

# vqa-nwxg-jkt (2024-03-27 16:04 GMT+1) - Transcript

## Attendees

Aarsh Thakker, Alexis Guijarro, Ayham Alharbat, Bonolo Mathibela, Junwoo Hwang, Khaled Elmadawi, Kimberly McGuire, Kimberly McGuire's Presentation, Mayank Joneja, Rafi S.M, Rhys Mainwaring, Rhys Mainwaring's Presentation, Riccardo Polvara, Rikin Ramachandran, Ryan Friedman, Samuel Chew

## Chat content

- Mayank Joneja: @Rhys @Kim we should start a Discord thread too for the sim group for informal chat
- Kimberly McGuire: @mayank we have a simulation discord thread already ;)
- Aarsh Thakker: <https://discord.com/channels/1077825543698927656/1214661509494349915>
- Kimberly McGuire:  
<https://discord.com/channels/1077825543698927656/1214661509494349915>
- Kimberly McGuire: ah yes thanks aarsh
- Mayank Joneja: Oh just realized Discord only shows 3 at a time
- Kimberly McGuire: ah yeah for me it's only 'the newest'
- Kimberly McGuire: but in the top at #cwg-aerial there is a 'thread' button so you can find them there
- Mayank Joneja: Yeah found it! Thanks
- Kimberly McGuire: We also had a presentation about vehicle gateway back in July last year  
<https://discourse.ros.org/t/summer-2023-meetings-aerial-robotics/32131/3>
- Kimberly McGuire: wow thats so cool
- Riccardo Polvara: Is there support for GPS navigation (plugin) in new gazebo?
- Aarsh Thakker: Wow. Learned lot of new things today!!
- Aarsh Thakker: Thanks
- Mayank Joneja: Awesome show and tell!
- Bonolo Mathibela: Excellent overview, thank you!
- Rikin Ramachandran: Very Informative. Thank you for the presentation.
- Riccardo Polvara: Thanks Rhys, amazing talk (sorry, no mic for me today)
- Kimberly McGuire: Here is also a nice overview of simulators  
[https://github.com/ROS-Aerial/aerial\\_robotic\\_landscape/blob/main/simulation.md](https://github.com/ROS-Aerial/aerial_robotic_landscape/blob/main/simulation.md)
- Ayham Alharbat: Thanks a lot Rhys! and Kimberly for organizing this :D
- Kimberly McGuire: and here is the landing page for the simulation subcommittee if you are interesting in contributing in development  
<https://github.com/ROS-Aerial/community/blob/master/subprojects/simulation.md>

## Transcript

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**Kimberly McGuire:** Okay, welcome everybody for the arable dis community group. for a presentation meeting on the March 27th 2024 and yeah, so we're going to have a nice presentation by Rhys Reese today about because people and aerial Vehicles going to presentation's overview. But before we're going to go into that, I have just a couple of announcement that we would like to share first. And after of course once recess is a presentation, that will be some time for questions for that. And then of course, the next meeting details will be shared as well. So that's going to announcements is a bit similar to the announcements I had last time but it would be nice to Still have a nice let's say headlines for them because last development meeting we presentation like two new subcommittees.

**Kimberly McGuire:** Which we have next to the outdoor navigation subcommittees that we have in our politics community group, which is indoor navigation. and simulation and there's currently two discourse threats going on to talk about what kind of development goals can be done within these fields of topics. We had quite some comments already on internet navigation, but we also have one of open for simulation. So if you care about development goals for simulation, please send Sister. Yeah, but we won't go into this topics that's going to be part of the developer meeting in two weeks.

**Kimberly McGuire:** But I just want to let you guys know in case you weren't more and of course you must have seen also on this discourse that they start the open source politics Alliance. So there's going to be some changes in governance. I will just leave the details all to those. that means is that we're no longer a Ross Community working group. But for just a community group or something like that.

**Kimberly McGuire:** So at least that's the term that they want to use internally to refer to us. So to make it easier we're no longer a community working group, but in practice I've asked them nothing will change in terms of let's say influence like epic customer we've never really had influence in terms of as a group directly to the government of open republics. And however, you have an influence as an individual by contributing to the code base and hopefully something that we can let's say provides as early try to orient. It's now And with everybody here in here with the same interest, but let's talk about that in a developing meeting next time.

**Kimberly McGuire:** Yeah, so we're going to have the presentation by Rhys about gazebo on aerial Vehicles. So I'm going to stop sharing my screen and I will give the floor to reach you can share your slides.

**Rhys Mainwaring:** Thanks Let me just see if I can. Bring these up, okay.

**Rhys Mainwaring:** how's that looking? We see the Great.

**Kimberly McGuire:** That looks perfect.

**Rhys Mainwaring:** so it's really just a review and It's going to be. Pretty heavily slanted towards using gazebo with Ardupilot because that's where I do most of the work. There's a little bit on PX4 and overview of other things as So you please exclude the the bias, but I think it's better to talk about what I know as

opposed to what I don't know and that we can certainly let others who are more familiar with some of these other flight Stacks in their integration with gazebo talk to those and very much like people to do that and follow up talks.

**Rhys Mainwaring:** Some of the slides in here are reproduced from a presentation. I gave at last year's argue pilot conference. So apologies to anyone who attended that and may have seen some of them before but I think they're quite useful for this review as well. So

**Rhys Mainwaring:** The kind of outliners will have a look at sort of gazebo's capabilities and then there's a couple of projects and there may be more. So, please accept any apologies for flight if your project users gazebo and I've missed it out. Then nothing meant by that. this is what I'm aware of but there's a couple of projects by osrf that have used gazebo and the native support for plugins and aerial vehicles within the Gazebo packages. And then there's a few flights that have subtle Frameworks that work with gazebo and we'll have a look at them and cover some of the vehicles that we've got some of the extensions that have been made and just generally review so there's mostly a show and tell of what's there hopefully to kicks that some ideas about

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**Rhys Mainwaring:** Where perhaps we can look at some collaboration between the various flight stacks and common development. So this is really just to get the simulation. program on the way, so gazebo has Two major versions, I would say there's the Gazebo classic which some people are still using so it runs up to version 11. It's end of life and 2025 and

**Rhys Mainwaring:** and quite a lot of work had been done for area vehicles and in the previous versions of gazebo. I'm not going to be talking about that. I'm going to be looking at the new version which sort of had various names. So Under The Fortress it was called Ignition. It's now back to gazebo. The current version is harmonic. Although most of the work will be looking at is in gazebo Garden, but both garden and harmonica are available. it's a toolbox really of simulation libraries. it's got a good physics Engine with dark and a plug-in system. So you can plug an entire physics back end for aerial Vehicles will probably not be doing that. We'll be looking at riding.

**Rhys Mainwaring:** System extensions. So the main simulation environment is for a rigid body system, and I don't think we'll be replacing that unless you're looking at replacing the entire coordinate system. For rendering it uses or ogre two. It's quite a powerful rendering engine. It's fairly tricky to use under the hood. Unfortunately. You don't have to do too much of that unless you're riding rendering plugins, but it allows you to do physically based rendering and have much better lighting, but it does require.

**Rhys Mainwaring:** More powerful graphics card and a more powerful CPU to run so some of the simulations that you might be used to running on Old Hardware are going to struggle under gazebo garden with all the rendering switched on there's a rich camera system. You can extend sensor plugins one of the really big improvements that they've made in gazebo is the ability to add sensors. It used to be quite difficult to add them in if you were a third party writer, it's much easier to do now simulation engine can be extended with system plugins. So everything is really a system now or a sensor and tins not to differentiate between models and joints and all the other bits and pieces. So it's more uniform a bit more abstract in order to achieve that look at that a little bit more.

**Rhys Mainwaring:** you can also write custom widgets for the gui's plugins. These are QT widgets. and so if you've got an environment manager or something that you can do that integration with Ross and

Ross 2 is provided by a project called Rost gz and that allows you to bridge between the Gazebo messaging system, which I think is

**Rhys Mainwaring:** Underneath It All and uses what does it use Proto buffers into the Ross messaging systems? Okay, so if you're looking to move from one platform to the other so gazebo classic was a pretty monolithic application and you would run it with gazebo and in the world name and then Dot World file see what the SDF files but the naming has changed in gazebo Garden, which is sort of gz77 is the repo which sort of pulls it all together as a simulator.

**Rhys Mainwaring:** Is collections of libraries and plugins. So it's much more modular. So there's lots of different moving Parts. It's a little bit harder to get your head around but I think it's easier for the developers to maintain and roll out the various pieces in them. The plugins have kind of changed a little bit so You'd have a model plugin, which would have an on update method in the new one. It's kind of looking at it. They're all called systems and they have a pre update and post update so you can control whether you get everything set up before the physics update or with you analyze the results after the physics update if you're looking at sensors and things. and that probably the main change is that gazebo Sim uses something called an entity component system, which is really just

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**Rhys Mainwaring:** integers labeling objects and you attach various properties to them. It's quite complicated to use initially. It's very powerful in that everything is at some level treated on the same level. So the object model as far as the simulation is concerned is just lots of IDs with various features that get added and the features basically add the ability to attach types of data to those objects, which then gets calculated during the update steps. I believe that this is a technique that has been borrowed from game development and allows the simulation to scale quite quite well.

**Rhys Mainwaring:** In the models and Worlds the materials for more complicated rendering was managed using oga scripts. They've been deprecated and it now uses the ogre next physically based rendering system. So discrete materials won't work and you can write your own rendering scripts as well. That's fairly complicated to do but you probably

**Rhys Mainwaring:** Do that most of the time so the systems in gazebo classic would be available automatically. And in the new one, everything is a plugin. So if you wonder why your IMU is not registering it's probably because you haven't attached the IMU system to the world and things like that. So things tend to work or not work without warning and so in your world file, you'll see a lot of systems being initialized. So things like broadcasting the visuals enabling the physics engine and enabling all we custom senses. These all have to be enabled as plugins. So it's a bit more involved to set up. But again, it makes it much more natural to extend and once you're familiar with things it becomes apparent why things aren't working, but it would be a few catches when you start

**Rhys Mainwaring:** so things that come On board or out of the box with it. So in the physics that these are relevant to sort of area robotics there are other systems as well for other types of vehicles and things. So in Garden, there's a lift drag plugin. And this has been ported over from the Gazebo classic and the advanced lift drag plugin, which I think is used by PX4 has also been made available. I think it's only in harmonic. I don't know if it's been back ported to Garden. There are various controllers for joints so you can either velocity or position control joints. and in addition to that is some more custom controllers for a multicopter control, which I think has used in the osrf projects.

**Rhys Mainwaring:** Not so much by the flight controllers where we're the actual argue pilot or PX4 or betafight would provide the actual copter control. There's a motor model which is a port of the rotor S motor model originally developed for sibo classic. Then there are things that publish the state so states have joints odometry or pose. They get pushed out on to the messaging framework. There's a bunch of sensors for air pressure speed ultimators a load of cameras, which gets extended and there are things I haven't included in there such as segmentation logical cameras. There's a inertial measurement unit is lidar scanners. These are all GPU enabled magnetometers navset sensors and thermal sensors, and then the global systems are presentation for

**Rhys Mainwaring:** Things like physics and sensors need to be enabled at the top level in the world. So that all the features such as without a physics system in your world, then there will be no physics. So objects will just stay static where they are. There'll be no gravity. There'll be nothing else and without the senses plugins, your cameras can be attached to the models, but You won't see anything until you actually enable the Global Systems to do that. There are some limited environmental effects. There's a wind effects plugin. I think that's something that would be good to extend further, but there's kind of limited ability to provide environmental effects, but not highly customizable at the moment.

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**Rhys Mainwaring:** So projects that use gazebo and have been developed by osrf. So this nbz IRC was a big Maritime challenge simulator. It's quite a nice project. It covers include both terrestrial and Maritime environments supports multiple aerial and surface Vehicles sort of water vehicles. And there's a range of s Aerial Vehicles is a fixed-wing vehicle, which is I think based on the Zephyr a quadrator and a hexarator one thing. This is that the SDF models are templated using embedded Ruby and that allows configurable slots for payloads now.

**Rhys Mainwaring:** This is something that's in this project only hasn't really been pushed up higher into gazebo, but it's quite nice and you'll see. As we look at other vehicle types, one of the problems you have is that if you want to run multiple vehicles, or you want to add a sensor to a vehicle you can wind up having to replicate quite a lot. There's no equivalent to the exact Crow for SD format and gazebo uses SD format directly.

**Rhys Mainwaring:** So if you want to template your XML files for loading worlds and putting models, there isn't really a standard way of doing that that's available built into the system. But extension libraries such as these use templating either with embedded Ruby or sometimes embedded python in order to parameterize the models and then have the files generated on the Fly before the launched and that's something maybe worth as a stream for the simulation program.

**Rhys Mainwaring:** the multi rotors controlled using a velocity control using twist and the fixed swing UAV is controlled using a combination of mavrox messages one for the takeoff and one for the attitude Target. I think the vehicle controllers fairly simple. I think the main purpose of this was not model aerial Vehicles. It was really to carry out kind of more search and location of various objects on the boats and then report back. So the controllers used in this are not the controllers that you would use on real vehicles. I don't think and I think it's one of the big differences. It doesn't appear to be actively maintained since it was developed for the

**Rhys Mainwaring:** for the challenge. So the last PR is in September 2022. So I think it's interesting as a project. It's got some nice ideas in there, but I don't think it's an ongoing concern. I'll be happy to be

corrected on that. But that's just from what I can see in there and The next one is the vehicle Gateway and there was a talk about this given last year in the Gazebo Community meetings. So again, I think this is

**Rhys Mainwaring:** Clearly probably the last PR from the project owners was May last year and there's someone going community support but not a great deal. So I think as an idea, it's quite nice. I think practically it's possibly not an ongoing concern again. If the code owners are happy to correct me on that. I be happy to update this. It was intended as sort of a way of consolidating

**Rhys Mainwaring:** interfaces into a number of different vehicle sdks in particular it started with betafight and PX4. So it does a number of things that managers to download and build the autopilot Stacks it provides Python and+ bindings. The platform at Targets is really just Ubuntu it won't build on Mac OS it's tied to gazebo Garden fairly tightly. It does use Zeno for messaging which is quite interesting because that's something that actually be looking at using for real Vehicles. So it needs to have the rust framework installed.

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**Rhys Mainwaring:** So that the setup works on Ubuntu quite well, I haven't managed to get it running for betafight it sort of runs up, but I'm not getting the vehicles don't tend to respond. I don't intend to try and debug and get it all working, but it has got some nice ideas in there.

**Rhys Mainwaring:** One of the challenges in putting together a framework like this is arriving at a common interface vehicle modes and commands. So each flight stack has its own interpretation of what loiter might be or how you map from the various vehicle modes to integers and it even varies between vehicle type and a flight stack. So for example, an argue pilot the flight modes for copter and plane and all So coming up with a single set of modes that works for everybody is possibly very unlikely. So you need to probably not do that and have some method of having at least one step away from that.

**Rhys Mainwaring:** It doesn't include argue pilot and it's probably because of license compatibility argue Pilots GPL. So if you want to pull in a whole lot of binaries and build the stack, you probably need to be consistent with all the licenses. So that also makes it difficult to use this approach. If you want to extend it more broadly and again cross platform support is focused on Ubuntu. That's no surprise. Really Mac OS is not a tier one supported platform Butters is available and used for a number of the flight sex. So both PX4 and RG pilot will run and build on Mac OS as well gazebo. So as I mentioned earlier project momentum, I think it seems to have slowed down doesn't seem to be actively developed. But again some ideas in there. So looking at it some of the useful ideas as perhaps a more Loosely coupled.

**Rhys Mainwaring:** Said joriented interrupt model may be more sustainable. So looking at projects like this to try and understand why they lose momentum is often quite useful to do when trying to figure out how we should direct our own simulation efforts. Okay.

**Rhys Mainwaring:** so now starting to look at so the next sections will be really just looking at kind of flight Stacks sort of autopilot Stacks simulation in the loop and they're integration with gazebos. So the argument here is that if you looking to do it's going to be very noisy here because it's raining like anything. I'm in Wales and rains a lot. So betafight

**Rhys Mainwaring:** has integration with gazebo. However, it appears from the documentation to mainly Target gazebo classic. It uses a binary protocol very similar to the way that I' your pilot gazebo plug-in does it's a kind of a bidirectional soccer and it has a couple of structs defined one to carry the pwms from

the flight controller to the simulation and then return some flight Dynamics information that the controller needs to do its processing basically pose orientation and a few other things the vehicle Gateway which mentioned earlier does offer support. There's gazebo garden and Ross to humble and

**Rhys Mainwaring:** The most recent PR to betaflight for gazebo support and February last year kind of added that support. But I don't get the sense that the Gazebo is actively used with betaflight and if they were bit of light users who are interested in doing that then that's perhaps something we could look at further. So that leaves the other two kind of flight controllers will be looking at here, which is PX4 and argue pilot now.

**Rhys Mainwaring:** I mainly work with Ardupilot. I've used PX for a little bit. So I'd be very happy as I mentioned earlier for someone to provide a much more in-depth guide to how PX4 works. So this is an overview that I've got by some of the work I've done with terrain navigation and just going through the picks for gazebo integration code at a high level. it's very nice. One of the things that depicts does very well. It's very easy to launch gazebo and the models that supports and the approach is quite nice. It's different to the way out your pilot doesn't and we'll look at that in a little bit. So there's the user guides all online and if someone wants to you want to find out more about it, then I'd recommend going through that and working through that in detail supports both.

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**Rhys Mainwaring:** Who in Mac OS I run the simulations on Mac OS so I can confirm that all works and one of the big differences is that it uses the Gazebo transport layer directly. So there's no need for a custom plugin a PX4 Plugin or a map a mavling program on the model itself. and that's quite nice because it means that the plugins in that sense are a kind of autopilot stack agnostic and that's a good thing. there's models and that lets you load the models up to the Gazebo Sam app I think it used to be called fuel tools. And that's a community repository of

**Rhys Mainwaring:** Of models that have been put together by organizations or individuals and there's a GitHub repo for the models as well. The vehicles offered there's a variety of aerial vehicles Multirotors so PX4 vision and the X500 there's a couple of planes. There's a standard Cessna, which is configured I think to use both the standard lift drag plugins, and I think there's a variant which uses the advanced lift drag plugin. There's a Skywalker X8 configured as a standard detail and then the X500 has a couple of variants which have

**Rhys Mainwaring:** Sense of different sensor payloads. So the models use all the package gazebo systems and tensors. So there are a with gazebo classic PX4 maintained a set of custom plugins to sensors manage the kind of socket integration with subtle and so on now these things are all available when you install gazebo with all the core packages. So these include lift drag position controllers the motor model since for air pressure various cameras the IMU and in some cases, they publish a dormitory. I think that's for sort of visual serving and that type of thing.

**Rhys Mainwaring:** okay and please come I can't quite see the Thing if anyone's got any questions, please feel free to interrupt or we can answer them at the end and come back. However you prefer.

**Rhys Mainwaring:** Okay, so my main interaction with PX4 and gazebo has been on some of the work we've been doing on another one of the streams on the terrain planning stream where we were looking at porting Jays terrain planner from one to Ross 2 and in this

**Rhys Mainwaring:** This was really just to test the end to end integration PX4 has a nice controller the non-linear path following guidance controller, which was designed to work with the terrain planner set points that were coming through and so that was a good first point to check that everything integrated. so here we have a standard veto frame. There's a Terrain model which we'll talk about how we generated that a little bit later on in the talk.

**Rhys Mainwaring:** Ground station is just The set points in this example are coming in Via mavros. So PX4 does have DDS support as well. But this particular example is not using that that would be I think a Target state for how the terrain planner would integrate with flight controllers as to use Ross directly via DDS, but that's not the case here an invisualization and others. So this is a nice example. It's the whole package where you've got off board control. You've got your simulation, which is mainly here. it's used if you cry into the ground, you know about it because there's a collision mesh sitting underneath the terrain in the vehicle hits it it stops.

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**Rhys Mainwaring:** And you get everything so it's gazebo simulation flight control for all the Dynamics and the bits that you want to flight controller floor and off-board planning. And what's nice is that most of this is transferable over to the real vehicle? And I think that's one of the things looking at in the Target state is and one of the reasons that I'm focusing probably so much on using autopilot Stacks as the flight controllers is that we really want to be using the autopilot flight control Stacks if we intend to use those and rear vehicles and that we get the simulation to do the stuff that we can't do such as the physics and maybe the visualization and other bits and pieces but I don't.

**Rhys Mainwaring:** Have a great interest and providing flight controller logic in the simulation. Outside of running a flight controllers core software in Linux which is doing that and that's a good setup. So you get the bit of software designed to solve solving the problem and you sort of augment with gazebo the bits that flight control is not doing and that's sort of having the right software and the right place. So That's the other flight controllers.

**Rhys Mainwaring:** Covered here and will be now moving and sort of archipilate. So this is where the kind of bulk of the work. I've done with gazebo and a Vehicles has been adding sort of support for more vehicles and kind of additional features in our Pilots at all starting with Of the plugins over to use the new gazebo Frameworks and then adding functionality in response to some of the sort of requirements of various devs or some of the users that we get on our discourse channels. So we'll go through some of the vehicles that we've provided. looking at getting terrain some features that are quite nice such as lockstep simulation and then to end a couple of examples where we've had kind of

**Rhys Mainwaring:** requests from the partner programs or part of our gsock work where we've kind of integrated everything together. and use the vehicles that we've got. so Vehicles by copter to start with so this part of the talk is really just a show and tell if you like what's available so

**Rhys Mainwaring:** Simple little vehicle two Motors really sensitive to center of mass positioning and really primed oscillations in the tune. So kind of careful rate Tunes required. Otherwise with the servos are a really prone to oscillate in this quite similar in many ways to another vehicle look at later, which is like a tilt rotor, but here you don't have any control so we had a user on audio pilot discourse who was looking to build one of these wanted some help getting his simulation working. And so we kind of did some work with them. It was quite interesting because we didn't have the particular vehicle covered say You need to be pretty careful with the way that you.



**Rhys Mainwaring:** Rig the model so that everything is in the right place try and get the inertial and physics properties is correct as you can and then the rest of it will be dealt with the tune in and the bright controller Stacks parameters. okay, this is another veto. So this is a mini Hawk, which is a 3D printed plane. I have built one of these so I wanted to have the simulation model to Test how this vehicle was going to behave before I put my own vehicle into the air. one of the main things with feet holes is you often have trouble with kind of your control on them. In this case. These tilt rotors are really prone to your oscillations initially. So the

**Rhys Mainwaring:** The standard vetoes where you don't have tilt rotors. You just might have four lifting Motors Barrel often. your underactuated because you're really only getting your through the drag from the motors or from the props. So you're relying on the talk from that to on these ones that the motors can tell forward and backwards to provide you with your control. And one thing we're observing is that

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**Rhys Mainwaring:** You would wind up with oscillations and that's mainly because the rate controllers need to be dialed back quite a lot for these and you have to Tinker around with the things like the angle which through you let those rotate through and while are in So quite a useful environment to set up I think real flight not probably will have better Dynamics But for the vital study this was good enough. So yeah to motor tricopter so that the rear motor is pitch forward, but doesn't actuate.

**Rhys Mainwaring:** Okay. So this is the vehicle that in some ways is similar to the bicopter again prone to oscillations as we're can see over on the

**Rhys Mainwaring:** On the right hand side before it's tuned properly. It can be unstable. And so you can tune these out but out of the box say they don't necessarily behave very well. So this is a vehicle that sits on its belly the road is tilt up. It has a vertical takeoff but Halls itself into the year. And then once it's Airborne it Transitions and to forward flight. So again quite nice to have that again and it enables you to study some of the properties mostly a qualitative description. You're not going to be able to transfer the pids for the right controllers directly over from the simulating vehicle to a real vehicle physics isn't captured well enough to be able to do that, but it does give you an idea of where to look and

**Rhys Mainwaring:** it really helps moving to a real vehicle to have some idea of the behavior in the simulated vehicle before transferring over. So an Hwang this is a vehicle with no moving control surfaces actually really difficult to tune in simulation. maybe another simulations. It's easier and gazebo turned out to be quite difficult.

**Rhys Mainwaring:** Or your and Pitch Authority comes from the canting of the motors outwards. and slightly inwards towards the wings. I can't remember which way it's either outwards through the wings.

**Rhys Mainwaring:** also also very sense center of gravity dependent. So in vertical flight, it's no problem at all. The difficulty comes and the transition into Ford flight and getting the pitch attitude correct and making it work. So it's another vehicle where the structure of the vehicle raises some challenges when trying to simulate it given all the limitations of the aerodynamics model that we've got. So the various round markers that you can see on the right either contacts or helping to visualize where the center of pressure for the lift and drag has been placed. A center of mass. So again all the models are quite sensitive to where these are put so getting that right is one of the processes involved in setting up the models.

**Rhys Mainwaring:** This is a really interesting aircraft that was put together by a group of Canadians and it's a community contributed. So it's a weight shift controlled aircraft. They have a real vehicle so Hang glider type size of vehicle. That uses this weight shift control principle. They wanted to test all of their Control Systems out using simulation before they ran on the real vehicle. So they've spent quite a lot of time configuring the model to have good.

**Rhys Mainwaring:** Aerodynamics properties good enough to match the vehicle that they actually have and it works very nicely in the end. The control system is just adapted using a standard argue playing controllers. It doesn't need a custom controller. Most of it is all around the setup Of the Hang Block in the way that's actuated and there's a link there to the company and the paper on this particular model. So that was quite a nice to have having sort of someone from the community add back into that.

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**Rhys Mainwaring:** This is a full-size model of a sail plane kind of had again a discourse request for. More text Wing type aircraft so it's capable of power take off. So here it's a sail plane. So it's lift drag traffic into quite different. So the other planes and vehicles we've got so the

**Rhys Mainwaring:** way that the lift drag plugin and gazebo set up. it's piecewise linear approximations to the lift drag curve. So you don't have a lot to play around with it's got very sharp transition at the store point. and so, there's lots of problems with that but given that that's the model. How do you go about fitting a lift drag car efficient for your particularly aircraft? So you have to choose the Reynolds number for the aircraft and then on airfoils tools.com. You can look up an airfoil which is a good match or an exact match for the airfoil that's with So the four profiles for this particular sail plane or available and it's flight manual they are available.

**Rhys Mainwaring:** And airfoils Tool and so once you have the lift and drag profiles you can just try and fit the lift drag model to them and It's not great either but it's good enough for a vehicle to have reasonable properties. So the process of doing this for a new vehicle is similar. So there's a piece of work to do again. It would be nice to have all of us automated. We had a database of the profiles you could set to but we don't have that and it may be better to have. a more precise lift drag model in any case So terrain there's a couple of

**Rhys Mainwaring:** tutorials for developing terrain models one for gazebo classic and one for the newer one it's actually in And the rendering kind of tutorial section. So you have to dig around to find it a little bit here. We take a slightly different approach. So we needed a Terrain model for the terrain planning example provided earlier for PX4.

**Rhys Mainwaring:** The way that we put that together is that we use this city skyline height map generator. It's quite nice free online tool you basically select an area. So if you want good resolution, you submit select the smallest Map size which gives you a 17 kilometer square area, you kind of dial and a couple of the settings and then you download the height map and the texture for that and then you can create a Terrain model using the height map.

**Rhys Mainwaring:** So the main things are just to get the size, correct? So you want to set the size of the tile to the height map to be the same as the tile. We downloaded you need to make sure that the elevation is equal to the difference between the lowest and highest point on the terrain map and then there's a little bit of fiddling around to get the actual overall position and height matched up properly because

**Rhys Mainwaring:** If you want the aircraft to be centered at a certain point you need to make sure that that particular point is at the right elevation and that requires a little bit of tuning be nice to have that automated but the end result is very good. You wind up with quite a reasonable Terrain map that does align quite well with the data and the terrain map we used in the terrain planner. So that's something to extend. Okay, right. Let's move on.

**Rhys Mainwaring:** So one of the things we put in place in argue pilot was the ability to lock step the simulation that's really invaluable for debugging you want to be able to either stop the simulation in gazebo. So if you've written a physics plugin and you want to check it, you need to be able to put a breakpoint on and stop that and then you have the flight controller also stop or vice versa. So if you put a break point in your flight controller code you want the simulation to stop so you can step through it and the way this works is that you just have the socket

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**Rhys Mainwaring:** either side of the socket the plug-in on the model and this sort of the API in the case of archipota. This is the Json so API both wait for the next message to come and if the message doesn't come it just sits there waiting. So that allows you to stop the simulation at either end and that's proved to be extremely useful when trying to trace problems either in your custom plugins or in the controllers as well. So this was really just a toy. one of the devs was thinking about attaching some rotors to hexacopter a hexa hexapod. We thought we can simulate that but what we needed to do is because

**Rhys Mainwaring:** the particular model for this is Lewis scripted. So the way that the robot unfolds its legs is a script that is running using the lower back end. energy pilot and you need extra service support, so we extended the range of servos in our plugins to be 32 rather than to That it's a little bit of history on how it was put together.

**Rhys Mainwaring:** Parachutes, so someone wanted a parachute gazebo classic simulations had parachutes. So we ported that plugin over and then quite often we'll get requests for gimbals. And so we had a one or two access gimbal we've extended that to three axes. It just uses rather than having a custom plugin for it. We just use the joint position controllers and the way Arjun pilot deals with it is because we don't argue pilot flight control step does not talk to the Jesus messaging. Layer directly. We just then forward the commands on the plugin on the model. So there's an option now to be able to do that.

**Rhys Mainwaring:** So another thing we added with the gimbals was the ability to zoom the camera. So this is again the flexibility of the new gazebo plugin system is demonstrated here. You can attach plugins to almost anything you can imagine. So in this case, it's a camera sensor. So there's a plugin that attaches to that and then just fiddles around with the field of view inside the camera by overriding some of the properties in that so Ryan extended that by adding a slew rate control. So we've got sort of three axis gumballs was zoom on them as well. So that's quite a nice ad and the gimbal with the zoom camera can be attached to any of the models you like.

**Rhys Mainwaring:** Okay, so then applications were all of this being put together. So one of our developers was working on a script to manage takeoff and landing of quad planes on moving platforms. So they were running this in sort of the normal settle with mad proxy which is really a 2d system. They wanted to have a 3D view of it just to check that and be able to talk through with some of the partners about how it's going to work. So here we have quite a large quad plane landing on the back of a large research vessel so there's quite a lot going on in the simulation. There's multiple Vehicles. There's custom environments. The

ship is sitting on an ocean simulation. So it's moving around in the waves is at least three GPS beacons kind of all tied. And so

**Rhys Mainwaring:** Gazebo lets you do quite a lot in that respect and the other simulation platforms may have better aerodynamics, but they don't have the flexibility to be able to pile all of this stuff into them. So that's where gazebo starts to shine. We had some nice projects for some of our gsox students last year. So Ryan, he's on the cause involved with student on this and this was for off-board GPS tonight navigation, really nice project where quite a lot of background work that have been going into the flight controller was all tied together in the kind of Ross DDS support offboard support and then a simulation in gazebo to provide.

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**Rhys Mainwaring:** Sort of light off feedback so that you could then use the nav2 stack and cartographer to navigate through a maze. So this is an iris ua Navigating through a maze and it's the normal Arvis thing. You can do with a Rover you kind of point and click set the goal and it goes to the goal using a velocity controller in the autopilot to fly the thing around and then have two stack to talk to where to go. So that's all quite nice and there's more details online of people want to follow up on that and then the most recent one is again, one of the davises involved with some. and Australia fire service and looking to be able to use

**Rhys Mainwaring:** quadcopters to spot small fires and then put them out. So they have a problem where the quadcop is now carrying a payload and the payloaders of a mass which is of same order of magnitude as the copter so that can cause interesting effects for position control. And so they wanted to have a simulation to be able to model that so here we have a tether which is just made up of a whole heap of short sections if rods with universal joints and a sphere hanging on the end with a mass which you can configure and there we go. So application to Bushfire control and also magnetic surveys as well. That's another thing that people seem to be using quadcopters for you hang a large sensor array on the bottom of a long tether with a number of magnetometers and I am you so that's another practical application of it.

**Rhys Mainwaring:** and there we go, so Kim happy to take any questions.

**Kimberly McGuire:** All right. Thanks those very interesting. So. Anybody that wants to ask questions, just raise your hand or open up your mic or just ask it in the jet. Still have a few minutes ago.

**Kimberly McGuire:** All right. I am gonna go for it.

**Ayham Alharbat:** Hi, do you hear me? Yes, thank...

**Kimberly McGuire:** Yes.

**Ayham Alharbat:** So thanks a for the presentation. It's really a lot of interesting examples. I wasn't interested in the last example that you showed where you have a tethered payload. Do you have an idea the tether itself? the Rope? Let's call How was it model?

**Rhys Mainwaring:** It's very simple. So There isn't a soft body simulation in gazebo. So It's just a set of short rigid. bodies connected with universal joints, you could probably get some soft body effects or stretch Effects by missing around with the parameters that control the joint so the way most of these rigid body systems manage the joint is that they are managed by a set of constraints and...

**Ayham Alharbat:** Christmas

**Rhys Mainwaring:** so you can have spring constants friction constants within those joints.

**Rhys Mainwaring:** I haven't done too much with that. So it's a fairly rigid rope from that respect. So it's a set of short sections about 0.2 meters long joined with two revolute joints at each point and it gives a reasonable qualitative effect, and certainly you can see the effect of the payload on the vehicle if you wanted to model the Rope more accurately in I believe this work that's been done on other Ross projects and gazebo projects. It does that people looking at robots with power cables and things like that. I've seen something there quite nice about

**Rhys Mainwaring:** Better modeling the cable of course that the issue is with the more sections that you have. It's going to be more expensive to simulate and At present at least gazebo doesn't have a elastic or soft body simulation to be able to switch into so it's an approximation at best.

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**Ayham Alharbat:** Great. Thanks a lot.

**Kimberly McGuire:** All right, that was actually also my question so that this has been instant. Thanks There is one from riccardo who's asking. Is there support for GPS navigation in the new gazebo or a GPS navigation plugin? I guess there's

**Rhys Mainwaring:** Yeah, yeah, so there is a knob set sensor and there is a element you can set on the world which is a spherical coordinate system. So I think in one of the examples back in the size and I can make the flights available if there's a place for sharing them I'd be happy to do that. one of the examples does have the widget app on gazebo. However the navset sensor data is not being fed back into the flight controller. So the flight controller is simulating an abscess sensor based from the ground truth information coming back with the other flight Dynamics information, but for most of the simulations, you saw apart from the one about the GPS denied example, which is using nav2.

**Rhys Mainwaring:** They're all using GPS Waypoint navigation. So the flight controllers generally expect the GPS to be present. And so I'd say yes, it's been simulated but no the data for the GPS is not being provided by gazebo in the examples. I showed. I hope that answers question. So.

**Kimberly McGuire:** Let's see is regards Association satisfied with your action with a few answer and...

**Rhys Mainwaring:** Okay.

**Kimberly McGuire:** to also answer your question. Yes, if you could send your slides to me by email or discourse then I can share them on the same discourse thread where I am supposed to recordings and all the documentation of the meeting. So yeah.

**Rhys Mainwaring:** Okay with that. Yeah.

**Kimberly McGuire:** So that will be just the PDF for a link to drive is fine.

**Rhys Mainwaring:** Yeah, I'll give you The Google share and you can take a copy if you want and put it somewhere. So. Yeah.

**Kimberly McGuire:** Yeah, perfect. That will be One more question and then I'm just going to close off today because we're already over the hour. So my young go for it.

**Mayank Joneja:** Spot Aries amazing demos. It was really fun Show and Tell we should do more of these and a question. Have you ever come across a system Plugin or something in gazebo for Telemetry or communication simulation? Because I think it'll be useful for testing things like feel safe mode. So either other physical layered of RSSI path loss or maybe at the higher layers for packet loss or range in some fashion, or have you not because you want

**Rhys Mainwaring:** No, I'm not familiar with that. I know that so in the mbz IRC That there is a radio communication plugin that comes as part of the Gazebo packages. I've not used it. I don't know whether it can simulate package loss and things like that. So it's a good question. I haven't looked into it. So I'm not sure what the functionality of those plugins is and it would be worth looking into

**Kimberly McGuire:** I'll look close to meeting for now. If there's any questions that you have to reach this better to maybe kind of ask them on a different platform and then this could meet.

**Rhys Mainwaring:** yeah, I think there's a simulation subgroup and Discord now, so Feel free to fire questions through there.

**Kimberly McGuire:** Yes, indeed. Yeah.

**Rhys Mainwaring:** And yeah, happy to help.

**Kimberly McGuire:** yes, I've also share it at least the eldest to go ahead and share the meeting slides now for moments. I've also shared a couple of interesting links. And can I share my screen already? Yes, I can.

**Kimberly McGuire:** working let me just stop the screen sharing and open up again.

**Kimberly McGuire:** sticking a long time There you go. Let's I want to say of also shared some links to both also a overview of different simulators including gazebo, of course, but compared to each other and there's also the landing page to the simulation Swift committee with also link to this discourse discord's subthread about simulation where you can ask questions. but yeah Rhys was really interesting was a very nice to see all of those applications. What is all possible in?

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**Kimberly McGuire:** Thanks a lot for that.

**Kimberly McGuire:** So the next meeting is going to be a developer meeting with the subcommittees at different subcommies that we have for to talk a little bit more about developing rules and everything like that. So that's going to be on Wednesday 10th of April. It's 3 pm UTC. However, do we mind that we might change this time because it's kind of gone slides with some other meetings as well and people that don't use same UTC so you might need to change that's but I will set an announcement on this course the Ros discourse and next week and I will of course post it on this course if there's any specific particular time changes also the GitHub Organization for this working group is called [github.com/rush](https://github.com/rush) - Ariel, and so there's also the source for there are both extenscape and also you can ask yourself remember and it feels want to do a presentation which has done. Please send me an email or

**Kimberly McGuire:** an email about that. thanks a lot for joining this presentation meeting and I hope to see you all in two weeks.

**Rhys Mainwaring:** Thanks for hosting.

**Kimberly McGuire:** Yeah, and thanks thank you for the presentation of super interesting

**Rhys Mainwaring:** Okay, right.

Meeting ended after 01:01:57 🙌