Remote Triggered Labs
Vanishing Rod Experiment

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The Objective of the RTL initiative is to be able to perform high school level experiments remotely without the physical presence of the experimenter with the help of IoT implements.
Under this initiative, the following document records the working and details of the Vanishing Rod Experiment.

Materials Used

- Raspberry Pi 3B+ Microprocessor
- Raspberry Pi camera (Noir V2)
- 28-ybj-48 5 V stepper motors
- Uln2003A stepper motor drivers
- Glass rods (Refractive index ≈ 1.5)
- Glass Beakers
- Sunflower Oil (Refractive index ≈ 1.47)
- Water (Refractive index ≈ 1.33)
- Wooden planks and foam board (for making frame)

Physics of the Experiment

The main physics behind the experiment can be summarized as

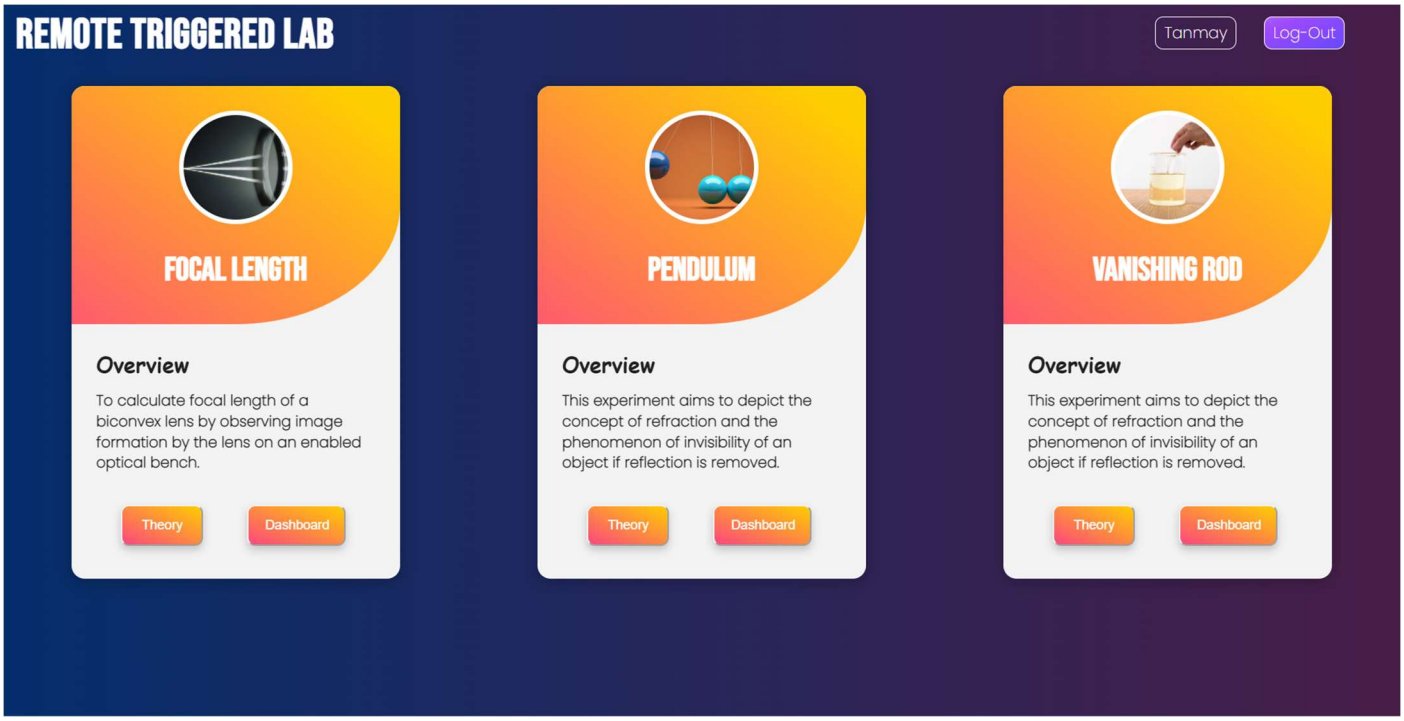
- Whatever we see around us is due to the light which gets reflected from the object and reaches our eyes.
- If this reflection is somehow removed, then no light will reach the observer and hence he/she will not be able to see the object, effectively making it invisible.
- When the rod is immersed in water, due to different refractive indices of the water and the glass, light bends to different degrees in both the mediums and hence we are able to discern between the separate mediums.
- On the other hand, when the glass rod is immersed in oil, since the refractive indices are similar, light behaves as if it is passing through a homogenous medium. As a result, our eyes are not able to differentiate between the glass rod and the oil and hence the rod appears to have disappeared.

The Dashboard and How to use it

In order to actually perform the experiment, we have made a dashboard to control the setup remotely. In this section, we'll see how to actually use it
The dashboard can be accessed through the following URL
https://sehgaladitya26.github.io/

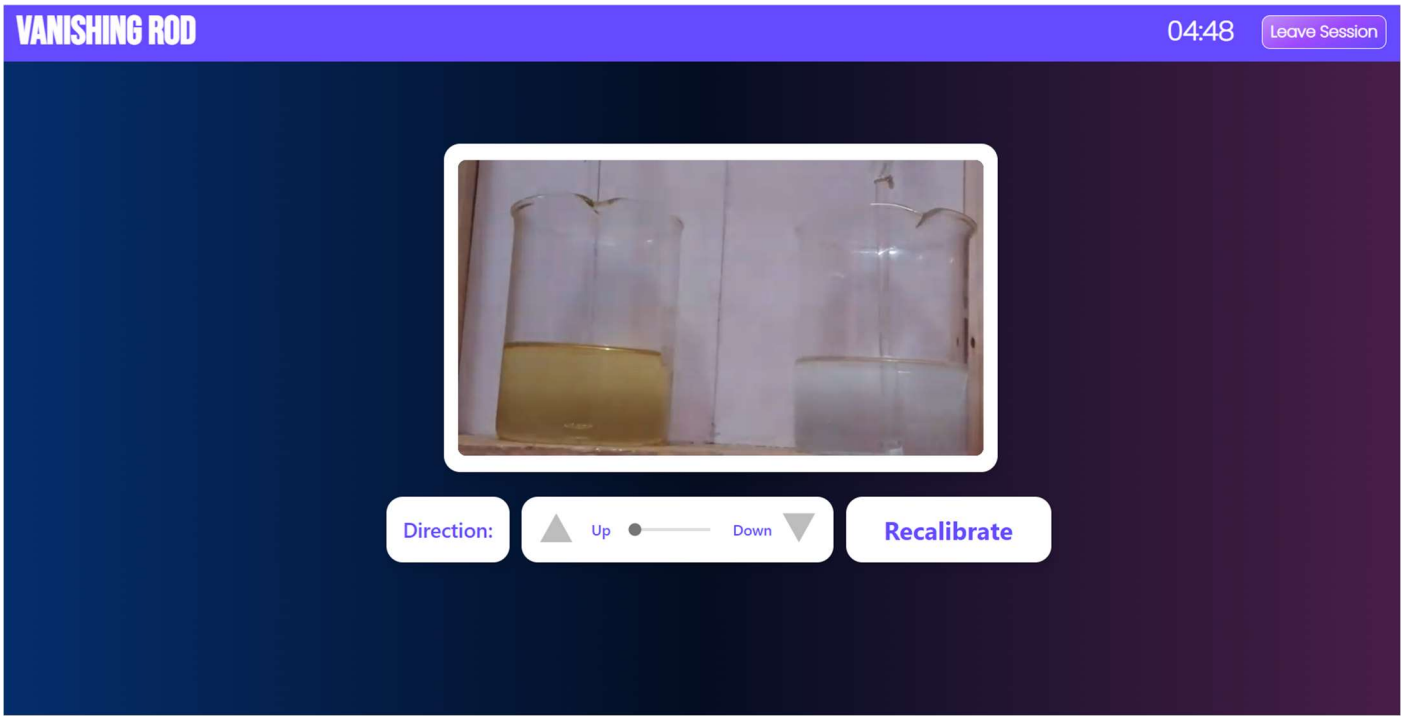
As soon as you visit the above URL, you will see the following page

Click on the Sign Up button to register using your Gmail account.
You will obtain a verification email in your inbox, click on the link inside the email to verify your account.
Now come back to this page and sign in using your account credentials.
This will take you to the following page



Click on the theory button on the Vanishing Rod card to view the theory of the experiment.
To actually perform the experiment, click on the Dashboard button.

Clicking on the dashboard button will start a 5 minute experiment session and redirect you to the following page



You will be able to see a live stream of the setup and some control widgets.
The session timer will be visible on the top-right corner. As soon as this timer reaches 0, your session will end automatically.

Use the Up and Down arrows in the control widget to control the position of the glass rods. You can do this multiple times to see the rod vanishing in the left beaker containing sunflower oil while it remains clearly visible in the right beaker containing water.

You can click the Recalibrate button to reset the setup to its default state.
After you are done with the experiment, click the "Leave Session" button on the top-right corner to exit the session. This will redirect you to the home page.

In order to see a demo of the usage of the dashboard and to see how the actual physical setup looks, click the following video link
https://tinyurl.com/5n7wux9u

Note: There will be a small time lag (about 3-4 seconds) between clicking the button on the dashboard and the rods actually moving on the setup. This is because of the latency of the streaming service and cannot be improved, hence please be patient while performing the experiment.

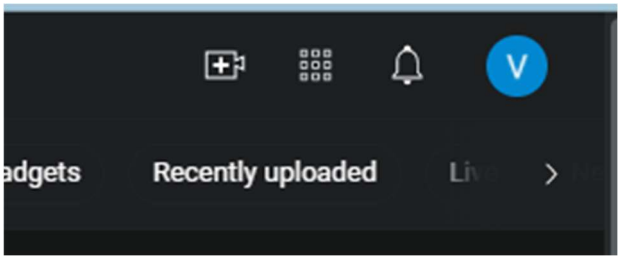
Technical Details

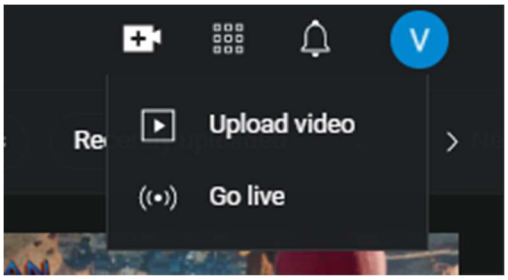
*This section is for people who will be maintaining the setup.

The microprocessor has already been configured to start all the required protocols as soon as it boots up so nothing needs to be done, but in case something goes wrong, you can find the required codes on the following GitHub repository
https://tinyurl.com/2p96yp7p

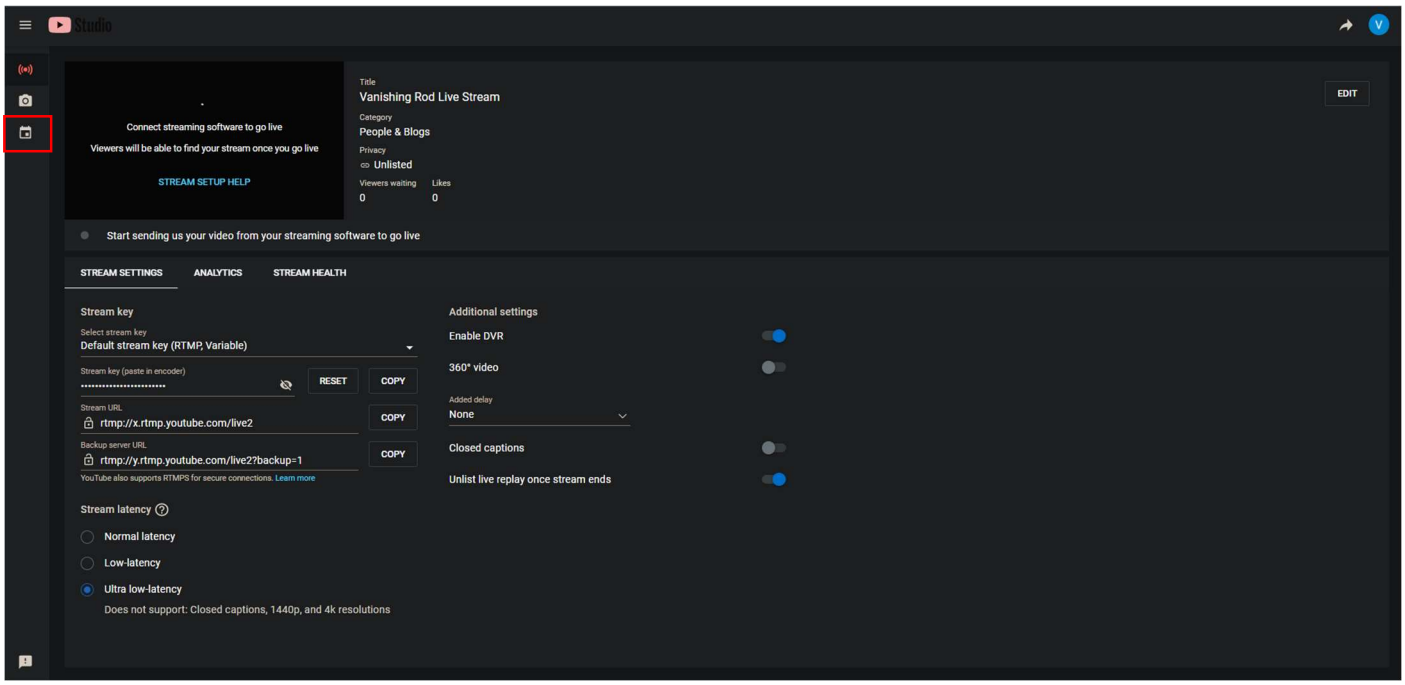
Starting the YouTube Stream : This step has to be done every time after the Pi has been disconnected for more than 12 hours. Follow the steps given below to start the stream.

1. Go to youtube.com and login with the given credentials
   Username – rtl.vr.iiit@gmail.com
   Password – iiit.ac.in
2. On the top right corner, click on the video camera icon and click on go live



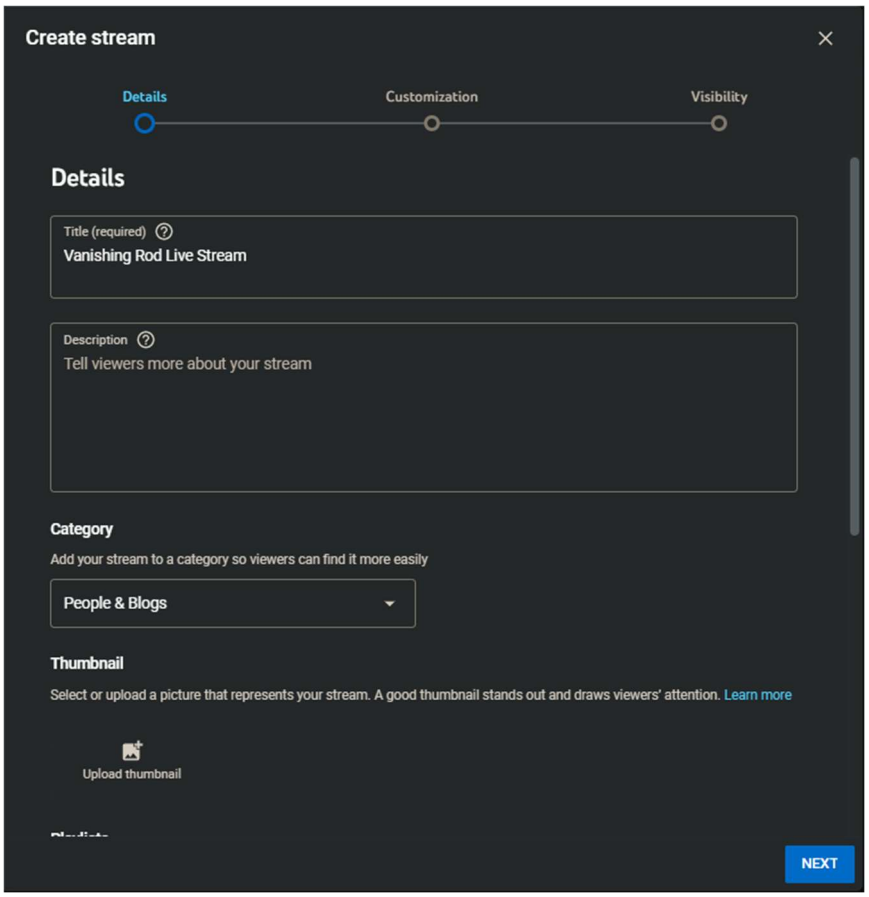


3. The previous step will take you to YouTube studio



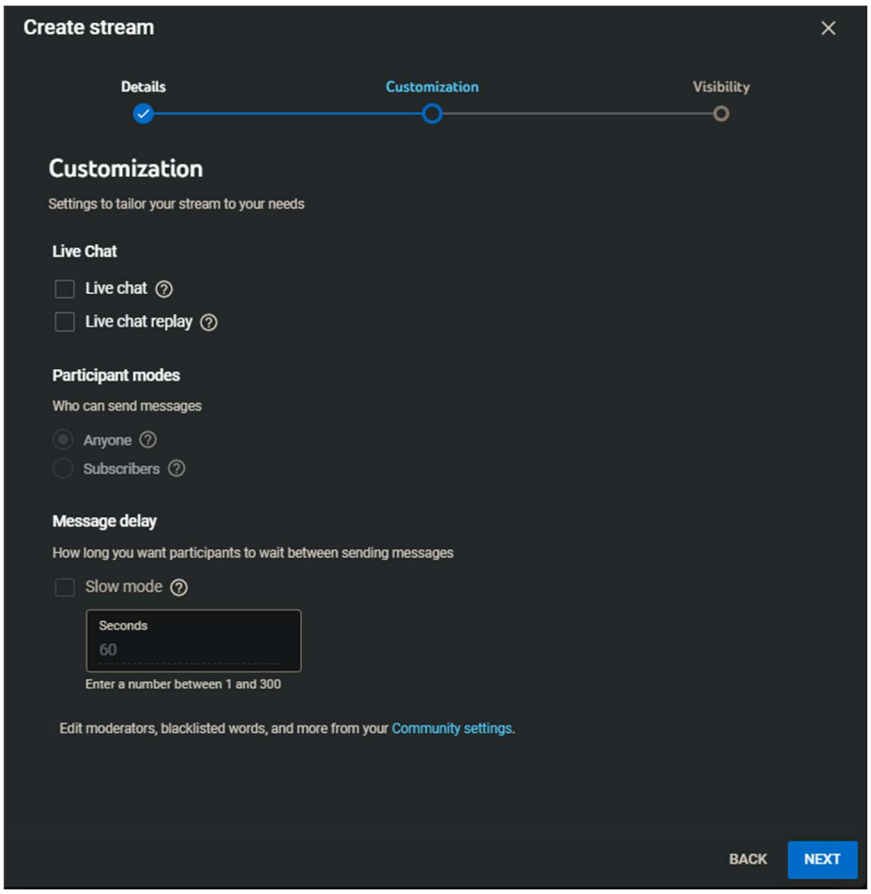
4. After reaching here, click on the schedule icon (3rd icon on the left hand side pane). It has been highlighted with a red box in the image above. Click on the "Schedule Stream" button

5. You will see a dialog box

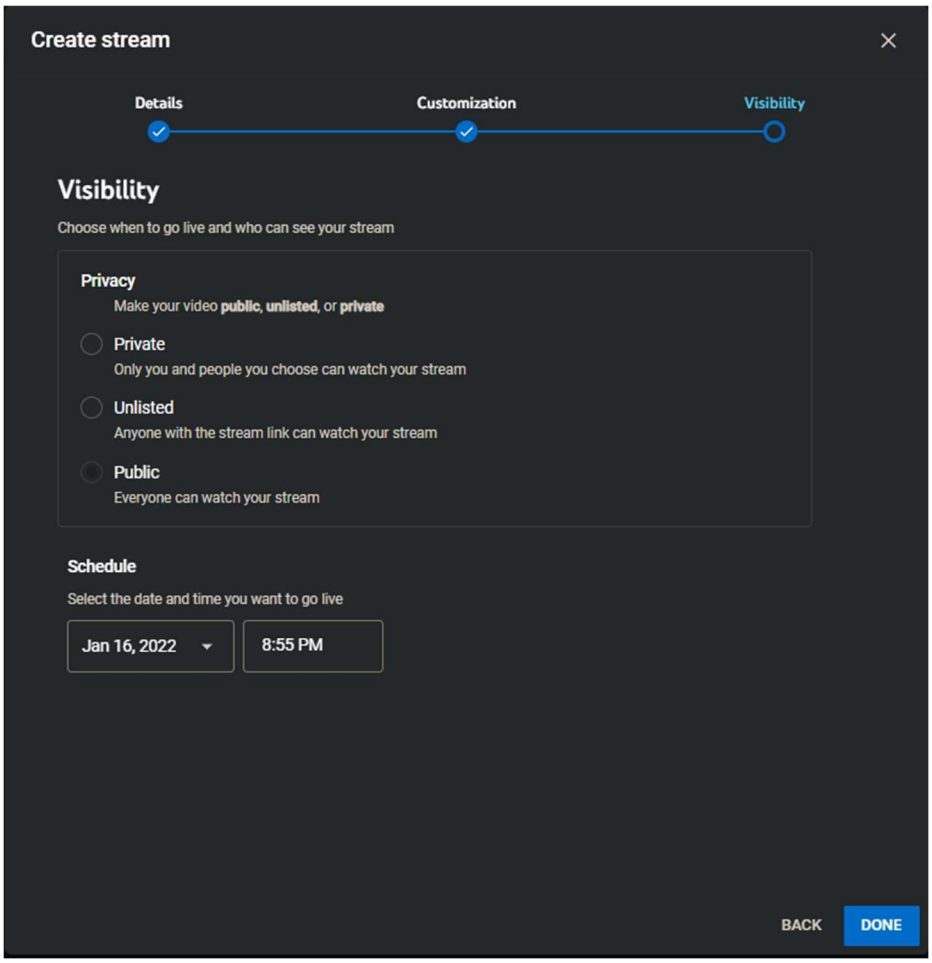


Add the name of the stream as shown and select the "No, it's not made for kids" option and click next.

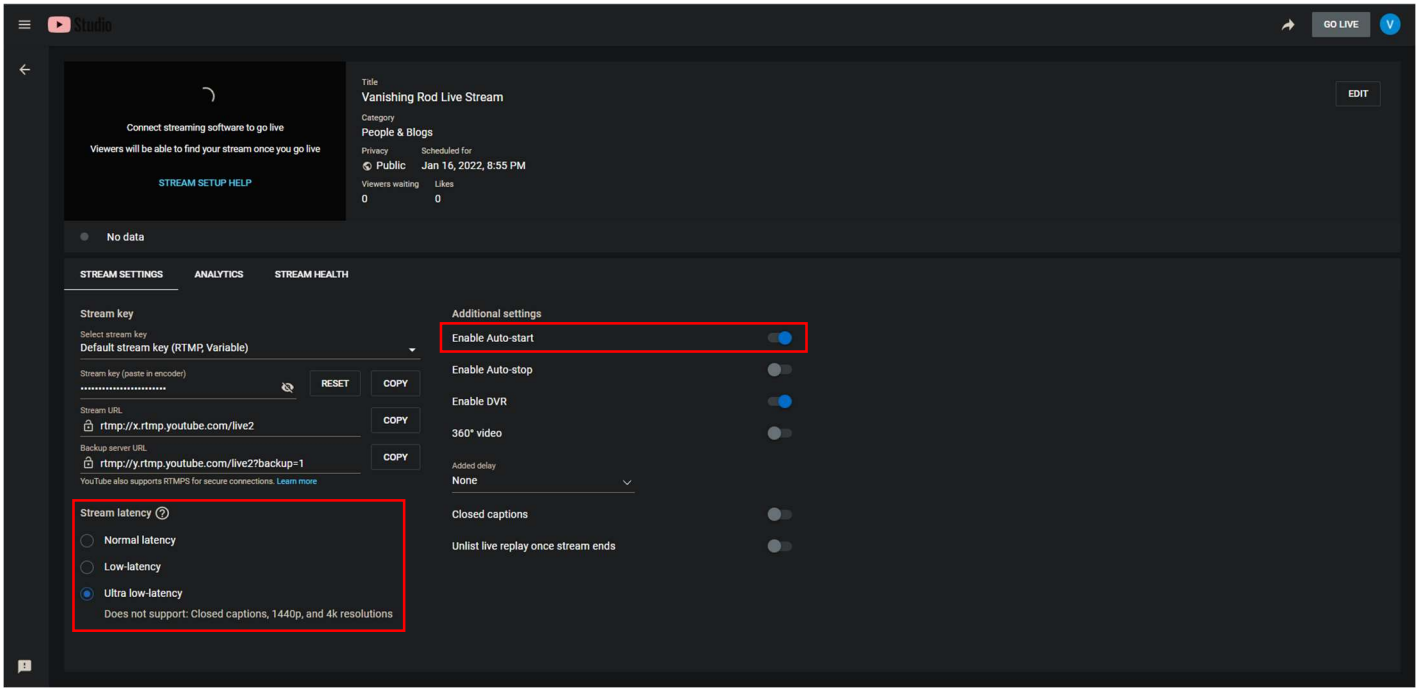
6. In the customization menu, deselect the live chat option and click next.



7. Finally, set the visibility as "public" and click done.



8. You will see the following page



In the areas highlighted with a red rectangle, set stream latency as "Ultra Low" and enable Auto-start. (**Note** : Make sure you **do not** enable Auto-stop)

9. Switch on the Pi, and the streaming should start automatically

Manual Tuning of Rod levels : Sometimes due to intermittent power cuts, it may so happen that the rods stop in the middle. In such a case, the rods need to be manually reset to the original level. In order to do this,

1. Switch off the main power to the Pi
2. Manually rotate the shaft couplers at the front of the stepper motors to wind the strings and take the rods up
3. Make sure that the position of the rods is completely up before switching on the power of the Raspberry Pi.
4. Step 3 is very important because the code is written in such a way that the initial state is defined to be up, if this is not so, it will mess up the working.

In case of difficulties which are not solvable using the above steps, you can contact me for assistance on Tanmay.b@research.iiit.ac.in