accurately count of the parasitic cysts.
  - Optimize the prototype to be user friendly and intuitive.

Project Proposed Milestones, Metrics, and Evaluation Criteria

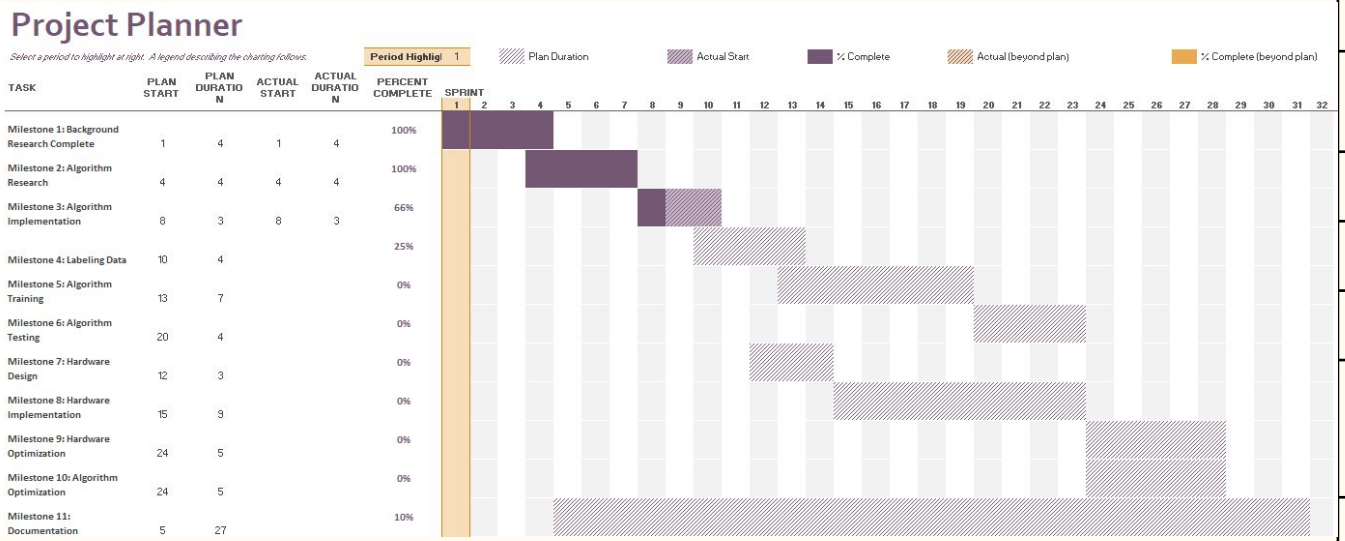
Milestone	Description	Metrics
1: Background Research	Progress is complete when we understand artificial intelligence, machine learning, and deep learning.	Progression through team training and onboarding tasks.
2: Algorithm Research	Progress is complete when the team members have sufficient understanding of machine learning algorithms to evaluate multiple different deep learning approaches and assess which one is best for our project.	Number of algorithms researched & evaluated (3 per person).
3: Algorithm Implementation	Progress is complete when a Faster R-CNN implementation/template is found on GitHub and is runnable on our computers.	Progression through developing a functional Faster R-CNN implementation.
4: Labeling Data (149 total images)	Progress is complete when all the data has all the cysts on the plants labeled.	Number of completed images.
5: Algorithm Training	Progress is complete when we have developed a model based on the implementation in milestone 3, trained on our soybean cyst data.	Progression through training set of soybean cyst data.

Project Proposed Milestones, Metrics, and Evaluation Criteria

Milestone	Description	Metrics
6: Algorithm Testing (50%+ accuracy)	Progress is complete when the algorithm sufficiently hits a high accuracy rating (For our purposes it is currently set at 50% subject to change).	Evaluation of results should show accuracy of model should be at least 50%.
7: Hardware Design	Progress is complete when the Hardware System-Level Diagram is properly developed and finalized.	Iterative development process with improving diagrams and ideas.
8: Hardware Implementation (50%+ accuracy)	Progress is complete when we have a working prototype of the image capturing device that can run the machine learning model.	Progression of creating the design from the previous milestone.
9: Hardware Optimization	Progress is complete when the hardware implementation is friendly and can be run by not an engineer.	Iterative development process dedicated to improvements over functionality.
10: Algorithm Optimization	Progress is complete once the counting accuracy of our algorithm has increased by a significant amount (5% or more).	Increase in accuracy of model.
11: Documentation (Website)	Document our design process, implementation, hardware & software designs, and provide next steps.	Progression of team managed website including documentation from each of the stages of the project.

Project Timeline/Schedule

Gantt Chart



Sprint Number (32 Total Sprints)	Milestone Complete
Sprint 4	Milestone 1: Background Research Complete
Sprint 9	Milestone 2: Algorithm Research
Sprint 12	Milestone 3: Algorithm Implementation
Sprint 13	Milestone 4: Labeling Data
Sprint 15	Milestone 7: Hardware Design
Sprint 20	Milestone 5: Algorithm Training
Sprint 24	Milestone 6: Algorithm Testing Milestone 8: Hardware Implementation
Sprint 28	Milestone 9: Hardware Optimization Milestone 10: Algorithm Optimization
Sprint 32	Milestone 11: Documentation

Risks And Risk Management/Mitigation

Task 1 - Developing a Deep Learning Model

Risk	Probability	Mitigation Plan
Available data is not enough to train an accurate algorithm on.	0.8	Develop a proof-of-concept model and allow the project administrators to collect more data over time to improve the model.
Labeling tools are incompatible with algorithm implementation.	0.1	N/A
Our algorithm does not provide a sufficient amount of accuracy rating.	0.1	Since we have a relatively low goal accuracy (~50%), even with our limited dataset we should be able to achieve this.

Task 2 - Developing a Prototype Device

Risk	Probability	Mitigation Plan
Our hardware does not have enough resolution for machine learning to detect.	0.5	Doing market research to find a high-resolution camera at an affordable price This may violate some of our requirements budget wise.

General Risk

Risk	Probability	Mitigation Plan
Less predictability, especially since no one has a strong background in this area	0.4	Spending time researching machine learning can help us anticipate issues we might have developing and working on an algorithm

Personnel Effort Requirements

Task: Develop a Deep Learning Model	Person-hours
Research and choose a deep learning algorithm/model	20
Label our existing data	40
Implement our model in our environment	10-15
Train the model on our data	40
Validate & test the model	20
Optimize the code for enhanced improvement	10
(Optionally) implement additional models for comparisons.	60
Software Documentation	50
Total Hours:	***190-255***

Task: Develop a Prototype Soybean Scanner	Person-hours
Set up a controlled environment for image capturing	10
Develop scanner that can scan all sides of the plant	20
Apply the machine learning detector to the scanned sides to accurately count of the parasitic cysts.	15
Optimize the prototype to be user friendly and intuitive.	10
Hardware Documentation	50
Total Hours:	***105***

Total Project Hours:	***295-360***

Other Resource Requirements

- Pictures of soybean roots to create a data set.
- Computing platform to train the algorithm.
- Colorized platform for Soybean plant image capturing.
- Camera
- Raspberry Pi with usb adapter
- Small motor
- Labeling tool
- Power source
- Grabber or tools to hold the soybean root

Questions?