Continue. So, I also noted down that 4.5 which is there, all of that data will help us in evaluating how the test run performed. So, during the testing, however it performs, we should be able to evaluate it. Then, I also mentioned to you before that we will be able to measure how much deviation we are actually getting on the real run versus the projected run. So, all of this data will help us do that.

Then, 4.6, this is basically, so these are all the features or the functionalities that we have added. In that, the first point is pre-functioning health check. So, before the rover starts moving or the GPS based navigation system starts, we should do a health check in terms of whether all the systems are responding. So, in this, whether all the hardware is giving enough data, whether the environmental tolerances are within limits, then whether the navigation parameters are in order. So, when I say navigation parameters, these are general entire rover health check in terms of whether all the motors are running or not. So, that health check you will get from the navigation stack which is already there. But then, the health check with respect to GPS system, that you should do.

So, when I say environmental tolerances, it means that we have to see in what conditions does the GPS system fail. So, say for example, temperature. So, what is the temperature on the system, whether it is breaching. So, it has a 60 degrees limit for operations. So, whether the temperature that is being recorded is beyond 60 degrees, all of that we should check. Whether there is cloud cover, all of such kind of. So, we should put in some prompts which either the system automatically gives through some sensor or the operator manually inputs that. Later on when we design the interface or get it developed, all of these points will be helpful.

In terms of whether systems are responding, for that we need to see that whether we are receiving GPS coordinates or not. Whether we are receiving satellite data from more than 2 or 3 satellites. Generally that goes up to 40-50 satellites. So, at least we need 6 satellites. So, that we should check whether minimum 6 satellites data we are receiving. Then connectivity. So, in terms of internet connectivity. Connectivity speed. While we are speaking, I am also noting down at my end. So, I also have that context. So, internet connectivity speed. That is also what we will require because we will require real-time correction. So, all of such things and I am writing PC etc. So, maybe you will also have to apply your mind to find what are the other health checks that need to be done or can be done. You can do a general research in terms of what the drones do in terms of health check. Drone health check.

Okay. Then compute and maintain real-time heading of the rover using GPS coordinates. So, the next point is about computing the real-time heading of the rover. So, that you should always be getting. So, that we should store somewhere in terms of what is the heading, the real-time heading, whether it is headednorth, whether it is headed south, northeast, whatever it be. We should keep on computing and logging. Again here we can add a fail safe case. Where if it is not happening, if we are not getting this real-time heading data, then your fail safe mechanism should get triggered. Then navigate from current location to the start of the first showing row autonomously. This we have done already. Align the rower's orientation to match the heading angle of the row before entry. Done. Then execute turns at headlands to align with the next row using geometric constraints.

So, till now what we have done is we have assumed the farm to be either rectangular or square. If there are polygons, irregular polygons, then in that case there could be certain constraints. So, we have to still discuss that. We will do that. So, I will just note down that discuss irregular polygon case. Okay, that is an open point.

Then detect and flag unreachable paths or waypoints based on minimum turning radius and physical constraints of the rower. So, for this you will need the dimensions of the rower and what degree it can turn. That I will have to provide. Dimensions of rower and turning constraints. Actually, there aren't any turning constraints. But we haven't yet finalized but we will be finalizing a few constraints. Like it cannot turn so much of angle while moving straight. Like that day I told you that when it is in the row it will take a differential turn and keep aligning itself in forward direction. It cannot turn 90 degree left and then again come back to the row and keep going straight. That won't be possible. So, these are certain constraints which are there while moving straight. So, there will be some similar constraints while moving from one row to the other. So, that we have to discuss. I am writing here to be discussed.

Realign or re-plan path based on GPS drift. So, this is one thing. So, if there is drift beyond certain limits. So, drift beyond limits. It will indicate that there is a significant drift that is happening constantly. And we have to basically and that drift is primarily because of terrain. Okay. Terrain or certain inherent limitations in the rover's navigation capabilities. One second let me note down. Terrain or inherent limitations. So, if this drift is beyond limits say for example more than 5 degrees. Okay. Then what action needs to be taken that we need to determine. And what are the number of instances when such realignment needs to happen. And whether the drift is beyond that limits for certain number of instances. What action needs to be taken. We should think about that also.

Okay. So, actually the document that you shared now about failsafe. In that with respect to GPS, the first point dealt with the GPS thing. But rest of the things were allabout general rover navigation. So, we have to focus right now only with respect to GPS. Okay. So overall health of rover and its navigation capabilities and its fail safe and all that has been taken care of in separate module.

Okay. Just give me a second. Hello. Hello, Rohan, am I audible? Yes, yes.

So obstacle detection is something that will happen using some other sensors. Okay, so we need not consider this in the GPS thing because the GPS system does not understand whether there is an obstacle or not.

Okay. You know right how GPS system works? Our system calibration, that is fine. Enable sleep mode activation in certain cases.

So I saw that in the document return to home was one of the features. So in our case, we cannot do return to home. Return to home would basically mean that it has to come back to the starting position, right? So if it comes to the starting position, it will trample on whatever work it has already done. So return to home would mean that it will have to enter the no go zone, correct? Yes. Which is not allowed.

So in that case, we have to trigger instead of return to home, it will go to the sleep mode. That it won't start, it won't allow the bot to navigate anywhere.

So what are these cases we need to identify? So one is where data, there is an issue in reading real time coordinates. Right, this is one case where the system won't work efficiently and we will have to go to sleep mode. Right, so reading real time data is one thing.

Slow internet speed.

Environmental tolerances getting breached.

And there could be some more cases where the system is not working basically and we might have to enter into sleep mode.

One also could be that the controller is not able to read the data which the GPS module is transmitting.

So it could so happen that the GPS module is receiving the data but it is not getting communicated to the computer. Whether that could be a case, I'm just wondering. Because we would not know it independently because that system or the GPS module is connected to the computer only. So unless, I mean in a case where the module is not reading data but computer is not ableto receive communication, that kind of scenario is very hard to detect. Scenario is very hard to detect because it would be only hardwired communication between them and there is no way to determine whether I mean the module itself does not have any intelligence or way to communicate apart from communicating to the computer. So that would be an inherent limitation actually. But you can think on this in terms of what more cases we can include.

Okay. Okay sir. Yeah. So the next thing is more about the control logic flow. So heading calculation using consecutive GPS fixes. So we have basically done that only. We would be reading the consecutive positions to determine where the rover is headed. Right? Yes sir. So we have used that logic. But there was something that I saw which was new to me or I wasn't aware of which is called as bearing. So in that process they mentioned compute bearing using Haversine or Vincenty formula. So I haven't come across this before so I don't know. So I want you to research on this in terms of what this is. Okay? Yes sir. Or do you already know it? I know the bearing part. The formula then I have not come across. Bearing is not then it is 0 degrees and then if it is east then it is 90. Okay so bearing basically means a compass. Yeah something like that. Okay. So but ChatGPT suggested using this formula. So just see what that formula is. I don't know whether it is relevant or not and how effective it would be in our case. But nevertheless if it is suggested we should at least consider it. Okay?

And the output that we are getting is it has mentioned that this output will be real time heading angle 0 degrees. So it would be in degrees but in addition to degrees what we want is the direction in terms of north, south, east, west. Okay. Yeah. Then navigate to start of row. So this we have already done. Then align with row heading this we have done. So in this one. Heading to align with current heading delta. Turn at headlands. Turn at headlands here. Headlands is basically end of row. Yes. So here they have added a checklist in terms of a checkpoint in terms of whether the turn is feasible or not and whether the destination is reachable or unreachable. For now we will park this because we don't have the exact data for this. Okay.

Unreachable waypoint detection is also similar. Sleep mode activation. So in what cases the sleep mode will activate. So the trigger points. We just discussed this actually. Yes. The action point is to retrieve the current coordinates and communicate that and then call for action. That it has gone in sleep mode and so call for action would be something like raising emergency alarm or turning on certain type of light. Something like that. Okay. I think to make the code robustwe should work on this. We should add these things whichever we have discussed right now. Now I am just going through the file that you sent in the morning. Wheels moving but GPS not changing. So wheels moving but GPS not changing. This case is where it is not receiving the GPS data. So it won't mean that the rover is sleeping or anything like that. So rover sleeping is a very different case. It's a navigation related issue. So the navigation module will take care of that. Because if the rover is sleeping, the GPS and the GPS system is working, the GPS will still show where its real time coordinate is. Right? Yes.

Stuck against an obstacle. In this case the wheels won't move or yeah, it could so happen that the wheels are moving but the coordinates are not being received. So that is a case where rover is sleeping. Right, right, right. Okay. That means...

So if there is a slippage, in that case what will happen is, we will, in that case the wheels will keep on moving. They will keep on rotating. But the GPS signal will say that the bot is stationary. So in that case certain actions need to be taken in terms of:

You should stop the navigation first of all.

There has to be a time limit in terms of logging the data. So we should be able to log data every 100 milliseconds maybe. The real time data of GPS system, we should be able to log it every 100 milliseconds.

It should try for 3 times. So in 300 milliseconds if the fresh data is not received, then it should say that there is issue in receiving data.

Okay. Now what happens when it says that there is issue in receiving data? What it will do is, it will first of all enter sleep mode. Then again try testing, keep on testing whether the signal has come back. If the signal has come back, it should notify that okay signal is back and it is stable. We basically need to verify that the signal is stable, right? So that is actually a major thing, no? To verify. Stability of signal. If the stability is below the threshold, then we should say that okay it is not safe to rely on the GPS data. Okay. This will also go in your pre-functioning health check. Okay. But again at a separate point we should keep on checking the signal strength parallelly in the background. Because it might so happen that at a particular point on the farm when we are doing a pre-functioning health check, at that time thesignal might be good or at that place the signal might be good or at that place the signal might be good, but while moving there could be instances of signal loss. So that we should be able to red flag. So maybe if every 300 milliseconds, if there is an issue in retrieving the data in 300 milliseconds, then we should say that okay, an instance of signal loss happened. And if that happens maybe say five times in a minute, then we should say that okay, there is a very poor stability in terms of signal. And then manually we will decide whether to continue or abort. Okay. What it makes sense? Yes.

And in case where we are receiving the GPS data properly, but the rover is not moving because of slippage. So we should, if the navigation system says that the rover is moving forward, but the GPS says that it isn't, then within maybe 500 milliseconds, we should stop the rover. Okay. Did you note this down? Yes, sir.

Okay. Second point was rover stops giving GPS data. We just discussed. Right. Yes. Then battery level critically low. That has been taken care of by the navigation module. Obstacle in the path that is taken care of by the stereo camera module. Communication loss with control center. So rover loses connection, can't receive commands or send updates. In that case, the failsafe should not include following a predefined safe path. Right. Yes. It should just stop, I believe. It should keep trying for a couple of minutes. And then if it says that the communication hasn't been recovered, then it should just stop.

Motor failure. Motor stops working. So typically what happens is in the current navigation system, the way it is designed is if a particular motor stops working, then the whole system stops. Okay. And it tries to recover, get into auto recovery mode, tries to recover. If it can recover, then it's fine. Otherwise, it stops. So that's how it is. But it has been taken, the motor failure situation has been taken care of by the navigation module. And what will happen if there is a motor failure, the GPS system will continue to collect and show data. And it will also say that the rover isn't moving. Right. Because it will be stationary. Yeah.

Stuck detection is again the same as the first one. Wheels moving but GPS not changing. Okay. SoWe've discussed all the seven. So there are only seven points, right? Yes. Okay. So I should implement only the second one? Which second one? The rover stops giving GPS data. We have to work on all, but you can start working with that.

Okay. Yeah, stability of signal and all of that. Okay. So the rest in later I have to do that? Yeah, we will just prioritize things. I think in terms of priority, getting a stable signal and ensuring that the communication is live, that is very important. If that is not happening, then that failsafe basically needs to be factored in. So let's prioritize that. And then the rest of the things are more or less easy to implement, I would say, relatively.

Okay. This one is also relatively simple to implement because it just has to keep on checking. But then that needs to be done, actually. So let's prioritize that.

Yesterday evening you had shared one document. I went through it. It was some Mr. Chatterjee's repository. Anything in particular you want to discuss from that? You might have missed out and you think we should discuss?

About the battery thing, then I don't have to do that, sir? Yeah, battery you can just remove. Battery is taken care by the navigation module. Okay. I think that's it, sir.

Okay. Let's discuss about... So today while I was going to the meeting and we spoke in the car, I had mentioned you to do two things, right? Which were they? You told me to... Let me just... I was implementing about... Like the rover not giving... If the rover was not... If the wheels were moving and the GPS was not giving, that one. And then... The other one was the... I didn't know that. I didn't have to do this. I was doing the obstacle part one.

Obstacle? Yeah, I was doing that also. Okay. So what exactly in obstacle? Like any object that is in... I mean on the waypoints, no? So any obstacle that is there, the rover will detect and I think it has to stop.

Yeah, it has to stop. But if obstacle is there, in that case first of all that waypoint should not get generated. If it's a permanent obstacle. If it is an obstacle that has... That's something which is kind of live or something that has just come up. Say for example somebody has kept some tool or somebody or say a stray dog has just come and stood in front. Then in that case it's a kind of obstacle detection that will get triggered by the particular thing. The particular sensor which is the depth counter. So from GPS point of view you need not do anything.

Are you getting a hang of things? I'm asking from the point of view that now the context would be much wider and you would have now known the context much better, right? Yes, yes. Compared to your first day. Yes, sir.

Okay. One more doubt. So about this data logging.Right now I just have to stick to what I'm doing in a sense that the program I'm running, I'm just assuming that I have the coordinates and the waypoints. Yeah, I believe I had shared that Python file also with you, right? To read the data. So you can include that code or you can modify that code to say that you have to store this in this particular path.

And you can modify that code to keep on checking whether you are receiving that data within those threshold times, say 100 milliseconds, whether that data was received and whether it's a fresh data. How do you know that it's a fresh data and it hasn't erroneously just given the same old data because it didn't get the new data? You see, there are these minute intricate points which you will realize once you start working on it. Everything is based on that real-time data.

So how do you know that the system is capturing the data? It might so happen that it is publishing data, but that data is old data. Correct? So there is some error that has happened and it is publishing the same old data. But if the system doesn't detect that it's the same old data and whereas there is a movement that has happened and the fresh data should have come in, which would be different. So that system should be intelligent enough to detect this.

So as GPT should be able to help you do this quickly because it has access to GitHub and it will have access to all of these algorithms. Okay, sir. And just keep on thinking of all such cases and document it and send me such cases. You can just WhatsApp me that there could be this particular thing that can happen. This particular case could happen where the system might fail. We just have to now think in terms of system. Where can the system fail? What could be the scenarios?

Okay. Is this too much? Is this creating any kind of pressure or is this overwhelming? No, no, sir. It's okay. I'll break it down step by step. Yeah, do it step by step. Just that I have not been able to apply my mind for last two days and things just started to strike me. So I thought let's have this conversation. But then you can do things at your own pace and your choice.

Okay. Anything else? Just starting but I'm just a bit thinking. So right now like the program that I made is technically working and like we're just using random values. So I have to make the program like just be able to take the file that you gave me like the coordinates, right? So I just have to make the program be able to take those inputs for now. So that in the future when we test with the real data we can just log in. Correct. Absolutely.

So in real scenario right now what you were doing was simulation, right? In the real world scenario we are going to get the waypoints file and the rover has to move along that based on that data. So it should be able to understand that waypoints file and if required you can also add a comment in your code by putting hash in terms of how the waypoints file should be designed or how should it be structured so that this code can basically read that file.

Understood? That is a requirement, no? For the code to work. If somebody designs a waypoint file which is not understandable to the code then that waypoint file is of no use, correct? So you should maybe just write a comment somewhere saying that the waypoint file should be structured in such a way it should have such headings and all of that. Understood?I didn't note this down right now but I am assuming you have noted it down and you will do it. Okay, fine. You will do it. Okay, fine. Perfect. Any queries? Any doubts? I think that's it.

So right now what we have discussed, let me tell you this is very high level. You will face certain questions or you might come across certain queries while working on it because you will start going into depth, right? Logically. And that time if you feel you want to discuss or just communicate or just let me know, feel free to message me. Okay? Just message me that I'm doing this, I'm working on these lines. So that if I have any contradictory thoughts I'll maybe just add them or I'll just let you do and give a thumbs up.

Okay, sir. Okay? Are we clear between us? Yes, sir. Okay, perfect. Good then. You can call me anytime, that's not an issue.

Okay, sir. Okay, fine. Good day. Thank you, sir. Bye.