## Stirring Subsystem

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The stirring subsystem is composed of a stirring rod, a CP2S700HCP photo-interrupter and a 3V DC motor with maximum current at 1 A. Both the photo-interrupter and the motor is connected to an Arduino board using jumper cables.

The Arduino board takes an input of the photo-interrupter, measures the time of each pulse, and calculates the rotations per minute (RPM). At the same time, it provides an output to the motor, controlling the voltage.

The Arduino board is also connected to ESP32 using I2C protocol. It sends the RPM values to ESP32, allowing them to be shown on the dashboard using HTTP protocol. In the mean time, it receives user input (if any) to change its range accordingly.

The circuit diagram of the subsystem is shown as follows:

Figure 1 Circuit diagram of stirring subsystem

The Arduino is also used to control the RPM within a given range: 500 - 1500. When the subsystem is started, it provides an output at 80, resulting in an RPM roughly at 1000. While the system is running, RPM is constantly calculated. When it falls below 650, the output is increased to maintain the RPM in the range. On the other hand, if RPM gets above 1350, the output is decreased.

The requiring range can be controlled by the user via dashboard. Then the upper and lower bounds to judge if the RPM is valid should be changed accordingly.

The graph of RPM versus time is shown as follows:

Figure 2 Graph of RPM versus time

Several tests are carried out to test the function of the subsystem. The table summarizing them is shown as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| **Test** | **Procedure** | **Expected operation** | **Result** |
| Starting with high output | A high output is given as initial value. This output causes RPM to exceed upper limit. | RPM decreases as output decreases. | Pass |
| Starting with low output | A low output is given as initial value. This output causes RPM to fall below lower limit. | RPM increases as output increases. | Pass |
| Interfere the system | Use hands to stop or slowing down the system for a while. | After the interference, output and RPM should increase. | Pass |

Table 1 System functioning test results