Department of Computer Science and Engineering
The University of Texas at Arlington

Team Sketchers

Sidewalk Sketcher

Team Members:
Jesus Parra
Pranil Maharjan
Sabin Bajracharya
Nishchal Pandey
Lam Pham

Late Updated: 29 January 2015 @ 7:53:00 AM

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1. Introduction

1.1 Purpose and Use

This document describes the architectural overview of the Sidewalk Sketcher and provides a detailed explanation on the system's meta-architecture as well as multiple layers and subsystem used. The document will also provide a set of guiding principles such as product concept, scope, and key requirements necessary to design the architecture. Ultimately, the ADS document will describe the operating system dependencies and testing considerations needed to achieve customer and client satisfaction.

1.2 Project Description

The Sidewalk Sketcher is a robot with two sets of independent modules. One module is the user interface using Windows 7 or higher operating system and the other module is carried out on the physical Sidewalk Sketcher. The user is required to convert their desired image into a two-color image in the user interface. Next, the processed image is then transferred into the Sidewalk Sketcher system via USB cord. The processed image will be stored into the Sidewalk Sketcher system. The system will provide the user options to load a file, crop the desired image, and input the size of image to be sketched. Besides these features, the Sidewalk Sketcher System will also provide an option to choose two colors that will be used to show the final image. Finally, the Sidewalk Sketcher will start sketching the image on the designated area using markers to keep tracked of its position.

1.3 Key Requirements

Requirement Number	Requirement Name	Description
3.1	Sketch Image	The system should be able to sketch an image with chalk.
3.2	Multicolor	The system should be able to sketch an image with a least two different colors.
3.7	Sketch Dimensions	The system should be able to print images with a maximum size of 8 by 10 feet and minimum of 2 by 2 feet.
3.8	Chalk Switch	The Sidewalk Sketcher will have two pieces chalk while sketching. During this process, the device will sketch all parts of the image that require the first chalk color. After the first chalk color is completed, the Sidewalk Sketcher will switch chalk colors by itself and continue the sketching process.
8.1	Image Loading	The Sidewalk Sketcher should be able to load the image into the Sidewalk Sketcher via USB cord.
8.5	Push chalk	The Sidewalk Sketcher will have the ability to continually push the chalk while the image is sketching.
8.6	Finished Image	The Sidewalk Sketcher will alert the user when the image is finished sketching.

2. Meta Architecture

This section describes the various design principles that were used in the design of the system's architecture. The Meta Architecture elaborates on the architectural vision of Team Sketchers, the guiding principles that serve as the foundation for the system architecture, assumptions as well as tradeoffs associated with the architecture design of the Sidewalk Sketcher.

2.1 Architectural Vision

The architecture design of the Sidewalk Sketcher is based on the principle of modularity. The project as a whole can be divided into simply two components: hardware and software. However, due to the various areas of work that this project will encounter, Team Sketchers have decided to make modularity a big principle. The modularly principle consists of the following: each layer will have a synchronization subsystem that in effect will be a controller for that particular layer. This subsystem will be in charge of distribution of data among the other subsystems along with being the primary interface in interacting with other layers. As a result, we have several layers all interconnected to communicate with one another to create a traceable process.

The architecture consists of ten layers that are in essence divided between hardware and software.

Software: Software Input, Software Output, Software Processing, UI, and Data Storage.
Hardware: Hardware Input, Hardware Output, Hardware Processing, Sketch, and Motion.

Each of these layers consists of several subsystems that will interface with one another and interface with other layers. The layers of the Sidewalk Sketcher can better be observed by following the flowchart, yet the basic outline is as follows:

The user will interface with the UI (UI Layer). This layer will attain its input (Software Input Layer) and then perform modifications to the image (Software Processing Layer). After this is completed, the user will have the option to save the project (Data Storage Layer). The user will then decide to transfer the desired image to the hardware (Software Output Layer) so the system will create the vector instructions and send it to the hardware via USB cable (Hardware Input Layer). The Sidewalk Sketcher will then be placed in the desired position to start the image and the markers will be set to their designated places and the hardware will begin execution when instructed. During this execution (Hardware Processing Layer), the Sidewalk Sketcher will keep track of the chalk depletion (Sketch Layer) along with its current position (Motion Layer). In case the Sidewalk Sketcher detects the battery is running low or reaching chalk depletion, the device will alert the user (Hardware Output Layer). Once the user has fixed this problem, the Sidewalk Sketcher will continue to sketch the image until the process is completed.

The input layers will be in charge of translating the information received into data that particular part of the system can use. From the software side, the software will translate the image file into an image that will fit the device’s requirements. From the hardware side, the hardware will parse the instructions received and store the data locally to get the sketcher ready for execution. The processing layers will be the units where the actual processing will be performed, analogous to a computer’s CPU. The output layers will be in charge of sending the right data to the appropriate places such as the user or the hardware.

2.2 Guiding Principles

Before architecture design can be started, it is important to define the guiding principles upon which the Sidewalk Sketcher will be built. This allows the team to have a better understanding of how the system should be designed. The guiding principles for the Sidewalk Sketcher – modularity, reliability, user friendliness, and safety– are described in this subsection.

2.2.1 Modularity

The Sidewalk Sketcher is specifically designed with modularity as a prime priority. The system is designed to have pseudo-independent components, in the way that many components could be performed without the assistance of other. Yet this is pseudo-independent in the way that each module, is dependent on each other’s interaction. This principle may appear invisible or transparent to the user, yet they will have to go through a certain process to sketch an image which is where the modules are essentially formed.

2.2.2 Reliability

The Sidewalk Sketcher should be a reliable sketching device that will be able to adapt to the image the user wished to sketch. The system should display the image in the software that will eventually be sketched with the hardware.

2.2.3 User Friendliness

The Sidewalk Sketcher will have an intuitive user interface that will set the look and feel for the application. Once the user has installed the software unit along with the drivers for the hardware, the user should easily be able to determine how to use the software. Of course, there will be a manual for both the software and hardware components. Nevertheless, Team Sketcher wishes the user to get a feel for the software without those components.

2.2.4 Safety

The Sidewalk Sketcher will be safe so that the hardware component shall not harm the user and the software unit shall not compromise any software that may be already installed in the user’s machine.

2.3 Design Assumptions

In order to develop the Sidewalk Sketcher, the team has made assumptions that each user will follow specific steps to achieve the desired image sketch. The list of assumptions is described in this subsection.

2.3.1 Markers

The Sidewalk Sketcher will have a set of three markers that will aid in determining the position of the device at all times. A crucial assumption for the project is that the markers are places in the appropriate location prior to the robot beginning sketching the image.

2.3.2 Image

The user will select an image that can be sketched manually for the Sidewalk Sketcher to sketch. The more complicated the image is the lower the quality of the sketch will be. To maximize the user's experience with this device, the user should select a simple image to be sketch such that if a person were to manually sketch the image, the image will result in good quality given the dimensions of the image.

2.3.3 Battery Life

The user is highly advised to have the Sidewalk Sketcher fully charged prior to beginning a new sketch. If the sketcher is not fully charged, the device will have to be charged during operation which may result in a lower quality image.

2.3.4 Chalk

The user is highly advised to have a full length piece of chalk installed in the Sidewalk Sketcher prior to beginning a new sketch. If the sketcher does not have a new piece of chalk installed, the user operation will be halted when the chalk nears depletion and will not resume until the user reloads another piece of chalk. This halt could result in a lower quality image as opposed to the image that would have been created if the sketcher had a full piece of chalk beforehand.

2.3.5 User Presence

The user is highly advised to be present in the sketching process in case there are any errors that arise that could compromise the image sketch.

2.4 Design Tradeoffs

In order to develop the Sidewalk Sketcher, the team had to consider a few tradeoffs when designing the Sidewalk Sketcher. The list of tradeoffs is described in this subsection.

2.4.1 Many Layers vs. Few Layers

Based on the concept of modularity there was a debate of whether to have multiple layers of abstraction or whether we should encapsulate the abstraction in fewer layers. The Sidewalk Sketcher design uses the wider spread of abstraction.

2.4.2 Vector Plotting vs. Bit-Map Plotting

There are two ways to sketch an image, either by drawing lines (vector plotting) or by drawing a bunch of dots (bit map plotting). The way in which we plot the image is heavily based on how we implement the rest of the Sidewalk Sketcher design. The Sidewalk Sketcher design uses the vector plotting approach.

2.4.3 Camera vs. Sonar Sensors

There are two ways to determine distance of objects relative to one another, either by sound or light. With each of these choices comes several ways of achieving the distance calculation. The Sidewalk Sketcher design uses the camera approach in determining position.

2.4.4 IRobot Create® vs Scratch

There are two ways to begin our hardware design, either by building off another component (in this case the IRobot Create®) or completely designing a new component from scratch. Due to the time constraint and the learning curve on other aspects of the system, Team Sketchers has decided to go with the IRobot Create® approach.

3. Inter-Subsystem Data Flow

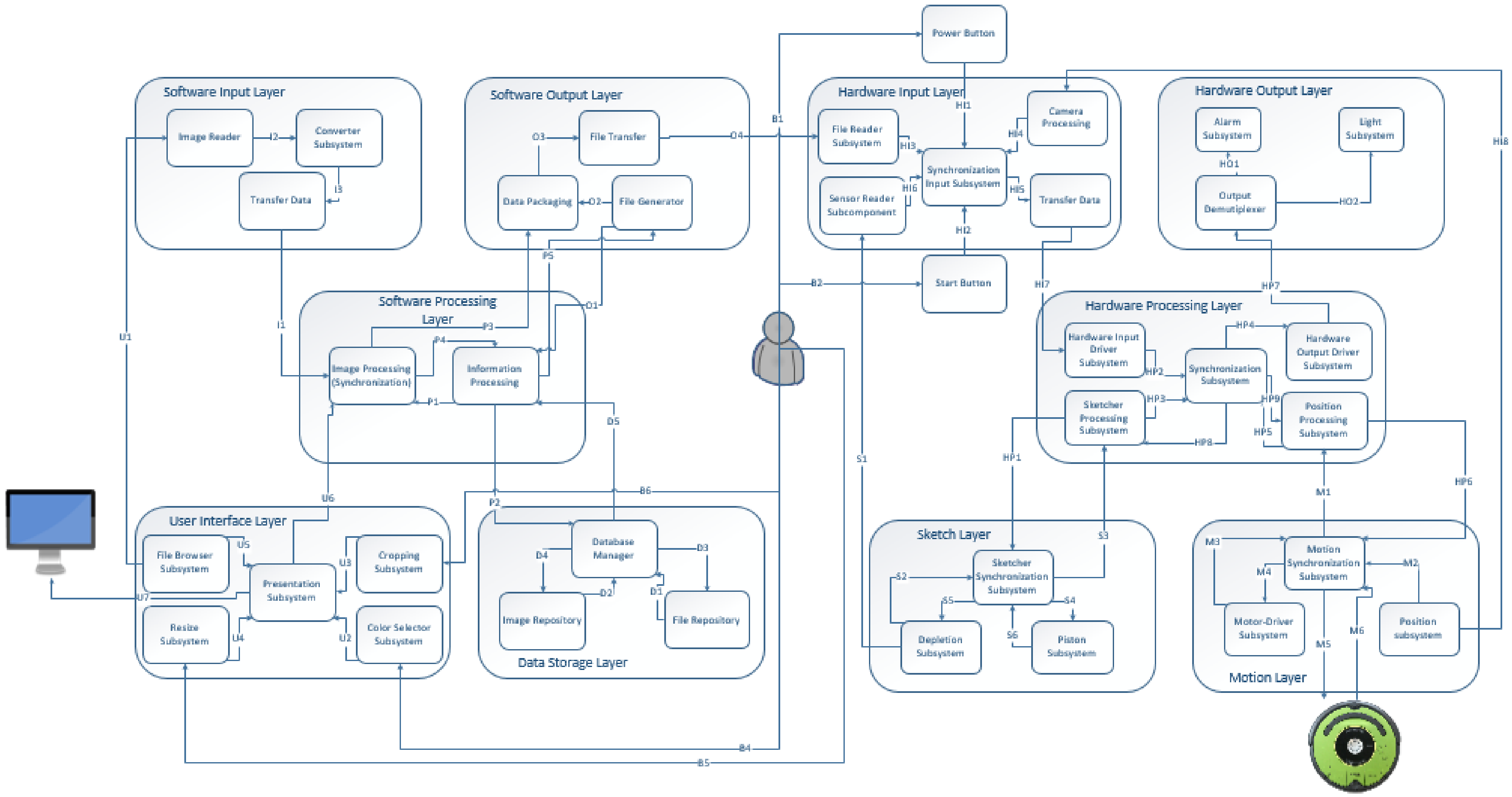
This section illustrates how the various subsystems interact within Sidewalk Sketcher. Each data flow is marked, which is described in the following subsections. The subsections provide a high level overview of the system and the data flows between each of the layers and subsystems describe how individual data elements are used. The relationship between data producers and their respective consumers is also shown below.

3.1 Data Flow Diagram

The dataflow diagram is divided into two sections: software section and hardware section. Overall dataflow diagram consists of ten layers. Starting from the User Interface in software section, data flows to the software input layer passing it to the software processing layer. Software processing layer constantly interacts with the data storage layer to store data or retrieve data. It also interacts with the software output layer to provide needed output.

The Software Output acts as the Hardware input. In the hardware input, along with the image data received from the software output, the camera positioning input as well as the sensor reading is integrated and transferred into the hardware processing layer. Hardware processing layer constantly interacts with the sketch layer, motion layer and hardware output layer so that proper processing can be done.

Sidewalk Sketcher



3.2 Data flow definitions

The table below gives a description of each element in the data flow diagram. Each description includes how the data element will be used and passed between subsystems.

Elements	Description
B1	The User presses the power button to turn on the Sidewalk Sketcher.
B2	The User presses the Start button to start printing the image.
B3	The User interacts with the User Interface to provide the user input.
B4	The User selects the color options from the UI.
B5	The User resizes the image to desired size.
B6	The User crops the image to print the desired portion of the image.
U1	User Interface layer interacts with the software input layer when user completes browsing the image and pass it to the image reader.
U2	After color selection is made, I get displayed.
U3	After cropping, final image is displayed in the UI.
U4	Desired file or image is displayed.
U5	After resizing the image, processed image is displayed.
U6	Presentation subsystem interacts with Image processing subsystem in software processing layer.
U7	All changes are displayed to the user.
I1	After filtering the image into two colors, the image will be sent for processing in the software-processing layer.
I2	When Image Reader in software input layer receives the image, it passes the image to the converter subsystem, which eventually converts the image into the two colors image.
I3	After changing image into the two-color image, converter subsystem passes it to the transfer subsystem so that it can pass it to the software processing layer.
P1	Information processing subsystem passes the required information to the Image processing subsystem.
P2	Information processing subsystem access the database to complete the queries requested by the user with the help of database manager.
P3	Completing the image processing, image is transfer to the software output layer, which is received by data packaging subsystem.
P4	After processing the image, if the user wants to process the information. Image processing subsystem passes it to the information processing subsystem.
P5	Needed information is passed to the file generator subsystem.
O1	File generator generates the information from the Information processing subsystem.
O2	File generator transfers the files to the data packager for packaging.

O3	Packaged data will be sent to the file transfer that will be the Hardware input.
O4	Processed data is transfer to the Hardware via USB cable, which is received by the file reader.
D1	Response to the requested query from file repository to the database manager.
D2	Response to the requested query from Image repository to the database manager.
D3	Database manager retrieves the file from the file repository.
D4	Database manager retrieves the file from the image repository.
D5	Database manager response to the queries from the information processing subsystem.
HI1	Receives the power signal when the power button is turned on.
HI2	Receives the start signal when the start button is pressed.
HI3	Data received by file reader is synchronized and further processed in synchronization subsystem.
HI4	Since we are using camera for positioning the robot. The user need set up the position of the camera and need to pass it to synchronization input subsystem.
HI5	When everything is set up, synchronization input subsystem passes the data to transfer data subsystem.
HI6	There are sensors that we so for different purpose. In order to start sketching user need to make sure all the sensor is functioning we will acts as the input as well.
HI7	Transfer data subsystem passes the input data to the hardware processing layer for further processing.
HI8	Camera input helps in the motion of the robot.
HP1	As sketch process starts, Hardware processing layer provides the image data so that the sketch layer so that it can sketch the image.
HP2	All the hardware input is received by the hardware input driver in hardware processing layer and pass it to synchronization subsystem.
HP3	While sketching, robot need to update its position, should update status of the chalk or any error so there need the constant communication between sketch layer and Hardware processing layer.
HP4	When robot needs to notify user, synchronization subsystem passes the information to the Hardware output driver.
HP5	Robot needs to know its current position.
HP6	Hardware processing layer needs to communicate with the motion layer to get the position of the robot.
HP7	In case of chalk depletion, battery depletion or completion of the sketch process, user is notified with the output from the Hardware output driver.
HO1	When the Chalk or battery is near depletion, the alarm goes off and notifies the user.
HO2	After the sketching process is complete, the system notifies the user with the LED.
S1	The depletion subsystem will use its data as input for the Hardware Input Layer.
S2	The depletion subsystem updates the synchronization subsystem when the piece of chalk is near depletion.

S3	The synchronized data from the Sketch Layer will be transferred to be processed in the Hardware Processing Layer.
S4	The synchronization subsystem will alert the piston mechanism when it is time to be in the high or the low position.
S5	The synchronization system will tell the depletion system to stop action when instructed from the Hardware Processing Layer.
S6	The piston mechanism will send its status to the synchronization layer along with any problems it may have encountered.
M1	The subsystem passes information regarding the position of the device along with any problems that may have been encountered.
M2	The position subsystem sends its updates and current position to the synchronization subsystem.
M3	This subsystem sends its updates and any problems it may have encountered due to the movement of the device.
M4	The synchronization layer lets the motor later what coordinates to move next.

3.3 Producer- Consumer Relationships

Producer-Consumer Relationships is divided into two sections: software section and hardware section. Those tables demonstrate the relationships between data producers and their respective consumers. Producers are represented in the rows on the left and the consumers are represented in the columns on the top.

	User Input	File Browser	Resize	Presentation	Cropping	Color Selector	Image Reader	Converter	Transfer Data	Image Processing	Information processing	Database Manager	Image Repository	File Repository	Data Packaging	File Generator	File Transfer
User Input		B3															
File Browser				U5			U1										
Resize				U4													
Presentation										U6							
Cropping				U3													
Color Selector				U2													
Image Reader								I2									
Converter									I3								
Transfer Data										I1							
Image Processing											P4				P3		
Information Processing										P1		P2				P5	
Database Manager											D5		D4	D3			
Image Repository												D2					
File Repository												D1					
Data Packaging																	O3
File Generator											O1				O2		
File Transfer																	

	User Input	File Transfer	File Reader	Sensor Reader	Synchronization Input	Camera Processing	Transfer Data	Hardware Input Driver	Sketcher Processing	Synchronization	Hardware Output Driver	Position Processing	Sketcher Sync	Depletion	Piston	Motion Sync	Motor Driver	Position	Output De-multiplex	Alarm	Light
User Input	■				HI1/ HI2																
File Transfer		■	O4																		
File Reader			■		HI3																
Sensor Reader				■	HI6																
Sync Input					■		HI5														
Camera Processing					HI4	■												HI8			
Transfer Data							■	HI7													
Hardware Input Driver								■		HP2											
Sketcher Processing									■	HP3			HP1								
Sync										■	HP4										
Hardware Output Driver											■								HP7		

	User Input	File Transfer	File Reader	Sensor Reader	Synchronization Input	Camera Processing	Transfer Data	Hardware Input Driver	Sketcher Processing	Synchronization	Hardware Output Driver	Position Processing	Sketcher Sync	Depletion	Piston	Motion Sync	Motor Driver	Position	Output De-multiplex	Alarm	Light
Position Processing										HP5		■				HP6					
Sketcher Sync													■								
Depletion													S2	■							
Piston													S6		■						
Motion Sync												M1				■	M4				
Motor Driver																M3	■				
Position																M2		■			
Output De-multiplex																			■	HO	HO2
Alarm																				■	
Light																					■

4. Layer Definitions

This section provides a brief description of all the layers in the Sidewalk Sketcher. It includes the Software Input Layer, Software Output Layer, Software Processing Layer, User Interface Layer, Data Storage Layer, Hardware Input Layer, Hardware Output Layer, Hardware Processing Layer, Sketch Layer and Motion Layer.

4.1 Software Input Layer

The purpose of the Software Input Layer is to accept input from the User Interface and output the image in a way the system can manipulate. This layer is responsible for reading the image file, converting the image to an appropriate data file, and outputting the data to the Software Processing Layer for final processing.

4.2 Software Output Layer

The purpose of the Software Output Layer is to provide processed information or requested data to the hardware component in a format that it will be able to process. The output of the software component for the Sidewalk Sketcher will be handled in this layer and this will ultimately serve as the input for the hardware component.

4.3 Software Processing Layer

The purpose of the Software Processing Layer is to handle all the software input data, process that data and then send it to the output layer. Also, the processing layer should retrieve and save files in the data storage layer. This layer will handle all of the processing involved in the back end logic that the user will request through the User Interface Layer.

4.4 User Interface Layer

The User Interface Layer allows the user to select an image that will be used by the Sidewalk Sketcher to draw an image. The User Interface Layer will also allow user to crop and resize an image to provide flexibility to users to sketch the desired size and portion of the selected image. The interface will provide an option to view the chalk color that will be used when the image is actually being sketched. This layer does not ensure the quality and coloring of the image processed by the Sidewalk Sketcher.

4.5 Data Storage Layer

The Data Storage Layer contains all the subsystems that manages and holds a repository of all the image and data files saved by or accessed by the application. These images and data files may be requested from the Database Manager Subsystem for Image Processing in the Software Processing Layer.

4.6 Hardware Input Layer

This layer is responsible for reading input from Software Output Layer, Sketch layer and Motion layer, packaging all these inputs and sending it to the hardware processing layer. This layer includes the File reader subsystem, Sensor Reader subcomponent, Transfer Data, Camera Processing and Synchronization Input Subsystem. Input from Power Button and Start Button is also read in this layer.

4.7 Hardware Output Layer

This layer will handle all of the notifications that will be sent from this device to the user, such as low battery alert and chalk depletion. This is the only layer that will interact with the user.

4.8 Hardware Processing Layer

The purpose of the Hardware Processing Layer is to analyze and process data as well communicate with the remainder of the hardware layers. This layer is the central processing unit of the hardware. Essentially, this is the microcontroller in the hardware that controls all of the motions including the Hardware Input Layer, the Hardware Output Layer, the Sketching Layer and the Motion Layer.

4.9 Sketch Layer

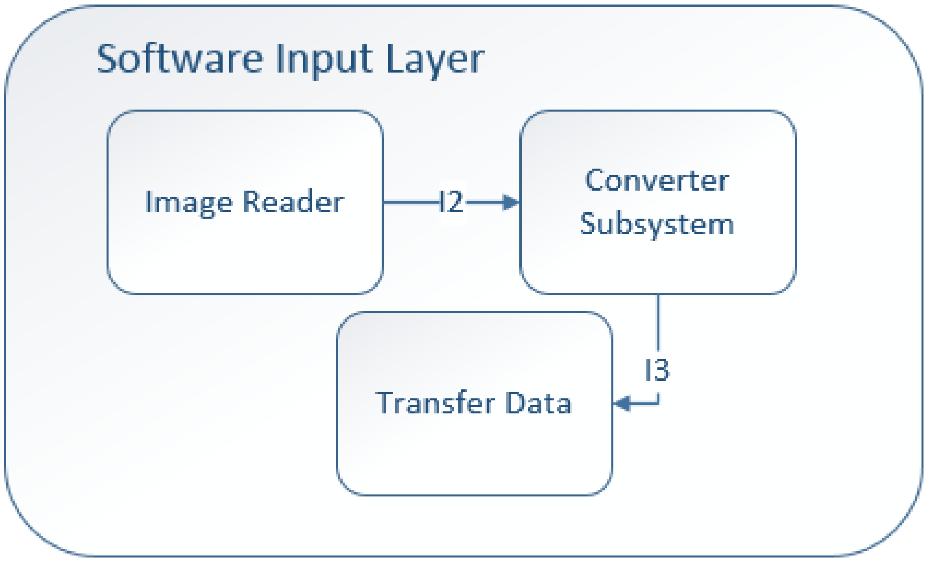
The purpose of the Sketch Layer is to analyze all of the actions that will be performed by the sketching device that will drag the chalk, pick up the chalk when it's not drawing, and send the update to the Hardware Processing Layer when the chalk nears depletion. This layer will communicate directly to the Hardware Processing Layer and the Hardware Input Layer. The Hardware Processing Layer will communicate to let the processor know whether or not the chalk is near depletion along with whether the device should be in its writing state or in its floating state (floating meaning the chalk is picked up and passing an area and not drawing lines) This layer will communicate with the Hardware Input Layer by sending information to make sure the chalk is connecting to the ground when sketching the image.

4.10 Motion Layer

The purpose of the Motion Layer is to analyze the mechanical motion that will be performed from the Sidewalk Sketcher and to ensure that the device is on the correct path. This layer will communicate directly to the Hardware Processing Layer and the Hardware Input Layer. The Hardware Processing Layer will communicate to let the processor know where the robot is at any given position so that the processing unit can determine where to go next and let this layer know the updated information. This layer will communicate with the Hardware Input Layer because it will have to send the positioning data collected from the data and sync this input to know its absolute position relative to the marker devices used for positioning.

5. Software Input Layer

The purpose of the Software Input Layer is to accept input from the User Interface and output the image in a way the system can manipulate. This layer is responsible for reading the image file, converting the image to an appropriate data file, and outputting the data to the Software Processing Layer for final processing.



5.1 Image Reader

5.1.1 Description: The File Browser Subsystem will provide the Image Reader an image file that will be read before conversion.

5.1.2 Assumptions: The Image Reader will be able to support .jpeg, .bmp and .png files.

5.1.3 Responsibilities: The Image Reader is responsible for scanning the image file making sure that it is an appropriate file prior to image conversion.

5.1.4 Inter-Layer Interfaces:

Method	Description	Information Required	Information Returned
readImg	The Image Reader will receive the image file from the User Interface layer	Image File	None

5.1.5 Public Interfaces: This subsystem does not have any external interfaces.

5.2 Converter System

5.2.1 Description: The Converter Subsystem will accept an input from the File Image Reader for file conversion into an acceptable data file.

5.2.2 Assumptions: The file has already been approved by the Image Reader.

5.2.3 Responsibilities: The Converter Subsystem is responsible for formatting the image file to an acceptable data file and outputs to the Transfer Data subsystem for Software Processing Layer.

5.2.4 Inter-Layer Interfaces: This subsystem does not interface with another layer.

5.2.5 Public Interfaces: This subsystem does not have any external interfaces.

5.3 Transfer Data

5.3.1 Description: The Transfer Data subsystem will take the converted image file and transfer the file to the Software Processing layer.

5.3.2 Assumptions: The file has been fully converted and ready for transfer.

5.3.3 Responsibilities: The Transfer Data subsystem is responsible for transferring the converted file to the Image Processing subsystem.

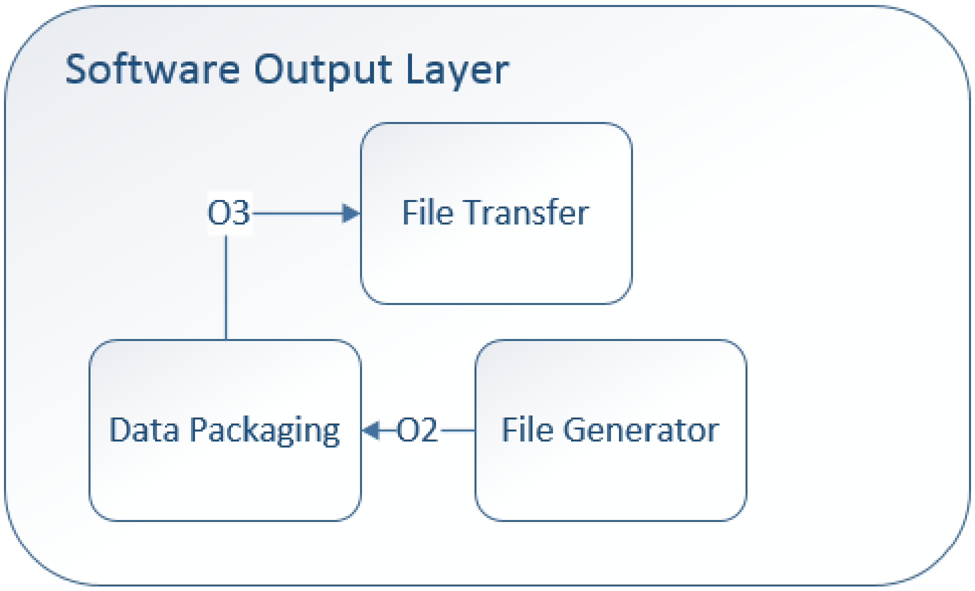
5.3.4 Inter-Layer Interfaces:

Method	Description	Information Required	Information Returned
sendImage	Transfer the file to the Image Processing subsystem in the Software Processing Layer	Image File	Image File

5.3.5 Public interfaces: This subsystem does not have any external interfaces.

6. Software Output Layer

The purpose of the Software Output Layer is to provide processed information or requested data to the hardware component in a format that it will be able to process. The output of the software component for the Sidewalk Sketcher will be handled in this layer and this will ultimately serve as the input for the hardware component.



6.1 Data Packager

6.1.1 Description: Data Packager subsystem helps to wrap up the data received from the Software processing layer. After wrapping the processed data, the Data Packaging Subsystem passes the data to the file transfer subsystem.

6.1.2 Assumptions: The data received from software processing layer is in postscript.

6.1.3 Responsibilities: This subsystem will be responsible for packaging the input processed data from the data processor to file transfer subsystem.

6.1.4 Inter-Layer Interfaces:

Method	Description	Info Required	Info Returned
getData	Receives the data	Instructions for hardware	None

6.1.5 Public Interfaces: This subsystem does not have any external interfaces.

6.2 File Generator

6.2.1 Description: This subsystem interacts with the information processing subsystem to generate the requested file by the user.

6.2.2 Assumptions: Data received from the information processing subsystem is not manipulated.

6.2.3 Responsibilities: This subsystem is responsible for communicating with information processing subsystem and get required information.

6.2.4 Inter-Layer Interfaces:

Method	Description	Info Required	Info Returned
retrieveInfo	Communicates with information processing subsystem for needed information.	None	Saved files.
receiveData	Receives information from the information processing subsystem.	None	Files.

6.2.5 Public Interfaces: This subsystem does not have any external interfaces.

6.3 File transfer

6.3.1 Description: This subsystem receives the postscript data from data packager. It helps to provide the postscript data to hardware input.

6.3.2 Assumptions: Data is not manipulated while transferring in between the subsystem.

6.3.3 Responsibilities: This subsystem accepts the data from data packager and provide that data as hardware input.

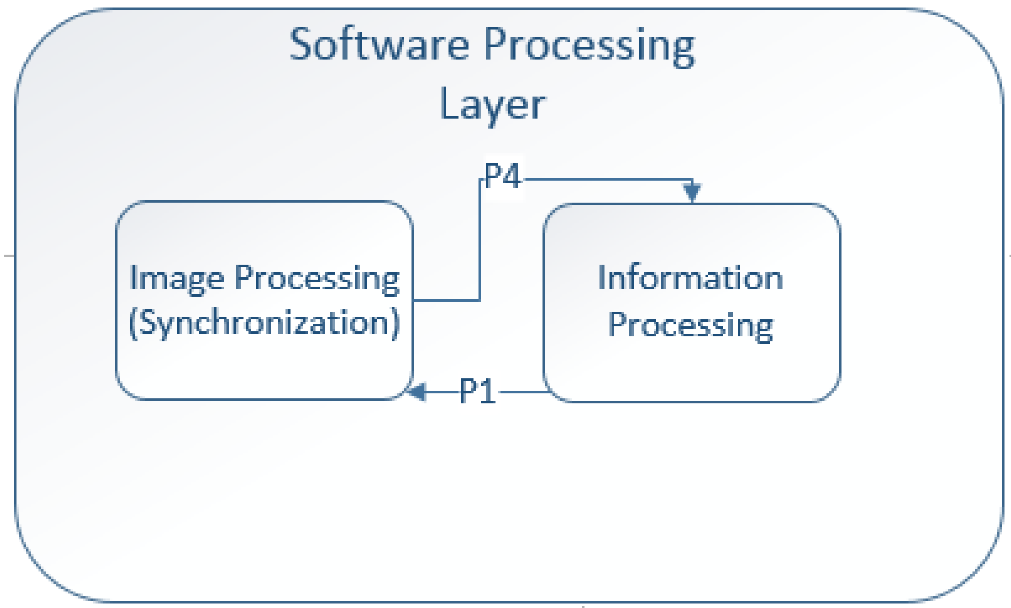
6.3.4 Inter-Layer Interfaces:

Method	Description	Info Required	Info Returned
putFile	Sends converted file to the hardware	None	None

6.3.5 Public Interfaces: The subsystem does not have any external interfaces.

7. Software Processing Layer

The purpose of the Software Processing Layer is to handle all the software input data, process that data and then send it to the output layer. Also, the processing layer should retrieve and save files in the data storage layer. This layer will handle all of the processing involved in the back end logic that the user will request through the User Interface Layer.



7.1 Image Processing

7.1.1 Description: Once the user input is received, the received image is converted into the postscript with the help of image processing layer. Besides converting to the postscript, the Image Processing Sub system also handles the user actions like resizing, cropping, image contrasts and so on.

7.1.2 Assumptions: It is assumed that the originality of the image remains the same and image is not corrupted.

7.1.3 Responsibilities: This subsystem will be responsible for processing all the image files and pass it to the output layer.

7.1.4 Inter-Layer Interfaces:

Method	Description	Info Required	Info Returned
processImage	Handle input command received from the user and process it	Image	Image
receiveData	Receives the image data from Transfer Data subsystem.	None	Image data
Transferdata	Transfers data to data packager.	None	Postscript data

7.1.5 Public Interfaces: This subsystem does not have any external interfaces.

7.2 Information Processing

7.2.1 Description: This subsystem interacts with the data storage layer in order to store the image file or retrieve the file from the database. The Information Processing also communicates with the file generator subsystem.

7.2.2 Assumption: It is assumed that there is no any communicating problem with database.

7.2.3 Responsibilities: This subsystem will be responsible for saving the image file and retrieving the stored file from the database.

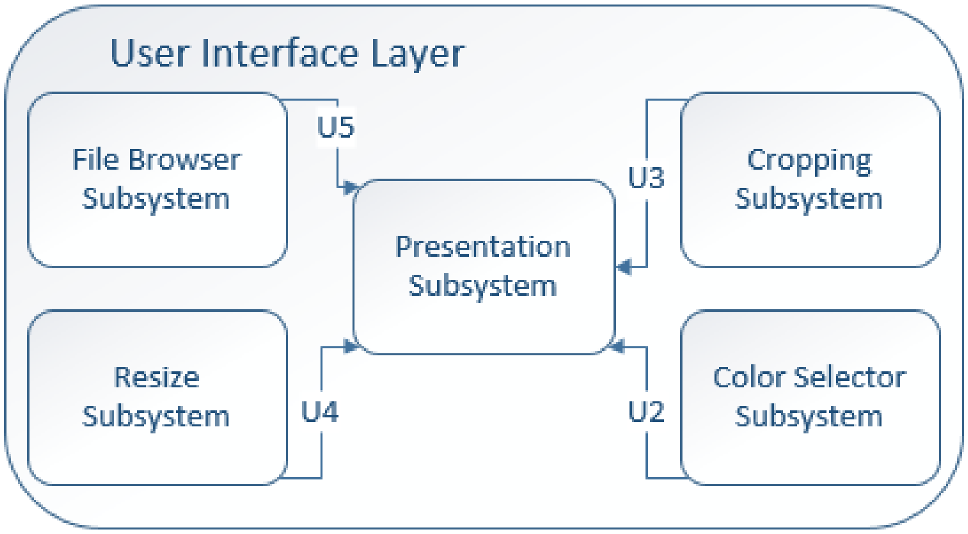
7.2.4 Inter – Layer Interfaces:

Method	Description	Info Required	Info Returned
storeData	Interacts with the database managers and stores the processed file	Image file	None
receiveData	Receives data from database.	Query	Image and data files
transferInfo	Transfers information requested by the file generator subsystem.	None	Files
receiveRequest	Receives requests from the file generator subsystem.	None	None

7.2.5 Public Interfaces: This subsystem does not have any external interfaces.

8. User Interface Layer

The User Interface Layer allows the user to select an image that will be used by Sidewalk Sketcher to draw an image. The User Interface Layer will also allow user to crop and resize an image to provide flexibility to users to sketch desired size and portion of selected image. The interface will provide an option to view the chalk color that will be used when the image is actually being sketched. This layer does not ensure the quality of the image being sketched.



8.1 File Browser Subsystem

8.1.1 Description: When Sketcher interface is opened the user can click on select file option to choose the desired image from user's computer in order to be processed.

8.1.2 Assumptions: Image files are present in user's computer and the user is in default working directory.

8.1.3 Responsibilities: The File Browser Subsystem is responsible to provide an interface for users to select desired image from the user computer. After an image is selected the subsystem is responsible of providing a confirmation button to confirm the selection.

8.1.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
selectImage	Selects the required image	String Filename	Image File

8.1.5 Public Interfaces:

Method	Description	Parameter	Data Returned
browseListener	Opens file chooser menu	None	None

8.2 Cropping Subsystem

8.2.1 Description: After the user selects an image to be processed the user can click on crop image option to print desired portion of selected image.

8.2.2 Assumptions: The file chosen by user is JPEG, Bit map, PNG format.

8.2.3 Responsibilities: The Cropping Subsystem is responsible to provide user a frame that can be enlarge or reduced to provide flexibility to select desire portion of the image. It is responsible to provide a crop button that will be clicked after user is done selecting required portion of an image.

8.2.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
cropImage	Crops the selected image	Four coordinates	Cropped image

8.2.5 Public Interfaces:

Method	Description	Parameter	Data Returned
cropAction	Opens the crop editor menu	None	None

8.3 Resize Subsystem

8.3.1 Description: The Resize Subsystem will allow user to enter the size of image that will be sketched by Sketcher.

8.3.2 Assumptions: None

8.3.3 Responsibilities: The Resize Subsystem is responsible to provide a text field where the user can enter the size of output image in an inch.

8.3.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
resizImage	Takes size of image to print	int length, int breadth	Cropped image

8.3.5 Public Interfaces:

Method	Description	Parameter	Data Returned
resizeAction	Opens the crop editor menu	None	None

8.4 Color Selector Subsystem

8.4.1 **Description:** The Color Selector Subsystem provides the user the option to select which two colors will be used in the sketch. This subsystem serves the purpose for the user to see the final sketch. However, the actual color of the sketch will be determined by the two actual colors that will be present in the Sidewalk Sketcher.

8.4.2 **Assumptions:** Chalk holder 1 is used for high contrast color and chalk holder 2 is used for low contrast color.

8.4.3 **Responsibilities:** The Color Selector Subsystem is responsible to provide an option for user to select the chalk color for high contrast and low contrast pixel of image so that the user can have view of final sketch output.

8.4.4 Inter-Layer Interfaces:

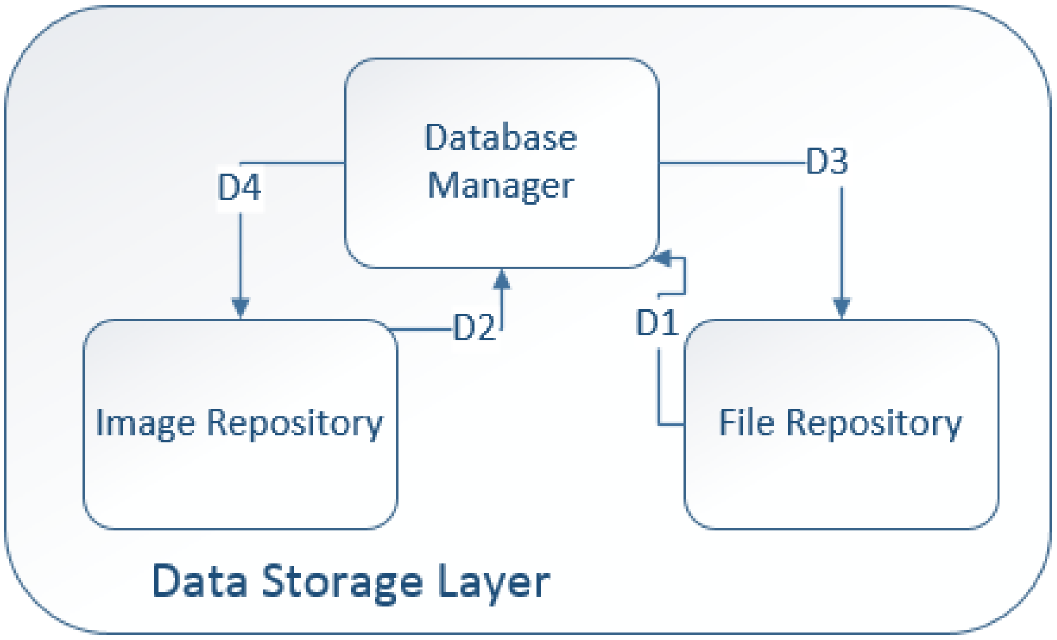
Method	Description	Parameter	Data Returned
selectColor	Takes colors for high contrast and low contrast color	String high, String low	Two colored image

8.4.5 Public Interfaces:

Method	Description	Parameter	Data Returned
selectColorAction	Ask for two colors	None	None

9. Data Storage Layer

The Data Storage Layer contains all the subsystems and holds a repository of all the image and data files saved by or accessed by the application. These images and data files may be requested from the Database Manager Subsystem for Image Processing in the Software Processing Layer.



9.1 Image Repository

9.1.1 Description: The Image Repository subsystem is responsible for acquiring and holding all image files given from the Database Management.

9.1.2 Assumption: The file is an acceptable file from the Software Processing Layer and there is enough storage space in the hardware.

9.1.3 Responsibilities: The Image Repository Layer will receive all image files and output any image files requested from the Database Management.

9.1.4 Inter-Layer Interfaces: This subsystem does not have any internal interfaces.

9.1.5 Public Interfaces: This subsystem does not have any external interfaces

9.2 File Repository

9.2.1 Description: The File Repository holds all data files of instructions generated and outputted to the Database Management Subsystem.

9.2.2 Assumption: The Image file is already converted to a plotter instruction data file for the hardware to process

9.2.3 Responsibilities: This subsystem is responsible for holding all data files for extraction to the File Generator.

9.2.4 Inter-Layer Interfaces: This subsystem does not have any internal interfaces.

9.2.5 Public Interfaces: This subsystem does not have any external interfaces

9.3 Database Management

9.3.1 Description: The Database Management System sends requests to the File Repository and Image Repository and sends the data to the respective subcomponents.

9.3.2 Assumption: The Image Repository will contain only Image files, and the File Repository will only contain data files. The Database Management Subsystem will send requests to files that are present in the repository, and throws an exception otherwise.

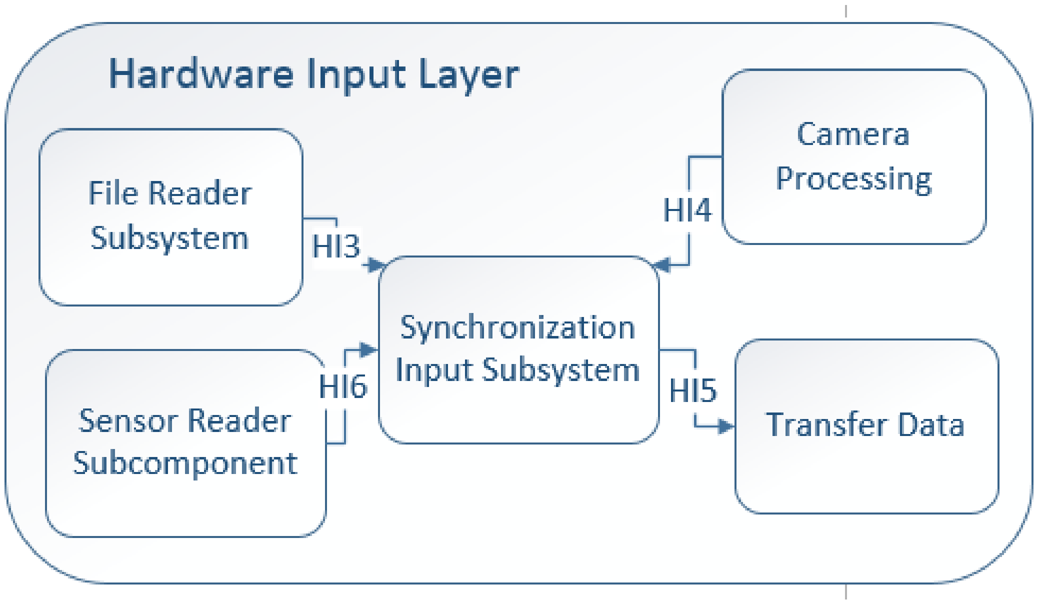
9.3.3 Responsibilities: The requests will be made when the Software Processing Layer requires an image/data file for Information Processing. The Database Management Subsystem responsibilities are to grab the requested image/data file.

9.3.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
grabFile	Interacts with the Information Processing subsystem by requesting files from the Image Repository or File Repository.	Data file	Data File
infoRequest	Request the file that the user selects	Message	None

10. Hardware Input Layer

This layer is responsible for reading input from Software Output Layer, Sketch layer and Motion layer, packaging all these inputs and sending it to the hardware processing layer. This layer includes the File reader subsystem, Sensor Reader subcomponent, Transfer Data, Camera Processing and Synchronization Input Subsystem. Input from Power Button and Start Button is also read in this layer.



10.1 File Reader Subsystem

10.1.1 Description: File sent for software output layer is received by this subsystem.

10.1.2 Assumptions: File with suitable format is sent from Software Output layer.

10.1.3 Responsibilities: The file received is checked for its integrity and sent to the synchronization input subsystem.

10.1.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receiveFileFromSOL	Receives data from File transfer subsystem	File	Image File

10.1.5 Public Interfaces: This subsystem does not have external interfaces.

10.2 Sensor Reader Subcomponent

10.2.1 Description: Output from chalk depletion subsystem is received by this subsystem.

10.2.2 Assumptions: Sensor are working fine and constantly sending their output to this subsystem.

10.2.3 Responsibilities: The data received from the sensors is converted to appropriate format that can be understood by hardware processing layer and then sent to the SIS (Synchronization Input Subsystem).

10.2.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receiveSensorData	Receive data from the depletion subsystem.	sensorId	Sensor Data (float)

10.2.5 Public Interfaces: This subsystem does not have external interfaces.

10.3 Synchronization Input Subsystem

10.3.1 Description: Merges data from File reader subsystem, Sensor reader subsystem and camera processing.

10.3.2 Assumption: File reader subsystem, Sensor reader subsystem and camera processing all are functioning and send desired data to this subsystem.

10.3.3 Responsibilities: Receives data from File reader subsystem, Camera Processing, Sensor Reader Subcomponent, power button and start button and sends it to transfer data sub- system.

10.3.4 Inter-Layer Interfaces: This subsystem does not have any internal interfaces.

10.3.5 Public Interfaces:

Method	Description	Parameter	Data Returned
powerButtonHandler	Handles power button push event.	User Input	integer
startButtonHandler	Handles start button push event.	User Input	integer

10.4 Camera Processing

10.4.1 Description: Receives position data from position subsystem in Motion Layer and processes it and passes it to synchronization input subsystem.

10.4.2 Assumption: Position subsystem is working and sending data to camera processing subsystem.

10.4.3 Responsibility: It is responsible for receiving data from position subsystem, format it and send it to synchronization input subsystem.

10.4.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receivedPositionData	Received data from the position subsystem.	None	Position data merged as a String

10.4.5 Public Interfaces: This subsystem does not have external interfaces.

10.5 Transfer Data

10.5.1 Description: Takes care of data transfer between Hardware input layer and Hardware Processing Layer.

10.5.2 Assumption: Synchronization Input subsystem sends required data.

10.5.3 Responsibility: This layer is responsible for receiving data from synchronization input subsystem, formatting the data, and sending it to Hardware input Driver subsystem.

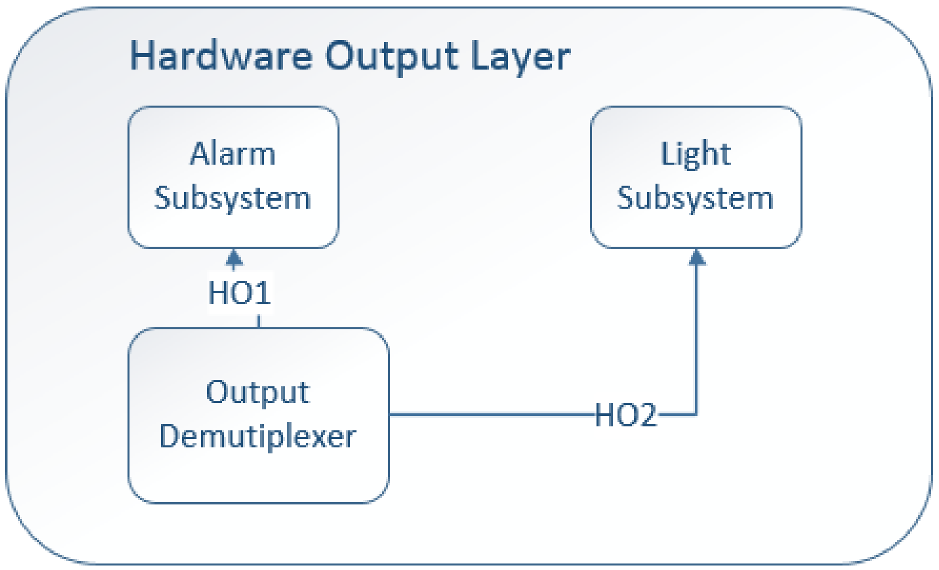
10.5.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
sendSynchorizedData	Send the data received from transfer data to HIDS	String of all merged data	Boolean

10.5.5 Public Interfaces: This subsystem does not have external interfaces.

11. Hardware Output Layer

All the hardware outputs in the form of light and sound are taken care of in this layer. The Hardware Output Layer includes alarm subsystem, output De-multiplexer and Light subsystem. This layer depends on the output from hardware output driver subsystem of Hardware processing layer.



11.1 Alarm Subsystem

11.1.1 Description: Receives input from Output de-multiplexer and generates sound alerts.

11.1.2 Assumptions: The speaker is working and output de-multiplexer is functioning properly.

11.1.3 Responsibilities: This subsystem is responsible for producing sound alert upon receiving instruction from Output De-multiplexer subsystem in cases when the user needs to be notified. The Alarm Subsystem can produce different sound pattern alerts depending on the instructions received.

11.1.4 Inter-Layer Interfaces: This subsystem does not have any internal interfaces.

11.1.5 Public Interfaces: This subsystem does not have any external interfaces.

11.2 Light Subsystem

11.2.1 Description: Receives input from Output de-multiplexer and causes the LEDs to flash.

11.2.2 Assumptions: The LEDs and de-multiplexer are functioning properly.

11.2.3 Responsibilities: The Light Subsystem is responsible for generating alert in the form of light on the LEDs upon receiving instruction from output de-multiplexer. It should be able to generate various patterns of light on the LEDs.

11.2.4 Inter-Layer Interfaces

11.2.5 Public Interfaces: This subsystem does not have any external interfaces.

11.3 Output De-multiplexer

11.3.1 Description: Receives input from Hardware Output Driver Subsystem in Hardware Processing Layer and sends it to Alarm Subsystem and Light Subsystem in Hardware Output Layer.

11.3.2 Assumptions: Hardware Output Driver Subsystem sends desired output to the subsystem.

11.3.3 Responsibilities: The Output De-multiplexer is responsible for receiving output from Hardware Output Driver Subsystem, de-multiplexing the outputs and sending these de-multiplexed outputs to alarm subsystem and light subsystem.

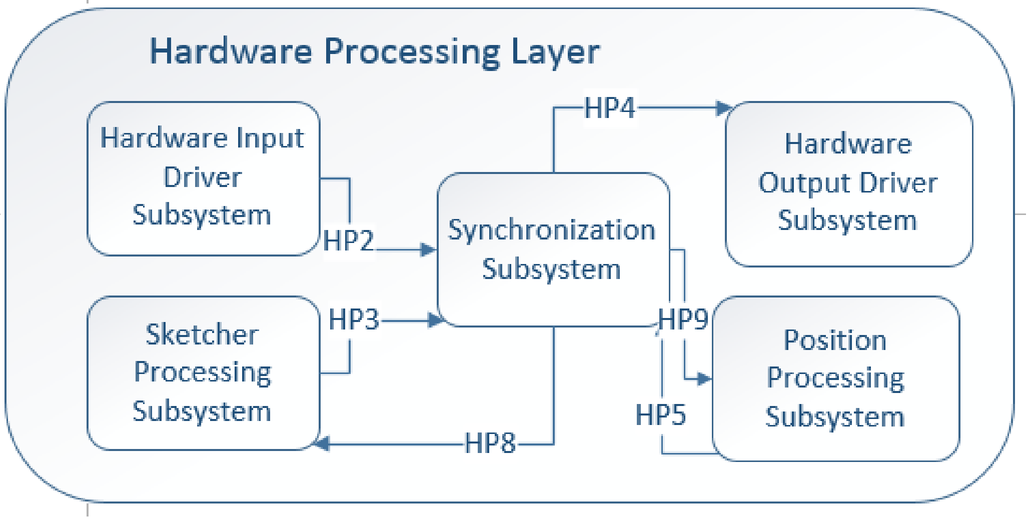
11.3.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receiveInstructionsFromHODS	Receives instruction from hardware output driver subsystem.	None	Data bits

11.3.5 Public Interfaces: This subsystem does not have external interfaces.

12. Hardware Processing Layer

The purpose of the Hardware Processing Layer is to analyze and process data along with communicating with the remainder of the hardware layers: Hardware Input Layer, Hardware Output Layer, Sketch layer and the Motion Layer. This layer is the central processing unit of the hardware. Essentially this is the microcontroller in the hardware that controls all of the motions including the Hardware Input Layer, the Hardware Output Layer, the Sketching Layer and the Motion Layer. The sections below provide a detailed description of this layer and its subcomponents – Hardware Input Driver Subsystem, Hardware Output Driver Subsystem, Synchronization Subsystem, Position Processing Subsystem, and the Motion Subsystem.


Hardware Processing Layer
Hardware Input Driver Subsystem
HP4
Hardware Output Driver Subsystem
HP2
Synchronization Subsystem
HP3
HP9
Sketcher Processing Subsystem
Position Processing Subsystem
HP5
HP8

12.1 Hardware Input Driver Subsystem

12.1.1 Description: Once the hardware has received the input from the software it will be synchronized and compacted in the Hardware Input Later. After this is completed, the information will be transferred through the Hardware Processing Layer through this interface subsystem.

12.1.2 Assumptions: The input layer has originally multiplexed the input information and has already synchronized the information received. The information is de-multiplexed ready to be processed.

12.1.3 Responsibilities: This subsystem de-multiplexes and processes the data that it receives from the Input later. Essentially this subcomponent is the interface that links the two layers of Hardware Input Layer and the Hardware Processing Layer.

12.1.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receivedInputCompacted	Received input from the Hardware Input Layer	None	Processed data

12.1.5 Public Interfaces: This subsystem does not have external interfaces.

12.2 Hardware Output Driver Subsystem

12.2.1 Description: Once the hardware has processed the input, sketching process and the motion component it will send the information to the output layer when it is required. When the Sidewalk Sketcher reaches a battery percentage of 20% the subsystem will send information to the Hardware Output Layer. Other information scenarios include when the chalk on the device is running low or when the image is finished being sketched.

12.2.2 Assumptions: The subsystem has received the correct flags from the Synchronization Subsystem letting it know when to connect with the Hardware Output Layer.

12.2.3 Responsibilities: This subsystem is responsible for interfacing with the Hardware Output Layer by zipping the information required for the output units in a data form that can be understood and process in its destination layer.

12.2.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
sendNextInstruction	Send the data required to trigger the output components	Flag identifier	Data to trigger the appropriate output subsystems

12.2.5 Public Interfaces: This subsystem does not have external interfaces.

12.3 Synchronization Subsystem

12.3.1 Description: This is the main processing unit of the Hardware Processing Layer. This subsystem will be controlled using the Raspberry Pi and its many ports. In this subsystem the information will all be stored, scheduled, and distributed through the rest of the subsystems in this layer.

12.3.2 Assumptions: There are no assumptions in this subsystem.

12.3.3 Responsibilities: This subsystem is responsible for storing, scheduling, and distributing the information to its necessary destination.

12.3.4 Inter-Layer Interfaces: This subsystem does not have internal interfaces**.**

12.3.5 Public Interfaces: This subsystem does not have external interfaces.

12.4 Sketcher Processing Subsystem

12.4.1 Description: Once the Synchronization Subsystem has gotten the data from the Hardware Input Driver Subsystem the Synchronization Subsystem will let the Sketch layer know what actions to perform next. This subsystem serves as the interface for this procedure.

12.4.2 Assumptions: The Synchronization Layer is performing its duty correctly.

12.4.3 Responsibilities: This unit is responsible for sending the data to the Sketch layer that will ultimately tell it what to do. This unit is also responsible for receiving status updates from the Sketch Layer to and eventually passing them to the Synchronization Subsystem that will be used in knowing how far in the sketching process is the Sidewalk Sketcher.

12.4.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receiveIntructions	Received data from the Synchronization Subsystem	File line number	Data concerning trigger flags for the sketch layer
sendStatus	Sends the status of the Sketch Layer to the Synchronization Layer	None	Data of the status of the sketching module

12.4.5 Public Interfaces: This subsystem does not have external interfaces.

12.5 Position Processing Subsystem

12.5.1 Description: Once the Synchronization Subsystem has gotten the data from the Hardware Input Driver Subsystem, the Synchronization Subsystem will let the Motion layer know what actions to perform next. This subsystem serves as the interface for this procedure.

12.5.2 Assumptions: The Synchronization Layer is performing its duty correctly.

12.5.3 Responsibilities: This unit is responsible for sending the data to the Motion layer that will ultimately tell it what to do. This unit is also receives status updates from the Motion Layer to be sent to the Synchronization Subsystem that will be used in knowing how far in the sketching process is the Sidewalk Sketcher.

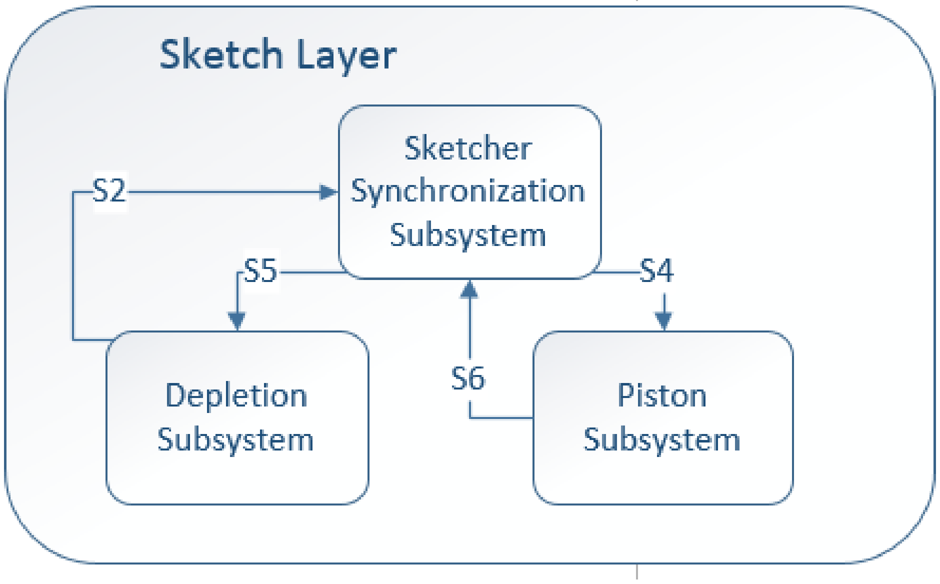
12.5.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receieveMotionResponse	Received the status of the Sketch Layer	None	Data of the status of the sketching module
sendStatus	Sends the status of the Motion Layer to the Synchronization Layer	None	Data of the status of the motion module

12.5.1 Public Interfaces: This subsystem does not have external interfaces.

13. Sketch Layer

The purpose of the Sketch Layer is to analyze all of the actions that will be performed by the sketching device that will drag the chalk, pick up the chalk when it's not drawing, and send the update to the Hardware Processing Layer when the chalk nears depletion This layer will communicate directly to the Hardware Processing Layer and the Hardware Input Layer. The Hardware Processing Layer will commute to let the processor know whether or not the chalk is near depletion along with whether the device should be in its writing state or in its floating state (floating meaning it is picked up because it is passing an area that there is no lines to be drawn) This layer will communicate with the Hardware Input Layer because it will have to send senor information to make sure the chalk is connecting to the ground when it is supposed to be sketching the image.



13.1 Sketcher Synchronization Subsystem

13.1.1 Description: This subsystem will be in charge of the communication between the Depletion Subsystem and the Piston Subsystem. Through this communication, this subsystem will know when the Sidewalk Sketcher's chalk is reaching depletion along with having the instructions ready to control the device. When this subsystem receives the instructions to lift up the sketching device, the subsystem will instantly communicate this information with its peer subsystems.

13.1.2 Assumptions: There are no explicit assumptions for this subsystem.

13.1.3 Responsibilities: This system will interface with the Hardware Processing Layer by de-multiplexing information received from the Hardware Processing Layer and distributing it throughout the remaining subsystems in this layer. It will also then send the current state of the Sidewalk Sketcher back to the Hardware Processing Layer.

13.1.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receiveIntructions	Received data from the Hardware Processing Layer	File line number	Instructions whether to pick up the sketching device or not
sendStatus	Sends the status of the Sketch Layer to the Hardware Processing Layer	None	Data updating the unit of its status and/or problems

13.1.5 Public Interfaces: This subsystem does not have external interfaces.

13.2 Depletion Subsystem

13.2.1 Description: This subsystem will be in charge of doing a sensor processing based on the remaining length of the chalk. This subsystem will receive input from the sensor readings and determine whether the chalk is nearing depletion.

13.2.2 Assumptions: There are no explicit assumptions for this subsystem.

13.2.3 Responsibilities: This subsystem will interface with the Sketcher Synchronization Subsystem and the Hardware Input layer to alert the system if the chalk is nearing depletion.

13.2.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
sendSensorData	Send input to the Hardware Input Layer	None	Sensor readings used to determine length of chalk

13.2.5 Public Interfaces: This subsystem does not have external interfaces.

13.3 Piston Subsystem

13.3.1 Description: This subsystem will interface with the Hardware Input Layer and the Sketcher Synchronization Subsystem. The main purpose of this subsystem is to pick up the sketching mechanism when the Sidewalk Sketcher is passing an area in the image that does not require vectors to be drawn. This unit will also consecutively work on making sure the chalk is always on the ground sketching the image when the system is supposed to be sketching.

13.3.2 Assumptions: There are no explicit assumptions for this subsystem

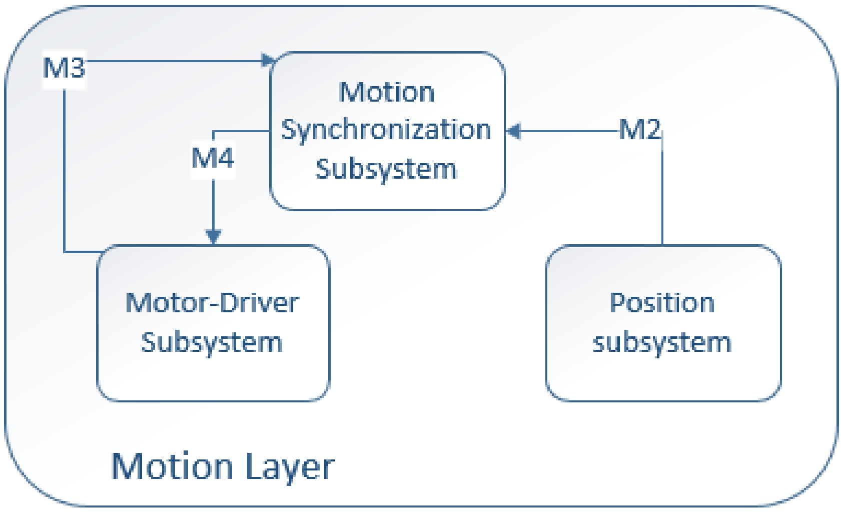
13.3.3 Responsibilities: This subsystem will is responsible for making sure the Sidewalk sketcher sketches when it's supposed to and does not when it is not supposed to (when it passes an area in the image that does not required to be sketched)

13.3.4 Inter-Layer Interfaces: This subsystem does not have internal interfaces.

13.3.5 Public Interfaces: This subsystem does not have external interfaces.

14. Motion Layer

The purpose of the Motion Layer is to analyze the mechanical motion that will be performed by the Sidewalk Sketcher and to ensure that the device is on the correct path. The Hardware Processing Layer will communicate with this layer and let the processor know where the robot is at any given position so that the processing unit can determine where to go next and let this layer know the updated information. This layer will communicate with the Hardware Input Layer because the Motion Layer will have to send the positioning data collected from the data and sync this input to know its absolute position relative to the marker devices used for positioning.



14.1 Motion Synchronization Subsystem

14.1.1 Description: This subsystem will be in charge of communication with the Motion-Driver Subsystem and the Position Subsystem. Through this communication, this subsystem will determine what where the robot needs to go next based on input which will receive from the Hardware Processing Layer. This subsystem will sync the information relative to position and next position instructions.

14.1.2 Assumptions: There are no explicit assumptions for this subsystem.

14.1.3 Responsibilities: This system will de-multiplex information received from the Hardware Processing Layer and distribute the information throughout the remaining subsystems in this layer. The subsystem will also then send the current state of the Sidewalk Sketcher back to the Hardware Processing Layer.

14.1.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
receiveIntructions	Received data from the Hardware Processing Layer	File line number	Position data
sendStatus	Sends the status of the Motion Layer to the Hardware Processing Layer	None	Data updating the unit if it is on the desired path

14.1.5 Public Interfaces: This subsystem does not have external interfaces.

14.2 Motion-Driver Subsystem

14.2.1 Description: This subsystem will be in charge of controlling the motors of the Sidewalk Sketcher and essentially controlling the physical motion of the device. This interface will control with the lowest level of the Sidewalk sketcher providing motion.

14.2.2 Assumptions: There are no explicit assumptions for this subsystem.

14.2.3 Responsibilities: This subsystem will interface with the motor drivers and provide the appropriate voltage to the motors in order to move the robot the required position.

14.2.4 Inter-Layer Interfaces: This subsystem does not have internal interfaces.

14.2.5 Public Interfaces: This subsystem does not have external interfaces.

14.3 Position Subsystem

14.3.1 Description: This subsystem will interface with the Hardware Input Layer and the Motion Synchronization Subsystem. The main purpose of this subsystem is to alert the motion layer about the updates of the robot's position so that the Sidewalk sketcher can be repairs its position dynamically.

14.3.2 Assumptions: There are no explicit assumptions for this subsystem

14.3.3 Responsibilities: This subsystem will interface with the Camera Processing Subsystem to get the position of the robot. The subsystem will then send the information to the Motion Synchronization Subsystem in order to synchronize the position the robot.

14.3.4 Inter-Layer Interfaces:

Method	Description	Parameter	Data Returned
sendPositionData	send position information to the Hardware Input Layer	None	Coordinates relative to the position markers

14.3.5 Public Interfaces: This subsystem does not have external interfaces.

15. Requirements Mapping

This section provides an overview of the key system requirements and how each layer provides its functionality to meet the requirement through a table. Note that the layers present in the table are only layers that complete key requirements. Some layers that are required to run the system are not present in this table.

Requirement Number	**Requirement Name**	**Software Input Layer**	**Hardware Input Layer**	**Software Output Layer**	**Hardware Output Layer**	**Sketch Layer**	**Motion Layer**	**UI Layer**	**Data Storage Layer**	**Software Processing Layer**	**Hardware Processing Layer**
3.1	Sketch Image		x			x	x				x
3.2	Sidewalk Sketcher Multicolor		x			x		X			
3.7	Sketch Dimensions							X	x	x	
3.8	Chalk Switch					x	x				x
8.1	Image Loading	x						X			
8.5	Push Chalk					x	x				x
8.6	Finished Image	x	x	x	x	x	x	X	x	x	x
8.7	Depletion Sensing		x			x					x
8.8	Chalk Reload		x		x						x
8.9	Positioning		x		x		x				x

16. Operating System Dependencies

This section is about the dependencies of our system layers with operating systems, form of libraries and interfaces. The system is designed to be dependent on two different modules. The initial step, which is to setup the user interface for Sidewalk Sketchers on users' computer, will be built using the Python programming language. The user interface will be designed for Windows users. Next, the user loads process image into the Sidewalk Sketcher, which uses Raspberry Pi that is dependent on a Linux kernel-base operating system known as Raspian.

16.1 Software Input Layer

The Software Input layer is designed for the Windows operating system. The user interface for Windows is created using the Python programming language. The Software Input Layer is responsible for converting the image file into a two color image using Open CV library or another similar library. In addition, the Software Input Layer is responsible for loading and reading the image file selected by the user. To read and load the file we expect to use the CSV library in Python.

16.2 Software Output Layer

The Software Output Layer communicates with the interface to send the final image to data manager, which is dependent on Windows operating system of the users' computer which will require Shutil.py library to be able to move file from one place to another.

16.3 Software Processing Layer

The image chosen by the user will be processed into two-color image on windows machine. The Processed image will be then communicate with Software output layer to transfer the file to Sidewalk Sketchers System.

16.4 Hardware Input Layer

The Hardware input layer is dependent on a Linux Kernel-base Operating System or Raspian. The Hardware Input Layer is responsible to read and load the processed image into the user interface for Raspberry Pi. The interface for the Raspberry Pi will also be created using Python.

16.5 Hardware Output Layer

The hardware output layer is also dependent on Raspian. The hardware output layer is responsible to communicate with the alarm subsystem and the light subsystem. This layer will perform this communication using source code written in Raspian.

16.6 Sketch Layer

Information will be received from Hardware Processing layer by the Sketch Layer. This layer is dependent on Raspian and will use the data it receives as conditions to know what action to perform next.

16.7 Motion Layer

Information will be received from Hardware Processing Layer by the Motion Layer. This layer is dependent on Raspian and will use the data it receives as conditions to know where to move next.

16.8 Hardware Processing Layer

The Hardware Processing Layer will obtain data packets from the Hardware Input Layer. The Hardware Processing Layer is dependent on the Raspian operating system as well.

17. Testing Considerations Section

This section details the testing considerations of all the different layers of the system. These testing considerations are specifically used to help assist the development and the testing process. To properly and efficiently test the functionality, modularity, and effectiveness of each layer, interaction between layers are minimized. These tests are conducted to help ensure that the functionality of each layer can be properly ensured.

17.1 Overall Considerations

17.1.1 Code Review: Code Reviews will be used to constantly ensure the functions of each layer are being implemented properly. This provides opportunities to find any bugs prior to testing that can help prevent larger problems.

17.1.2 Ease of Use: Everything should be intuitive and quick to respond to the user. The user should not be able to independently learn the implementation of the function in order to properly use to the system.

17.1.3 Beginning-to-End: Upon completing use cases, the system will be tested from beginning to end in order to test compatibility, completeness, and system functionality. These results will be compared to the expected output results to ensure the validation of the overall system requirements.

17.2 Software Input Layer

17.2.1 Modularity: The Software Input Layer must not be dependent on the internal subsystems of other layers.

17.2.2 Internal System Interaction: The Image Reader will send files to the converter system in order to transfer the files to Image Processing.

17.2.3 External System Interaction: This layer interacts with the User Interface Layer after the user has submitted any changes and configurations to the image.

17.3 Software Output Layer

17.3.1 Modularity: The Software Output Layer must not be dependent on the internal subsystems of other layers.

17.3.2 Internal System Interaction: The Data Packaging will receive data from Image Processing and the File Generator to transfer the file to the Hardware Input Layer

17.3.3 External System Interaction: This layer interacts with the Software Processing Layer and the Hardware Input Layer. The data file will be sent for processing and output to device in order to begin the Hardware Input Layer.

17.4 Software Processing Layer

17.4.1 Modularity: The Software Processing Layer must not be dependent on the internal subsystems of other layers.

17.4.2 Internal System Interaction: The Image Processing subsystem receives and outputs files from the Information Processing Subsystem.

17.4.3 External System Interaction: This layer interacts with the Software Input Layer, User Interface Layer, Data Storage Layer, and Software Output Layer in order to grab, send, and process information from all layers.

17.5 User Interface Layer

17.5.1 Modularity: The User Interface Layer must not be dependent on the internal subsystems of other layers.

17.5.2 Internal System Interaction: There is no internal subsystem interaction.

17.5.3 External System Interaction: This layer interacts with the Software Processing Layer and the Software Input Layer. The layer also interacts with the User for the File Browser, Cropping, Resize, and Color Selector subsystem.

17.6 Data Storage Layer

17.6.1 Modularity: The Data Storage Layer must not be dependent on the internal subsystems of other layers

17.6.2 Internal System Interaction: The Database Manger sends requests to the File Repository and Image Repository in order to grab image or data files.

17.6.3 External System Interaction: This layer interacts with the System Processing Layer and the Software Output Layer.

17.7 Hardware Input Layer

17.7.1 Modularity: The Hardware Input Layer must not be dependent on the internal subsystems of other layers

17.7.2 Internal System Interaction: The File Reader, Sensor Reader, Camera Processing, and Transfer Data subsystem all interacts with the Synchronization Input Subsystem.

17.7.3 External System Interaction: This layer interacts with the Software Output Layer, Sketch Layer, Hardware Output Layer, Motion Layer, and Hardware Processing Layer. The layer also interacts with the user for power and start button.

17.8 Hardware Output Layer

17.8.1 Modularity: The Hardware Output Layer must not be dependent on the internal subsystems of other layers

17.8.2 Internal System Interaction: The Light subsystem throws an event to the Output De-multiplexer which gives an indication to the Alarm Subsystem

17.8.3 External System Interaction: This layer interacts with the Hardware Input Layer and Hardware Processing Layer

17.9 Hardware Processing Layer

17.9.1 Modularity: The Hardware Processing Layer must not be dependent on the internal subsystems of other layers.

17.9.2 Internal System Interaction: The Hardware Input Driver, Hardware Output Driver, Sketcher Processing, and Position Processing will communicate to the Synchronization Subsystem for processing.

17.9.3 External System Interaction: This layer interacts with the Hardware Input Layer, Hardware Output Layer, Motion Layer, and Sketcher Layer.

17.10 Sketcher Layer

17.10.1 Modularity: The Sketcher Layer must not be dependent on the internal subsystems of other layers.

17.10.2 Internal System Interaction: The Piston and Depletion Subsystem communicates with the Sketcher synchronization subsystem for processing.

17.10.3 External System Interaction: This layer interacts with the Hardware Processing Layer and Hardware Output Layer

17.11 Motion Layer

17.11.1 Modularity: The Motion Layer must not be dependent on the internal subsystems of other layers.

17.11.2 Internal System Interaction: The Position and Motor-Driver subsystem communicates with the Motion Synchronization subsystem to process the location and motor of the hardware.

17.11.3 External System Interaction: This layer interacts with the Hardware Processing Layer and the Hardware Input Layer.