Allsky Camera Network for Detecting Bolides
Milestone 5

Members
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Progress Matrix for Milestone 5:

Task	Completion	To Do	Tyler	Vincent	Jean-Pierre	Charles
Client Hardware Interaction	0%	Return hardware status, figure out where the camera is located and the orientation (gps and starmap), humidity sensors, water sensors (warning email)	50%	0%	25%	25%
Orbit, trajectory, velocity, mass (of bolide)	50%	Determine angle of view and figure out how to undistort image	0%	0%	20%	80%
Client connectivity logic	95%	Hostname issues (hostname “not working” when on hotspot), event sending to void, hotspot password	10%	0%	20%	70%
Poster ~~and e-book~~	75%	Add actual data into skeleton, polish requirements, refactor code, clean everything	25%	25%	25%	25%
Finish UI	90%	Adjustments req’d by researchers, API integration	20%	80%	0%	0%

Server and client testing	50%	Integration tests (leaving it outside for a long period of time and just making sure the system works)	40%	30%	20%	10%
Video capturing and storage, move event detection to node	100%	Done	0%	0%	80%	20%

Discussion of each accomplished task for the current Milestone:

- Task 1: This was put to the side in favor of expediting the event detection and video sending code.
- Task 2: Code that can determine the position of an object in ideal conditions is present. The main concern is determining how to undistort the camera image and make the solution generic given there could be different cameras in the future. We also need to figure out the viewing angle, how to “position” an object (ie what is the “position” of the camera, is it in 3d space with the center of the earth as the origin?). Other problems include figuring out where the bolide actually is in the image (looking for the center of the bolide). Lastly, given the distance of the bolide, the resolution of the image, uncertainty regarding the center of the bolide especially when the weather conditions aren’t favorable, the margin of error will probably be high.
- Task 3: IoT works properly and now correctly evaluates when to turn on the hotspot. IoT also now returns success and failure messages despite the box losing connection and dropping either the hotspot or the connection to the user. Endpoint to reset the box’s known networks has been added. Users can now remotely rescan the box’s wifi. These endpoints are rate limited to prevent people from DDOSing the box.
- Task 4: This task encompasses everything that involves preparing for the showcase. Ebook removed from task as it is not required. Poster skeleton/layout created. Pipelines with linters, type checkers, and formatters are in place to ensure proper type consistency and code quality (important if people want to look at the code). Documentation is present for both the box and the server and can be accessed via an endpoint (/docs). Overall polish of the project is in its early stages but it is progressing.
- Task 5: Plenty of frontend elements implemented such as better time selection for when the node should record and progress bars. Further work has been done integrating a shared filesystem so the frontend can directly view, download, and modify files produced by the nodes. Design flow/navigation has changed to enable more consistent experiences when traversing the site and reduce performance impacts from excessive draws. Finally, a global toast system has been implemented to simplify communicating operations to researchers with minimal interruption.

- Task 6: Testing currently consists of on the fly testing functions and units of functionality to ensure they behave as intended. An example of this would be testing the IoT by manually disconnecting from wifi on a raspberry pi and seeing if the hotspot goes up, then connecting to the hotspot, going to the page, entering credentials, receiving success/failure message, and seeing if the raspberry pi connects to the internet. Other examples would be just investigating events that have been detected to see if they actually warranted being detected.
- Task 7: Event detection is now done using video segments (duration 5 minutes). Each segment is analyzed after it is created for events using an updated event detection algorithm that analyzes a smaller amount of frames at equal intervals such that the time it takes to analyze the segments is shorter than the segment time. Researchers can now also select a certain number of days that the system stores and holds full night recordings. It might also be preferable to add an auto mode (for recording interval) but that is not required.

Discussion of contribution of each team member to the current Milestone:

- Tyler Turner:
  - Continued assisting Vincent in making the UI functional by adding the backend functionality that is required for the front end.
  - Assisted the team by providing a better development environment and containerizing the server for easier deployment.
  - Set up a better logs system with Grafana and Loki
- Vincent Quintero:
  - Integrated more node endpoints with the frontend
  - General UX improvements, add global toast system
  - Groundwork for providing zips of research files via the frontend
- Jean-Pierre Derbes:
  - Logging for node events such as when it starts recording, receives requests, etc.
  - Segment and event archiving
  - GPS endpoint so server can update node locations
  - Faster event detection using frame scaling and skipping
- Charles Derbes:
  - Finished most of the client connectivity. This includes allowing the internet connection success message to be displayed by adding a timeout on the client side that uses a max duration that must pass before it is assumed no failure was received by the client. Worked on ideating for better event detection. Worked on general code to triangulate objects given two cameras with different, known positions and orientations. Made poster skeleton.

Task Matrix for Milestone 6:

Task	Tyler	Vincent	Jean-Pierre	Charles
Client Hardware Interaction	50%	0%	25%	25%
Orbit, trajectory, velocity, mass (of bolide)	0%	0%	20%	80%
Client connectivity logic	10%	0%	20%	70%
Poster, User/Developer Manual, Demo Video, Documentation	25%	25%	25%	25%
Finish UI	20%	80%	0%	0%
Full system server and client tests	40%	30%	20%	10%
Evaluation	25%	25%	25%	25%

Discussion (at least a few sentences, ie a paragraph) of each planned task for the next Milestone:

- Task 1 (Copied from last milestone as this was put to the side): Client hardware interaction involves making sure that all of the sensors and devices connected to the node can be verified as functional. It also involves communication with the devices i.e. to ensure emails are being sent out when there is water in the node, to ensure the camera can be properly calibrated, to ensure that the code works with a wide variety of different cameras should the researchers choose to upgrade etc. In order to move forward with trajectory and mass calculations we need to be able to calibrate the camera. Lastly, the hardware interaction being functional allows researchers to diagnose issues as hardware related rather than software related.
- Task 2: The primary concern is moving from the ideal world (knowing exactly where the camera is, the angle of view, orientation, knowing exactly where the object is) to the real world. In the real world figuring out exactly where the bolide's center is located is a

significant challenge and prone to significant error due to the resolution of the image. At distance a singular pixel on an image can "represent" an extremely large area. These two factors make it hard to find a guaranteed trajectory and rather an estimate with an error radius should be provided. Translating latitude, longitude, and altitude (from the gps) into an actual coordinate system might be tricky although it's probably a minor concern. Image distortion and determining the orientation and angle of view of the camera is also a big problem. Lastly the code has to actually be implemented into the backend and requires aggregating events from multiple nodes to see if two events have overlapping times. If multiple bolides are present in a single event it will complicate things even further.

- Task 3: Not much is left to do other than fix a couple of issues regarding the ability to use the hostname when connected to the hotspot. We also need to consider whether we are ok with just error logging when events get sent with no internet connection (events are still stored locally at least for one night, so they can be resent later), or rather if we should use a queue that accumulates events and polls for an internet connection then sends when it has one (or just adding some sort of loop on the actual sending endpoint handler). Lastly we have to decide on whether we should put a password on the node hotspot and if we do, how do we communicate the password with patrons.
- Task 4: User manual and demo video are not only required but they were also requested by the researchers. Documentation and the ability for the researchers to understand the system themselves (it's written in python facilitating comprehension for non-technical individuals) is extremely important. There will also be a developer portion of the manual that goes into more technical details if needed. The poster skeleton needs to be filled out but that can really only be done when the project is complete.
- Task 5: Implementing remaining few backend/node integrations to ensure all important functionality is provided through the frontend. Making final design revisions requested by researchers as they come up. Ensuring all views and components are behaving properly when interacted with.
- Task 6: Box has already proven it can withstand various weather conditions, however things like the humidity sensor and defogging system need to be tested over long periods of time. Software must be able to operate smoothly with clear user feedback when something goes awry. Not only should the system be stable but it should be able to handle the transmission of large amounts of data and make accurate predictions regarding what an event contains and the trajectory of the bolide. Scientific data (eg. light curve data) should be accurate and this should be verified with the researchers.
- Task 7: Researchers need to be given the system and they need to evaluate how useful and convenient it is compared to the previous system. The system requirements must all be met and the features must be evaluated. This includes looking at the bolide trajectory tracking software accuracy (this can be done by using the correct information provided by NASA), classification accuracy, UI response time, page load time, backend event processing time, humidity sensor false alarm percentage, classification and trajectory tracking pipeline run time.

Dates of meetings with Client during the current milestone:

see Faculty Advisor Meeting Dates below

Client feedback on the current milestone:

see Faculty Advisor Feedback below

Dates of meetings with Faculty Advisor during the current milestone:

- Feb 26, 2024
- Mar 5, 2024
- Mar 12, 2024

Faculty Advisor feedback on each task for the current Milestone:

- Task 1: Dr. Palotai urges us to move quickly such that the hardware interaction works flawlessly as that was a big pain point in the previous system.
- Task 2: Dr. Palotai thinks this feature is cool as if a large event occurs he will be able to provide media with an estimation of the size and impact zone of the bolide.
- Task 3: Dr. Palotai is glad that IoT is done properly and users don't have to open the box to connect it to their network.
- Task 4: Dr. Palotai agrees with the format provided and thinks we should emphasize the amount of problems associated with the old system we are solving. Dr. Palotai wants good documentation so he can manage the system without needing us.
- Task 5: Dr. Palotai likes that all of the nodes are visible in one central location and that event sorting is much easier.
- Task 6: Dr. Palotai wants everything thoroughly tested ensuring the system is robust.
- Task 7: Dr. Palotai is glad this is nailed down and we have a near real time solution.

Faculty Advisor Signature: ________________________________ Date: ________