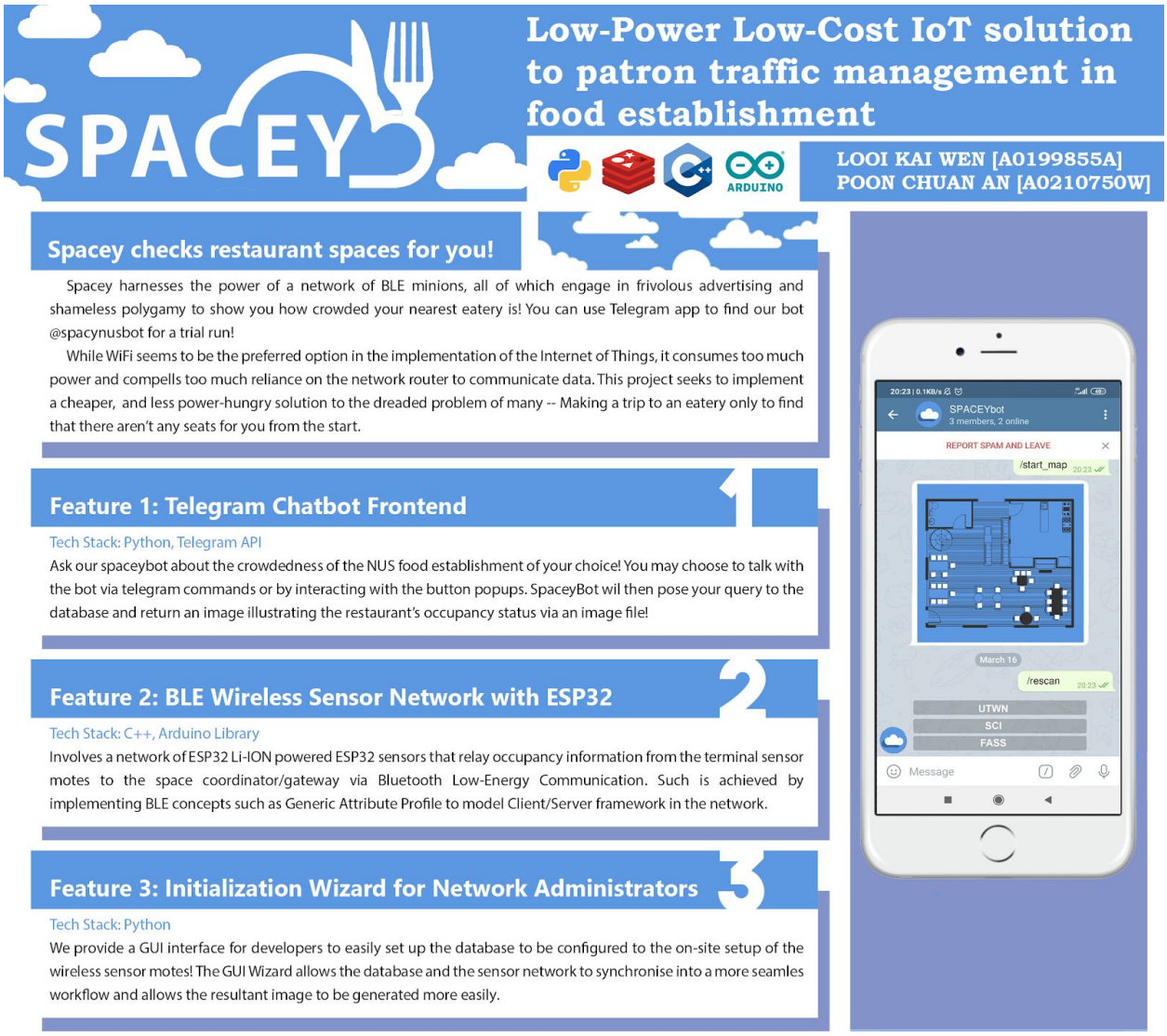
GUI Application for network administrators

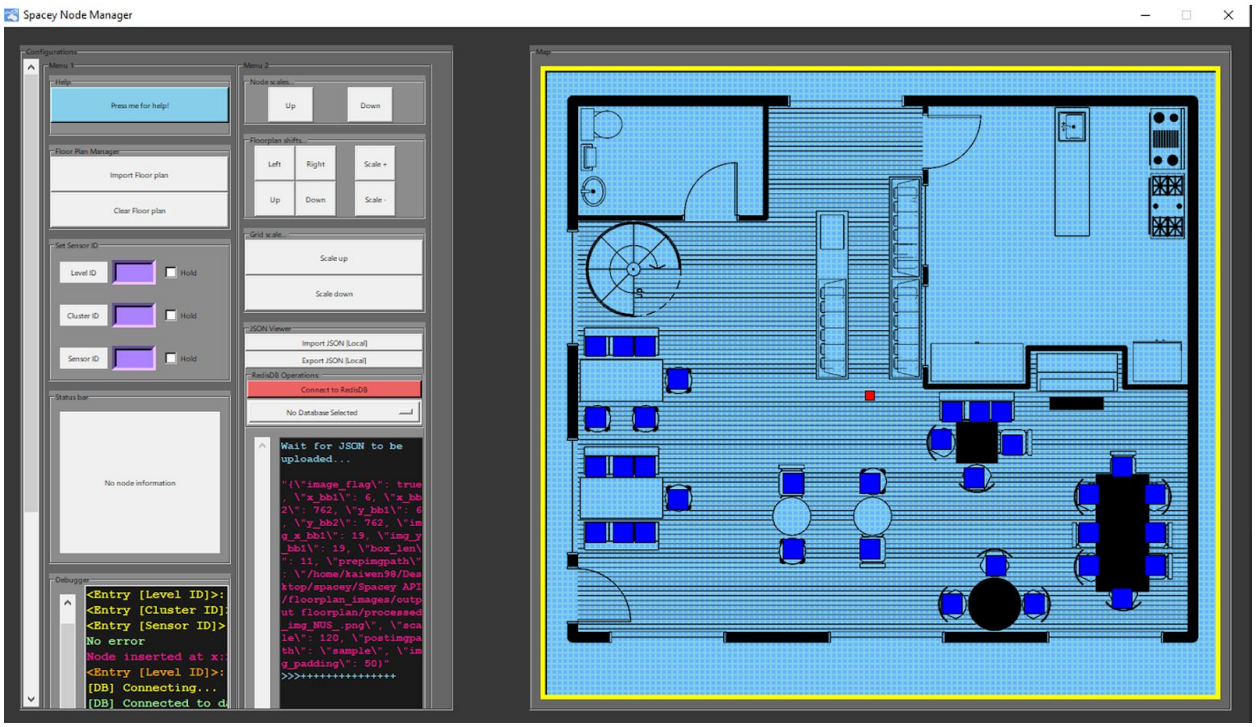
<Release 1.0.2>



Thank you for using Spacey Services. Kindly follow the instructions below for a painless setup for the BLE network, so that your sensor nodes can start to talk with your database!

If you have any issues, kindly visit https://github.com/kaiwen98/spacey/ and pull an issue! You can also contact the author on GitHub to pose your feedback!

Brief Summary



The Spacey GUI serves as the coordinating software between the sensor network and the database, especially the image generated. The GUI allows users to feed the cluster ID and seat ID of each sensor to the database, and configure such that a change in status in the corresponding cluster ID and seat ID will result in an update in the database which corresponds with the cluster and seat ID; all of which done in a very intuitive and simple manner.

The GUI also doubles as a graphic editor, whereby the administrator can denote seats in their relative positions along the fixed grid lines with simple mouse controls and keyboard shortcuts. He or she can choose to upload an image of the restaurant floor plan as overlay as reference. Upon saving the configuration, the coordinates of the seats will be saved in the database, whereby retrieval during user query will be used by a separate image processing library to draw a more refined representation before sending them out to Telegram.

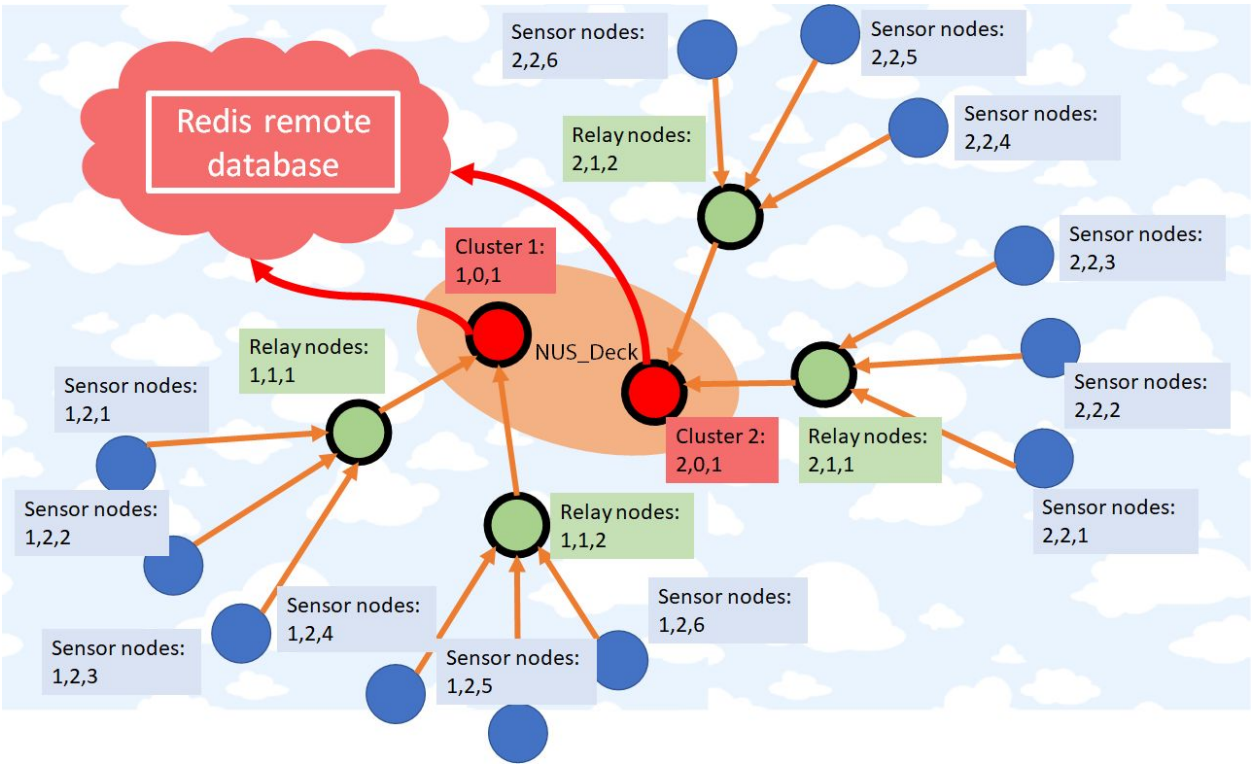
Please note that you are to use this GUI software with an existing sensor network setup. Kindly refer to the next section to quickly fill in on the required operational summary, so that you can begin your setup proper!

Technical precursor

Please make sure to understand the following before you proceed:

- **Hardware requirements:**
    a) Our solution requires the deployment of **ESP32** with WIFI and BLE support. You can go to https://github.com/kaiwen98/spacey and download the dependency libraries required to program your devices.
    b) Our ESP32 sensor nodes use a capacitive touch sensor to detect seat occupancy. You will need to acquire them via DIY/ purchase from other suppliers.
        i) The capacitive touch sensor is hooked up to GPIO 4 of the ESP32 microcontroller.
        ii) While the threshold value is automatically calibrated for you, you will need to hardcode your values if you wish to change the sensitivity of the touch sensor.
    c) The ESP32 powers with minimally 2X18650 Lithium Ion batteries connected in series.
        i) For an alternative power source, you are advised to acquire a power source that ranges between 5V to 12V as per ESP32 guidelines. **ONLY POWER THE ESP32 THIS WAY VIA THE VIN PIN. THE ON-BOARD VOLTAGE REGULATOR STEPS DOWN THE VOLTAGE TO 3.3V AND WILL NOT BE ABLE TO SUPPORT HIGHER VOLTAGES.**
        ii) You may also power the board from a stable 3.3V power source, supplying it to the 3V3 pin on the board. **YOU MUST ACCOMPANY THE SUPPLY WITH A FUNCTIONAL 3.3V VOLTAGE REGULATOR, SINCE THERE IS NO ELECTRICAL COMPONENTS OTHERWISE TO SHIELD THE ESP-WROOM MICROCONTROLLER FROM THE SPIKE IN VOLTAGE. WE STRONGLY RECOMMEND THE USE OF A BUCK-BOOST CONVERTOR ON ANY INDUSTRIAL-GRADE VOLTAGE REGULATOR, SUCH AS HT7333-A.**
- **Software requirements:**
    a) You will need to install Arduino IDE to program your microcontroller the first time. Note that you only need to program it once for basic operations, resetting of the cluster number can be done while the sensor node is running.
    b) The GUI package from the release section on GitHub is already bundled with the required dependencies. The installer is only for Windows OS. Linux users will need to install the package as a Zip File from the GitHub page and run the program from the shortcut.
    c) For the resetting of the cluster number on the nodes, you will need to install nRF Connect. You can then communicate with the sensor directly to reset the cluster number. Refer to the appendix for explicit instruction.

- **Setting up your BLE network:**



Cluster Number conventions

a) Each BLE node must have a unique cluster number to function properly. In addition, they must follow a certain convention as described below.
This is because each node is configured to filter off nodes with incompatible cluster numbers to preserve the concept of independent cluster and directed flow of information. A relay node will only listen for BLE advertisements from nodes with the same cluster ID and a cluster level greater than its own cluster number by 1..
You will need to follow the following cluster number convention for the BLE network to work:

XX,XX,XX

<cluster ID>, <cluster level>, <sensor ID>

i) **Cluster ID** refers to the sub-clusters that compose the entirety of your BLE network cluster and spans a subsection of your establishment. Each sub-cluster is represented by a single cluster head node, which consolidates all the information from the descendent nodes and relays them to the database. The bigger your restaurant, the more individual clusters you will need the span the entirety of the restaurant space.

ii) **Cluster Level** refers to the distance of the node from the root node. All cluster head nodes have the cluster level of 0. If the node is the direct child of the root node, it will have the cluster level of 1.

iii) **Sensor ID** is unique to each node that exists in the same cluster level in the same sub-cluster.

b) Following the conventions above and ignoring connection-distance constraint, you can cover 256 seats with 256 + 51 + 10 + 2 nodes with:

i) 256 sensor nodes with cluster level 3
ii) 51 relay nodes with cluster level 2
iii) 10 relay nodes with cluster level 1
iv) 2 cluster head nodes with cluster level 0

Physical setup

c) Sensor nodes should be placed in a discrete location near the seats and reasonably undiscoverable by customers. The sensor nodes require a portable power source, but the relay nodes and the cluster head nodes can be connected to the mains depending on its location.

d) Relay nodes one level below the sensor nodes should be distributed evenly such that each node covers around 5 or 6 sensor nodes ideally. Conversely, relay nodes should be distributed such that it covers around 5 to 6 direct children relay nodes. You can position them with the idea that they help to relay the information from the sensor nodes along the BLE network to the cluster head node.

e) Cluster head nodes **MUST** be placed in a location with strong WiFi signal.

f) You are strongly advised to follow the following basic steps leading to the set-up of the BLE network:

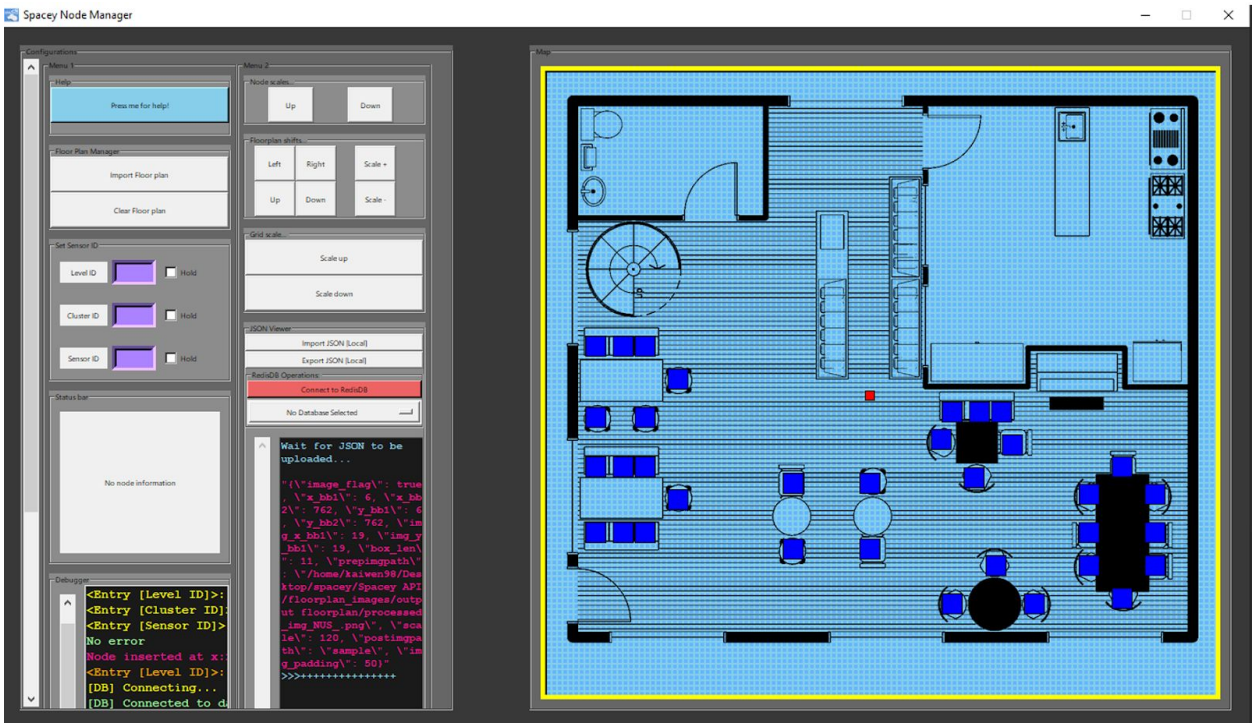
   i) Study your location and determine the possible locations of the various types of nodes.

   ii) Have the nodes programmed with their respective sketches and assigned their cluster number.

   iii) Place the nodes in location and ensure that the distance between each node is serviceable to maintain a reliable BLE connection.

   You can then communicate your mapping of the various nodes with their assigned cluster numbers and their location to the GUI, which then converts the information to an output graphic which can be updated appropriately when the occupancy status of any of the nodes change.

Instructions

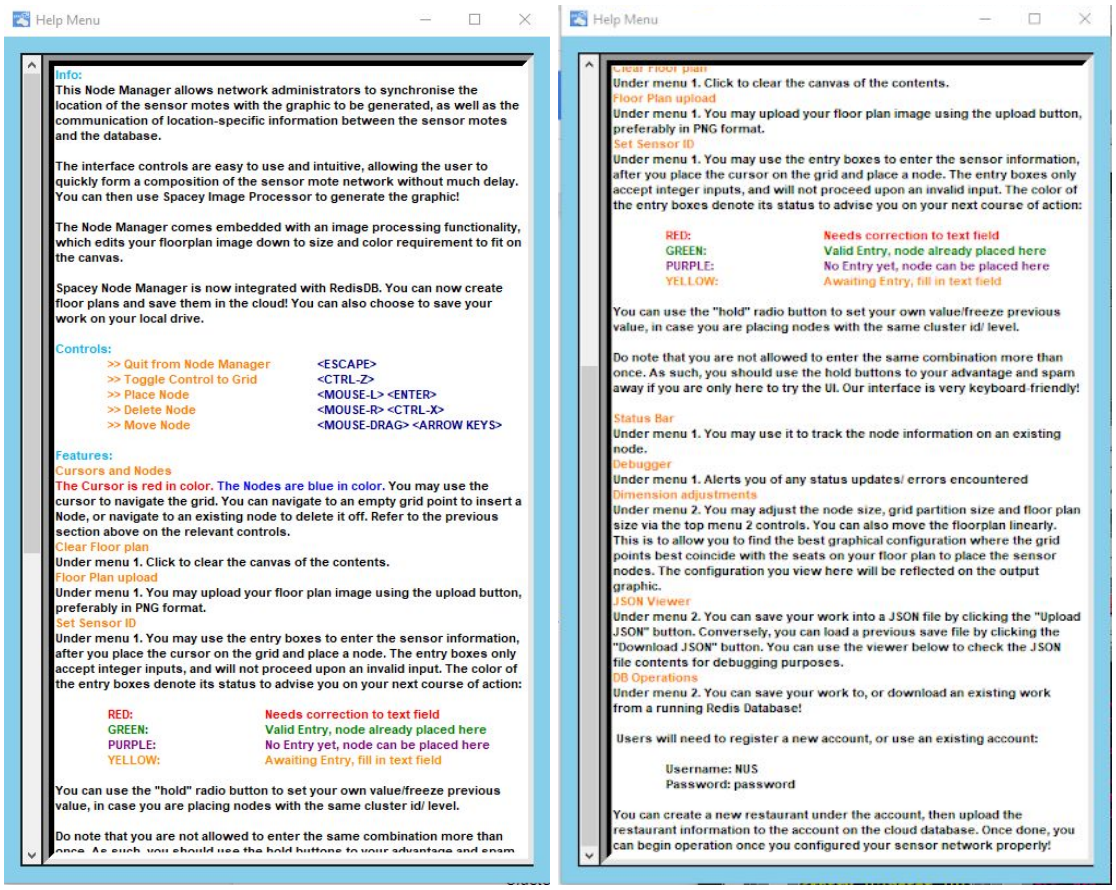


The GUI is rich with a plethora of features to help you integrate Spacey services to your establishment. The section below aims to document the various tools that are available to your free use.

- Tips:
    1) What you see on the right is the **Canvas**, it depicts the output graphic in terms of dimension details, such as the size of the nodes, the spacing between them, and the relative border height and width etc. What you see on the canvas is approximately what will appear on your output graphic.
    2) The left of the GUI are a list of controls that will be documented further below.
    3) The GUI is designed to be extremely keyboard friendly. We highly encourage you to use the available keyboard controls to register the cluster numbers.
    4) The GUI is also designed to be flexible in terms of size changes. Use the tools on the right to make sure your floor plan looks neat and tidy!
    5) Refer to the help menu for further information.

- **Help Menu**

  Features a pop-up window for users to browse through to quickly be acquainted with the controls of the GUI.

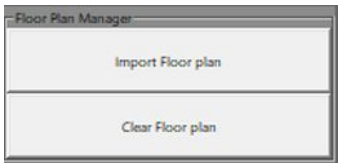


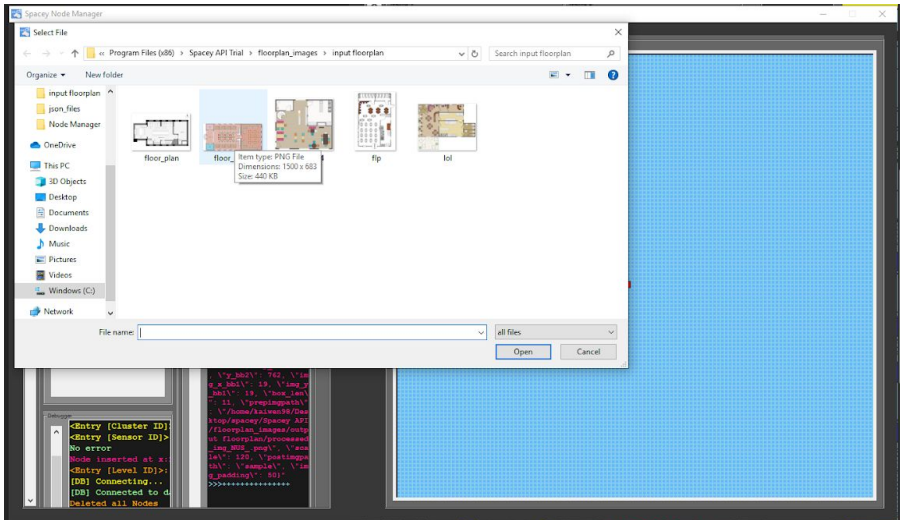
- **Floor Plan Control**

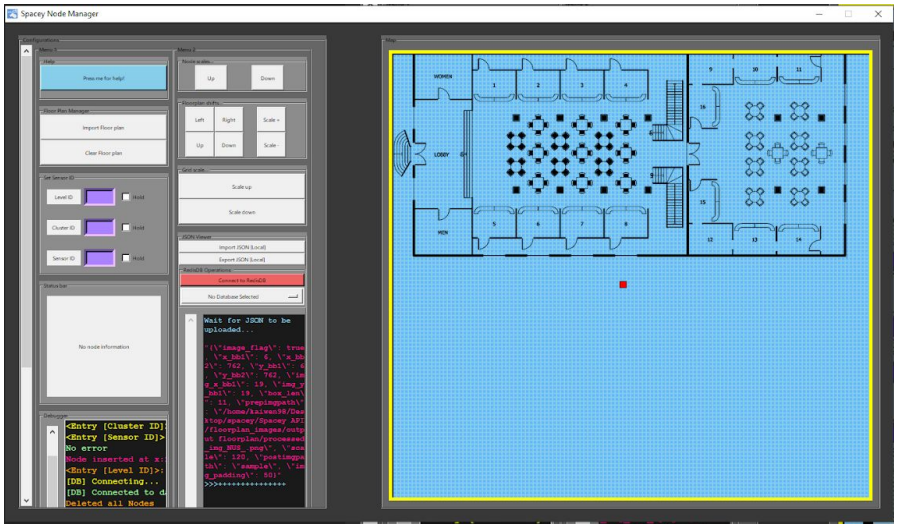
  Floor Plans can be uploaded from the user's local drive to be processed. The GUI backend uses the Python Image Library to process the image to give a clean and standardised floor plan template to be used in the output graphic.

  1. Convert the image to a sequence of RGBA pixel
  2. If the pixel has greater values in the first 3 components (RGB), they are unlikely to form the outline of the floor plan. Hence, we set the pixel in the new image to alpha=0, meaning such regions will be transparent in the output.
  3. If the pixel has smaller values in the first 3 components (RGB), they are likely to form the outline of the floor plan. Hence, we set the pixel in the new image to alpha=1 and of a standardised color, meaning such regions will appear in the output as outline.

  After the process, the modified image will be saved in a PNG file and will be displayed on the GUI canvas.

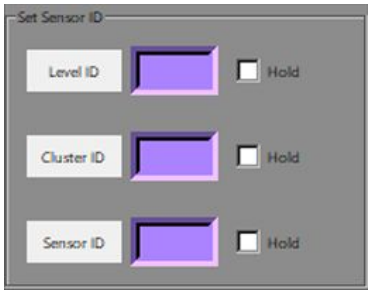




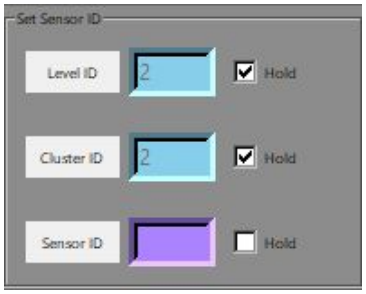


- **Set Sensor ID**
  Allows users to enter in the ID values of the sensor nodes. Although we have configured the 3 fields to be labelled as Level ID etc, the significance of each data field can be up to the administrator to decide, so long as the IDs set are all unique to one another.
  To assist the administrators in the assignment of the sensor node IDs, we have implemented a hold feature for the user to freeze the values in place and edit the relevant field.

  Default:

  The previous values are frozen:

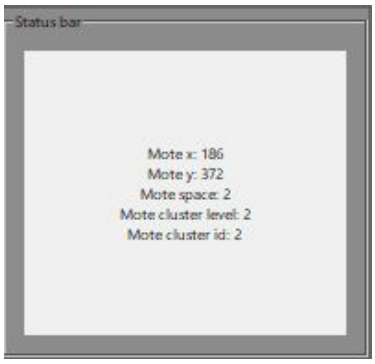
  Non-integer values not accepted:

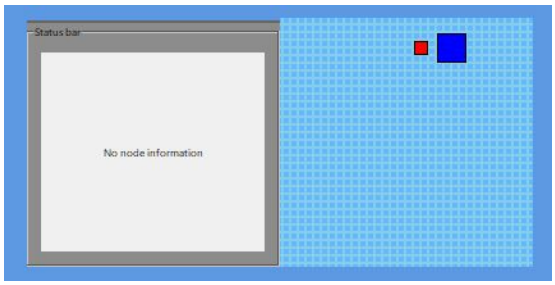
  

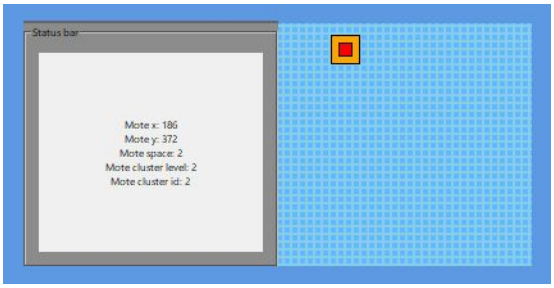
  Valid combination of values accepted:

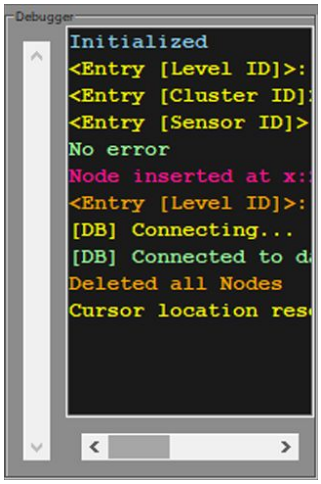
- **Status Bar**
  Displays the information of the nodes being placed, for reference purpose.





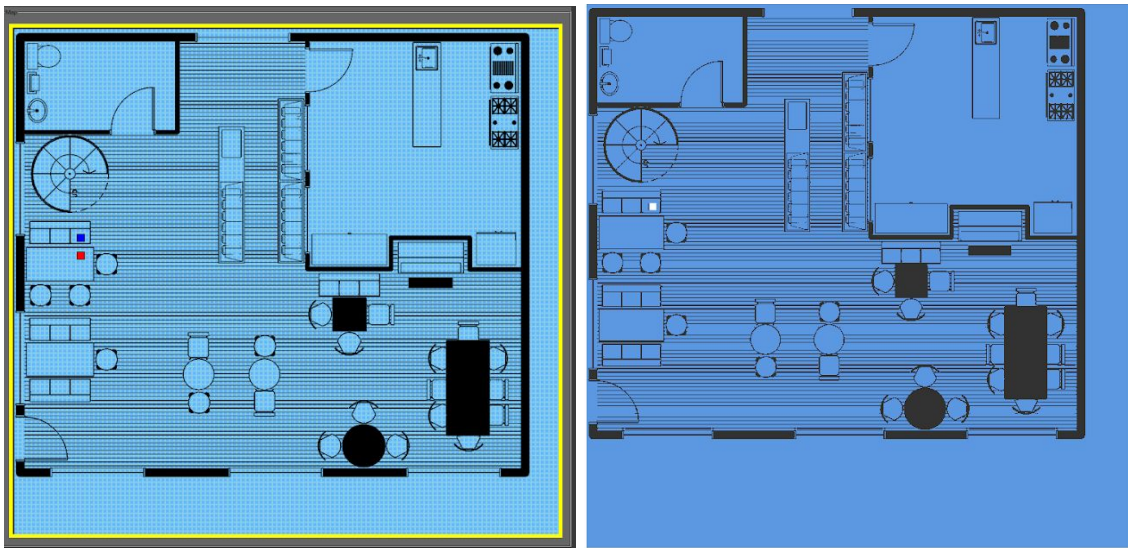


- **Debugger**
  Displays status information and error messages, including:
  - Error in input values of ID
  - Not connected to network
  - Reset of canvas
  - Repeat in sensor values
  - Invalid login information

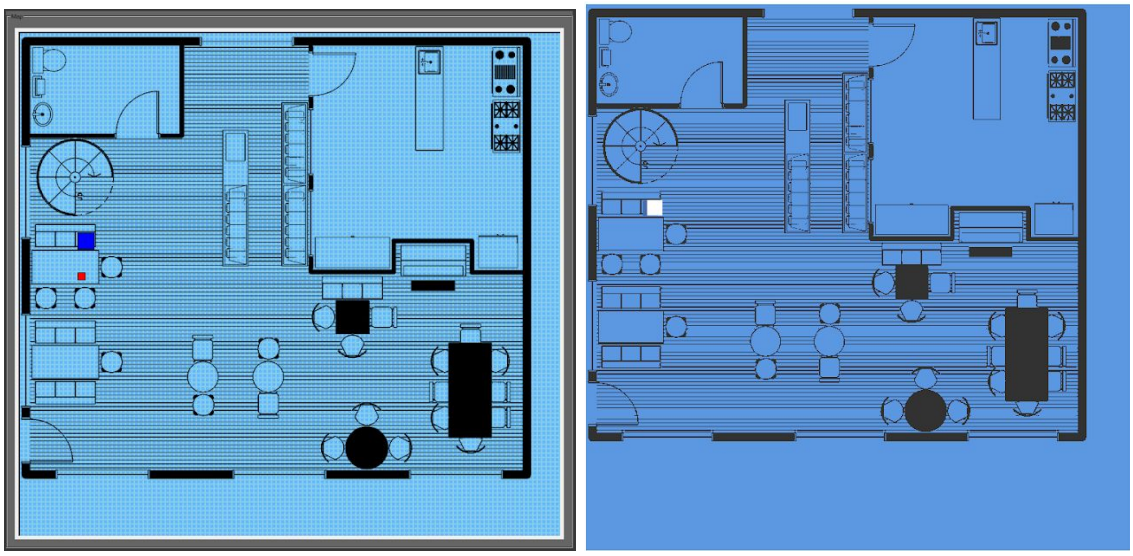


- **Node scaling**
  Allow the user to scale the node up and down in size for aesthetic purposes.

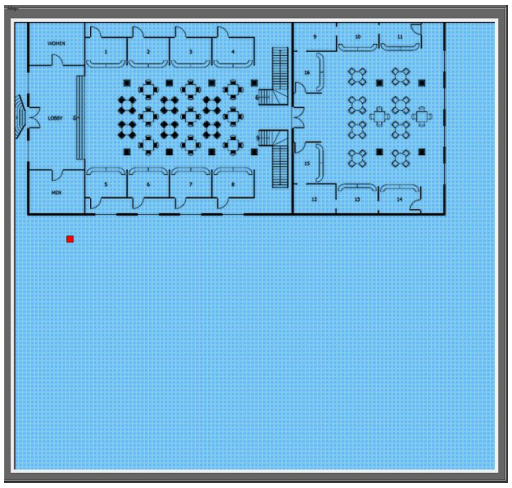
Before scaling:

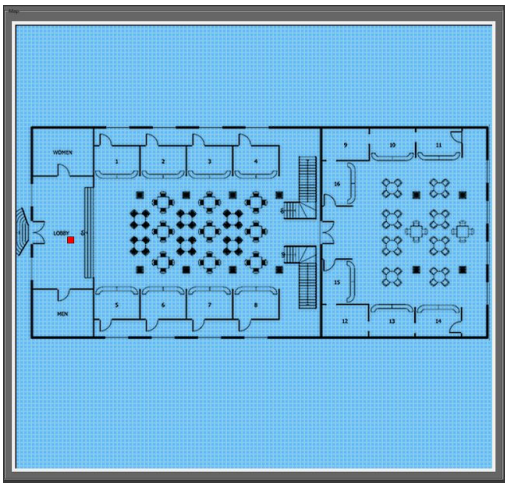


After scaling:

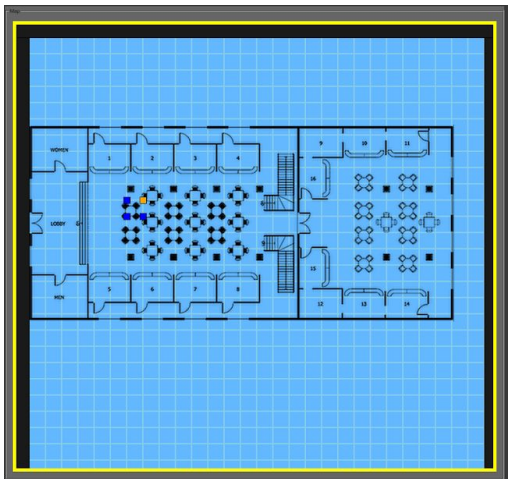


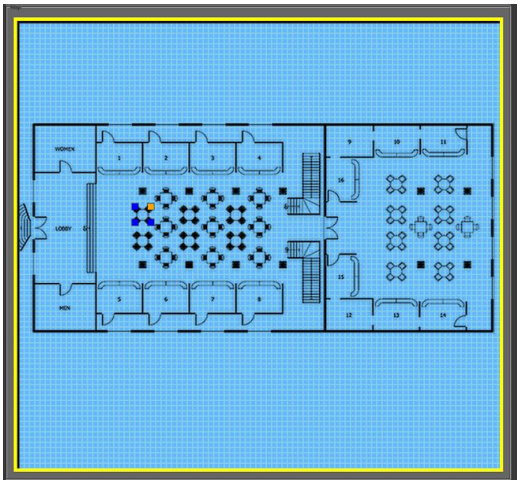
- **Floor Plan translation**
  Enables the user to adjust the size and position offset of the image for aesthetic purposes.



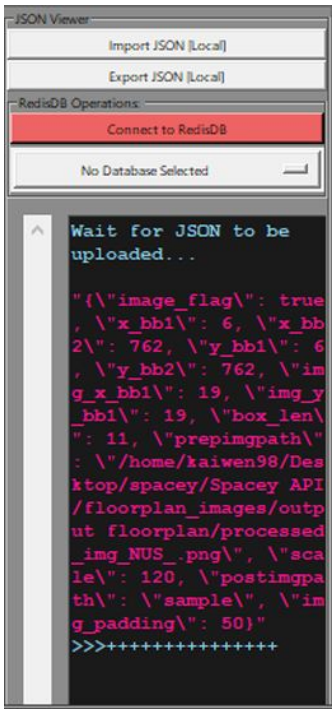


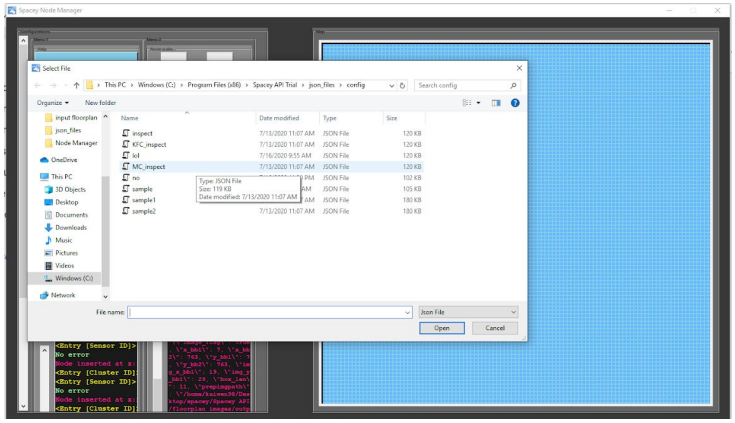
- **Grid Scale**
  Recognizing the fact that floorplan may differ from one to the other by the relative positioning of the seats, we allow the users to adjust the scale of the grid so that they can find one that best coincides with the seats on the floor plan.

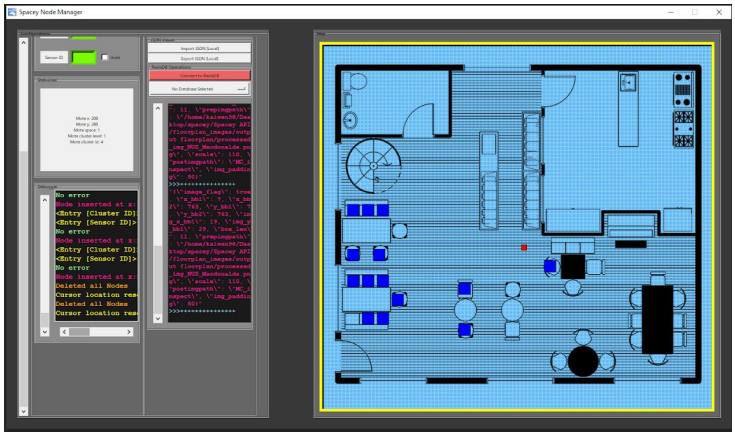




- **JSON viewer**
  The GUI allows users to save their work into their local drive into a set of JSON files, in which they can load into the GUI in the future to continue their work.
  The JSON viewer also allows the users to view the contents saved should they find the need to.







- **DB capabilities**

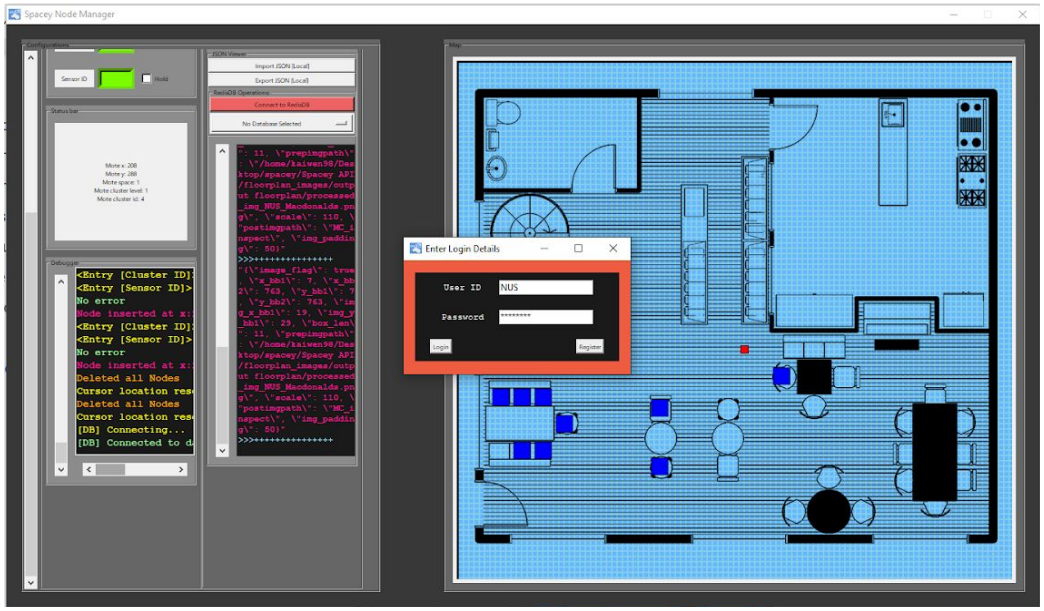
  Administrators can connect to RedisDB to access uploaded floor plans/ upload floor plans to their account. They must register for a new account, or log in to an existing one to gain access to the database which they are authorised to view and edit.

  The password of the users are not stored in the database as it is; their login details are processed through the “Spacey Secret Cipher” and SHA256 hash function before being stored in the database. In the event of accidental leak of data, the user’s login details will not be easily compromised.

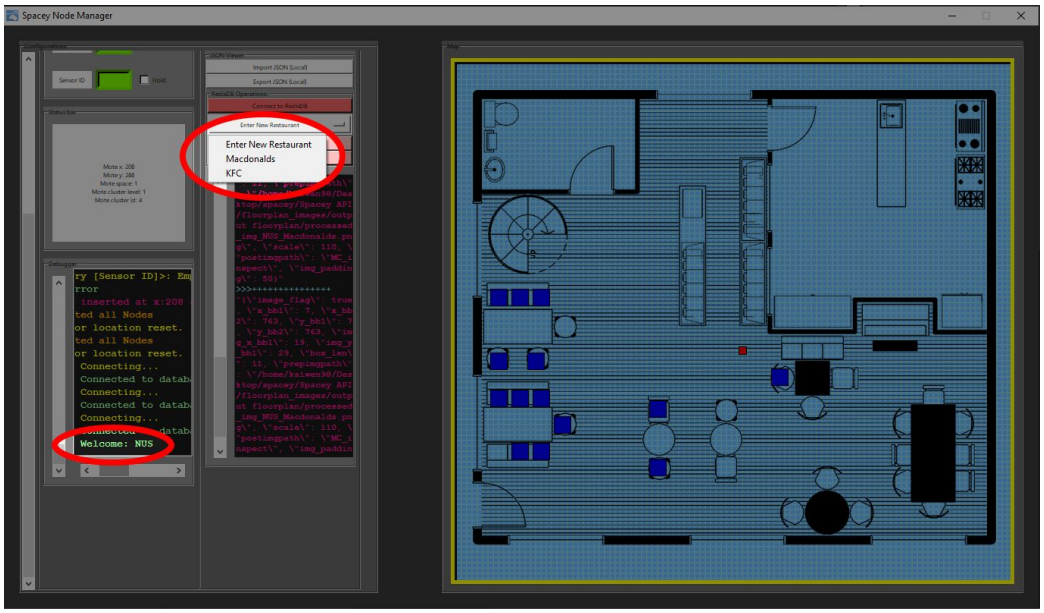
  ```
  {'NUS': 'ec9193f8f25777fc0dbd511fdd617feee807ca9c4de6b51045b9cf98c535bcac'}
  ```

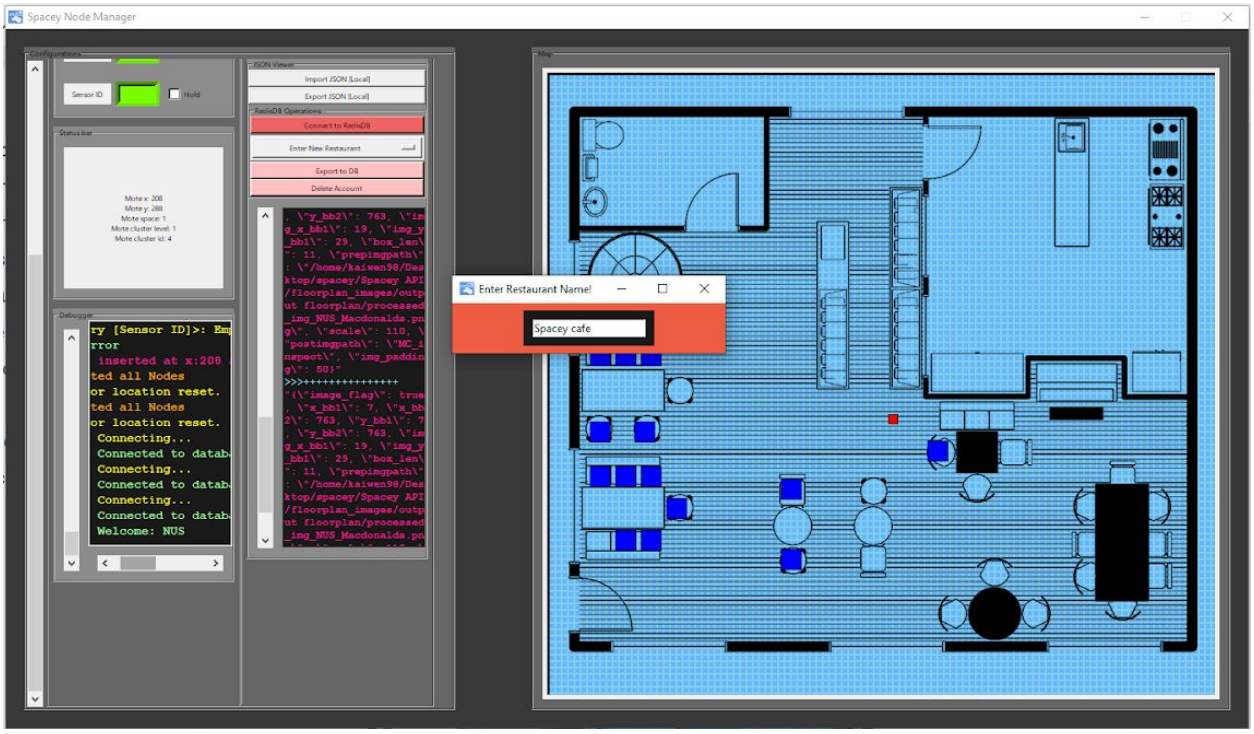
  After a successful log-in, users can upload or download floor plans from existing restaurants for edit. They can even upload floor plans from their local drive to a new restaurant.

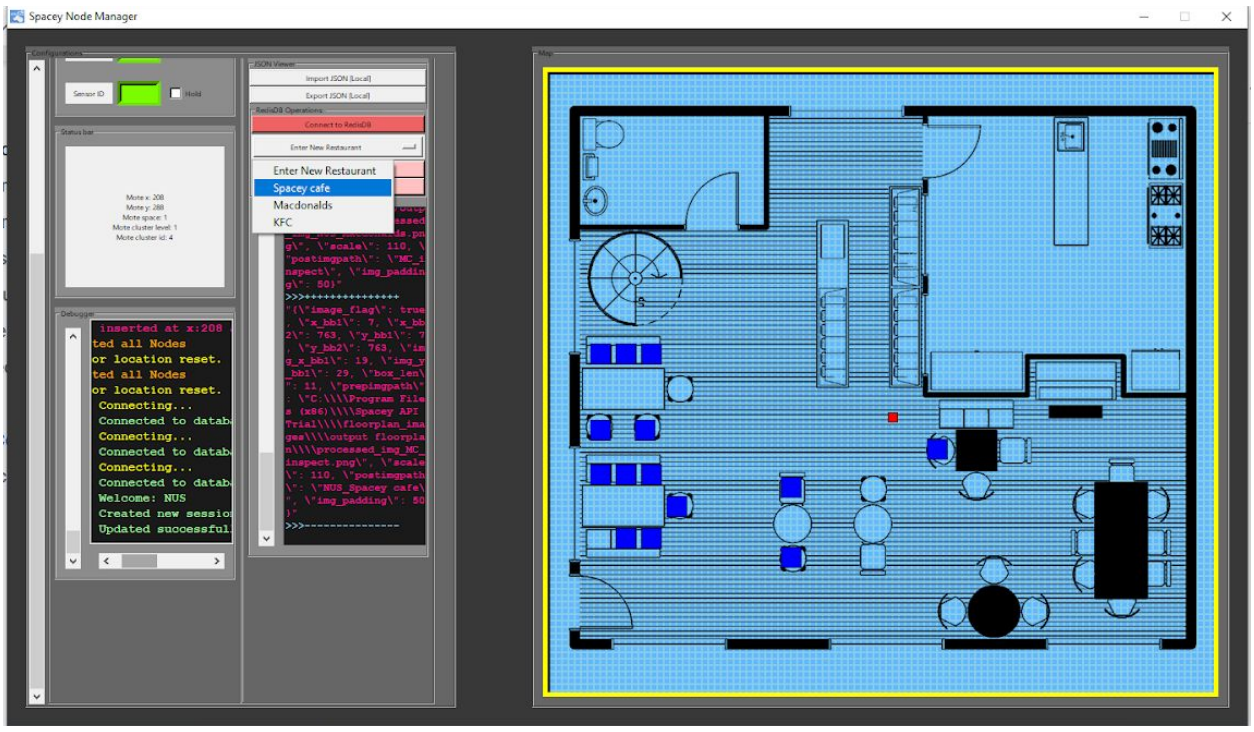
  Before Login:

  After Login:


Spacey Node Manager
Enter Restaurant Name!
Spacey cafe


Spacey Node Manager
Enter New Restaurant
Spacey cafe
Macdonalds
KFC