CUAV F9P GPS Problem Description

System Overview

- YANGDA FW320 fixed-wing VTOL drone
- Cube Orange autopilot
- Cellular telemetry module (XB Link)
- Two CUAV F9P GPS modules configured for RTK (moving baseline)
- ArduPlane v4.3.5 firmware (official)
- Parameters: https://drive.google.com/file/d/1XCfNob1rGizndLBCmdRpvwe_UM9Pkj8l/view?usp=drive_link
- Wiring of GPS to autopilot: 1 GPS module is connected to UART "GPS 2" , 1 GPS module is connected to UART "TELEM 1". Before 16.06 , 1 GPS module was connected to "UART "TELEM1" and the second GPS was connected to UART "TELEM2".
- The drone was purchased from YANGDA (in China), ordered to Poland, and we are now using it in The Gambia (West Africa).

Problem Description

The problem occurs in exactly the same way each time under the same conditions.

- The GPS behave completely fine when the drone is on the ground before it is armed. However, after some time the problem occurs. The problem occurs a lot sooner and more frequently when the drone is in flight (after 1-2 min, 100% of the time) than when it is on the ground (3-5 min, 20% of the time). This problem occurs with both of the two CUAV F9P GPS pairs that we have (1 original pair, 1 spare pair).
    - (Propellers off). When the drone is armed and mode switched to AUTO (propellers removed, so the drone is not moving), the GPS behave fine until after 3-5 minutes. After 3-5 minutes, 2 out of 10 times the GPS signal on both GPS is lost, "no fix" and the satellite count drops. We repeated this 10 times with both GPS pairs. The 2 of 10 times it happened, the problem occurred 2 min 58 s and 3 min 45 s after arming.
        - Logs: https://drive.google.com/file/d/1MFFnrSTro4ktFB0I-QTKhEY5bOO_D3ih/view?usp=drive_link
        - Video of problem on the ground: https://drive.google.com/file/d/1ayd5uRhitJCdVkUmEEK3g0H6vG200CqV/view?usp=drive_link and https://drive.google.com/file/d/1HcCtkckLFWhtAODd_m7oqIgdH0VoYhw_/view?usp=drive_link
    - (Propellers on). When the drone is armed and mode switched to AUTO and takeoff, after 1-3 minutes, 3 out of 3 times the GPS signal on both GPS is lost, "no fix" and the satellite count drops. This causes a dangerous situation and the pilot needs to switch to QHOVER (this mode does not use GPS) and manually land the drone. This is how long after arming the problem occurred during each flight: 3 min, 3 s 402 ms, 3 min 5 s 362 ms , 1 min 36 s 351 ms.

- Logs: https://drive.google.com/file/d/1MFFnrSTro4ktFB0I-QTKhEY5bOO_D3ih/view?usp=drive_link

Testing

Test procedure: power on drone, wait for GPS to get fix and for all pre arm checks to pass, arm (start timer), switch into AUTO mode, observe GPS behavior for 5 min, complete test and record results.

These are with the first pair of GPS modules with which we were flying and had the problems occur with (we labelled these GPS modules "N1" and "N2"). We were flying with these modules before 18.06. The following tests were conducted on 17.06. The day before this, on 16.06, and on 11.06 the problem occurred in flight.

- Arm test 1 - GPS perfect, no problem
- Arm test 2 - same GPS problem occurred at 2 min 58 seconds
- Arm test 3 - GPS perfect, no problem
- Arm test 4 - same GPS problem occurred at 3 min 45 seconds
- (GPS cannot even get any fix or any satellites, could not arm, had to power off, wait 10 min then power on / power off before GPS got fix again)
- Arm test 5 - GPS perfect, no problem
- Arm test 6 - GPS perfect, no problem
- Arm test 7 - GPS perfect, no problem
- Arm test 8 - GPS perfect, no problem
- Arm test 9 - GPS perfect, no problem
- Arm test 10 - GPS perfect, no problem

These are with the second pair of GPS modules with which we were flying and had the problems occur with (we labelled these GPS modules "O1" and "O2"). We flew with these modules on 18.06. The following tests were conducted on 17.06. The day after these tests (18.06) the GPS problem occurred again in flight.

- Arm test 1 - GPS perfect, no problem
- Arm test 2 - GPS perfect, no problem
- Arm test 3 - GPS perfect, no problem
- Arm test 4 - GPS perfect, no problem
- Arm test 5 - GPS perfect, no problem
- Arm test 6 - GPS perfect, no problem
- Arm test 7 - GPS perfect, no problem
- Arm test 8 - GPS perfect, no problem
- Arm test 9 - GPS perfect, no problem
- Arm test 10 - GPS perfect, no problem
- Arm test 11 - GPS perfect, no problem
- Arm test 12 - GPS perfect, no problem
- Arm test 13 - GPS perfect, no problem
- Arm test 14 - GPS perfect, no problem
- Arm test 15 - GPS perfect, no problem

- Arm test 16 - GPS perfect, no problem
- Arm test 17 - GPS perfect, no problem
- Arm test 18 - GPS perfect, no problem
- Arm test 19 - GPS perfect, no problem
- Arm test 20 - GPS perfect, no problem

Log Analysis and Observations

1. **Interference (external or onboard the drone in the installation environment) is very unlikely to be the cause of the problem.**
    a. External interference: the problem happened at 2 different locations (~ 30 km away from each other) in the same way. One of these locations (the flying location) is far away from any infrastructure / city, and it is in the middle of a farm in a rural area. There is very unlikely to be any GPS jamming or radio devices around. Therefore, external interference is unlikely to be the cause of the problem.
    b. Internal interference (onboard the drone): the problem happens when the VTOL motors have no power as well as when they have power. There is little correlation between high current and the problem occurring. The problem occurs both when the drone is not moving, motors off and on the ground as well as in flight. The problem occurs both in VTOL and fixed-wing flight. After the installation environment was improved (GPS antenna cables moved away from power cables, GPS modules moved away from each other) the logs show that the GPS noise is reduced, but the problem happens anyway. Therefore, internal interference is unlikely to be the problem.

2. **The problem occurs both in fixed-wing and VTOL flight mode.**
   Therefore, it is unlikely that it is the vertical / fixed-wing flight mode that is causing the issue, or the airspeed / electric current on the drone. However, the problem does usually happen right after the transition from vertical to fixed-wing flight.

3. **The problem occurs both in flight and on the ground. However, the problem happens a lot sooner in flight (either almost immediately, a few seconds after takeoff, or after 1 min) than on the ground.**

   This shows that the problem is not caused by the drone flying or moving, however flying the drone makes this problem happen faster.

4. **The problem has only ever occurred after the drone was armed. The problem has only ever occurred in AUTO mode.**

   This shows that the GPS modules are able to work perfectly fine - just not after the drone has been armed and switched into AUTO mode. This also suggests that this is unlikely to be a problem with the GPS antenna or antenna cable.

   Here is a log from a flight in QHOVER mode that was conducted < 2 minutes after when the GPS problem occurred in AUTO mode in flight. As you can see, the GPS behavior is normal:
   https://drive.google.com/file/d/1OxXscxn7iQBnkVpmmORoQWO20jBSKqtX/view?usp=drive_link

5. **The problem has occurred on two different GPS pairs (both CUAV F9P) in the same way.**

   This suggests that this is very unlikely to be a hardware problem on the GPS modules themselves, as there is a low probability that all 4 modules are damaged identically. This suggests that there could be a problem with the GPS firmware; a bug in the GPS software configuration / firmware; the GPS modules are incorrectly configured with ArduPlane / the Cube Orange autopilot. In both cases, tapping the GPS antenna / moving the GPS antenna around sometimes can cause the GPS Fix to come back after the problem occurred.

Conclusions

1. **CUAV engineer needs to analyze if the configuration between the GPS modules and the Cube Orange autopilot is correct.**

2. **CUAV engineer needs to analyze if the firmware / software configuration on the GPS modules is fine and correct for flying in The Gambia.**

   a. The issue looks very similar to the problem described here, when they are also using an F9P GPS (from Holybro) as a moving baseline for yaw with ArduPilot and Cube Orange and having similar problems with RTK. https://discuss.ardupilot.org/t/new-thread-transmission-buffer-at-100-on-sik-radios/88962/5 and for more details https://discuss.ardupilot.org/t/ekf-failsafe-f9p-rtk-corrections-causes-gps-glitches/88818/46?u=jan_kryca