Soybean Hydroponic Deep Learning Model

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**Functional System Requirements**

REVISION – Draft

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Functional System Requirements

for

Soybean Hydroponic Deep Learning Model

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**Change Record**

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# Introduction

## Purpose and Scope

Deep Learning for Hydroponic Soybean Growth is a deep learning model trained for use with hydroponic soybeans to detect the day of growth and the nutrient solution its being grown in. Figure 1 shows the subsystem block diagram for our project.

Input (user interface)

Deep Learning Model

Output (user interface)

Image Annotation

Samuel He

Mary Hughes

Shared

Figure 1. Your Project Conceptual Image

## Responsibility and Change Authority

The team leader, Samuel He, will be responsible for ensuring that both subsystems meet specifications. Any changes made to the project must be cleared by Samuel He and the project sponsor, Sambandh Dahl.

# Applicable and Reference Documents

## Applicable Documents

The following documents, of the exact issue and revision shown, form a part of this specification to the extent specified herein:

|  |  |  |
| --- | --- | --- |
| **Document Number** | **Revision/Release Date** | **Document Title** |
| IEEE 2941-2021 | 3/18/2022 | IEEE Standard for Artificial Intelligence (AI) Model Representation, Compression, Distribution, and Management |
| IEEE 3652.1-2020 | 3/19/2021 | IEEE Guide for Architectural Framework and Application of Federated Machine Learning |
| IEEE P3123 | 11/9/2021 | Standard for Artificial Intelligence and Machine Learning (AI/ML) Terminology and Data Formats |
| IEEE P2841 | 9/21/2022 | IEEE Approved Draft Framework and Process for Deep Learning Evaluation |

## Reference Documents

The following documents are reference documents utilized in the development of this specification. These documents do not form a part of this specification and are not controlled by their reference herein.

|  |  |  |
| --- | --- | --- |
| **Document Number** | **Revision/Release Date** | **Document Title** |
| IEEE P3123 | 11/9/2021 | Standard for Artificial Intelligence and Machine Learning (AI/ML) Terminology and Data Formats |

## Order of Precedence

In the event of a conflict between the text of this specification and an applicable document cited herein, the text of this specification takes precedence without any exceptions.

All specifications, standards, exhibits, drawings or other documents that are invoked as “applicable” in this specification are incorporated as cited. All documents that are referred to within an applicable report are considered to be for guidance and information only, except ICDs that have their relevant documents considered to be incorporated as cited.

# Requirements

This section defines the minimum requirements that the development item(s) must meet. The requirements and constraints that apply to performance, design, interoperability, reliability, etc., of the system, are covered.

## System Definition

Provide a brief overview of the project, and then describe some of the main sub-systems of your proposed solution.

Diagram

Description automatically generated

Figure 2. Block Diagram of System

The block diagram above illustrates a high level overview of our project. As shown, we will be training and testing a deep learning model with images that we have annotated and labeled according to specifications. We will have a UI that takes images as inputs and uses the deep learning model to process these and output the dataset we have defined for it. This data will be output to the UI, which will then be read by the user.

## Characteristics

### Functional / Performance Requirements

#### Day of Growth Identification

The SHDLM shall be able to identify the day of growth of a soybean from an input image based on its training.

Rationale: This is the 1st of two core system performance requirements.

#### Nutrient Solution Detection

The SHDLM shall be able to detect the nutrient solution a soybean was grown in. There were eleven (11) nutrient solutions used to grow the subjects for the experiment.

Rationale: This is the 2nd of two core system performance requirements.

#### UI Output Delivery

The SHDLM shall deliver an output to the UI in a readable manner after an input is processed by the deep learning model.

Rationale: An intuitive and readable UI is necessary for the deep learning model output to be effectively interpreted by the user.

### Physical Characteristics

*N/A as project is entirely software*

### Electrical Characteristics

#### Inputs

1. While there are no electrical inputs, this SHDLM does require a large collection of complex input (images). The first area that has a necessity for input is the development of the deep learning model. Training a deep learning model requires an abundance of examples to ‘teach’ the model and shall also call for inputs to test the trained model.
2. It follows that the use of the model also demands inputs to serve its purpose. Through the UI, anyone using the model must have inputs to give the model.

Rationale: By design, will require input to use the trained model.

##### Power Consumption

N/A as project is entirely software.

##### Input Voltage Level

N/A as project is entirely software.

##### Input Noise and Ripple

N/A as project is entirely software.

##### External Commands

The SHDLM shall document all external commands in the appropriate ICD.

Rationale: The ICD will capture all interface details from the low-level subsystem to the high-level usage format.

#### Outputs

##### Data Output

The SHDLM shall include an interface compatible with the deep learning model that outputs the data label laid over the plant that the model predicts an output for.

Rationale: The UI will pass information directly to the deep learning model and receive outputs from output directly from the model to the interface.

##### Diagnostic Output

The SHDLM shall not include a diagnostic interface.

Rationale: Provides the ability to control things for debugging manually and a way to view/download the node map with associated potential targets.

##### Raw Video Output

The SHDLM shall not include a raw video interface.

Rationale: There is no video aspect involved with this project.

#### Connectors

N/A as project is entirely software.

#### Wiring

N/A as project is entirely software.

### Environmental Requirements

N/A as project is entirely software.

### Failure Propagation

The SHDLM shall not allow failures beyond the failure detection systems implemented.

#### Failure Detection

##### Application Failure Detection (AFD)

The SHDLM shall have an internal subsystem that will generate test queries from the front-end application to the back-end application to test the functionality of communication between the two.

Rationale: As the application is hosted on a third-party web-hosting service (such as AWS or Heroku), the reliability of the web application is heavily influenced by the reliability of the web-hosting service.

###### Model Failure Detection (MFD)

The web-application should have a method of detecting whether the model returns a valid output or not.

Rationale: If the model outputs some sort of invalid output that is not useful to the user, then the web-application should either communicate the lack of output to the user or re-run the model on the input until a valid output is given.

# Support Requirements

As the web application will be hosted on a third-party web-hosting service, extensive information on how to contact the help desk for the application will be provided within our technical support documentation. The only system requirements our However, as our clients are well-informed on the process of creatin/synthesizing data and training the model, there is a lack of need for technical support on that end.

# Appendix A: Acronyms and Abbreviations

AWS Amazon Web Services

AFD Application Failure Detection

ICD Interface Control Document

MFD Model Failure Detection

N/A Not Applicable

SHDLM Soybean Hydroponic Deep Learning Model

UI User interface

# Appendix B: Definition of Terms

**Deep Learning Model:**

*A computational model that processes data with multiple layers of pattern recognition in order to better identify data on a higher level.*

**Image annotation:**

*A method of assigning segments of an image a label in order to help train the model for future input data.*

The following definitions differentiate between requirements and other statements.

Shall: This is the only verb used for the binding requirements.

Should/May: These verbs are used for stating non-mandatory goals.

Will: This verb is used for stating facts or declaration of purpose.

# Appendix C: Interface Control Documents

There shall be one Interface Control Document for the SHDLM.