SKYLARK DRONES

Pixhawk 2.1

With the advent of Intel Edison

A study report on application prospective

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Chapter 1

The Problem Statement

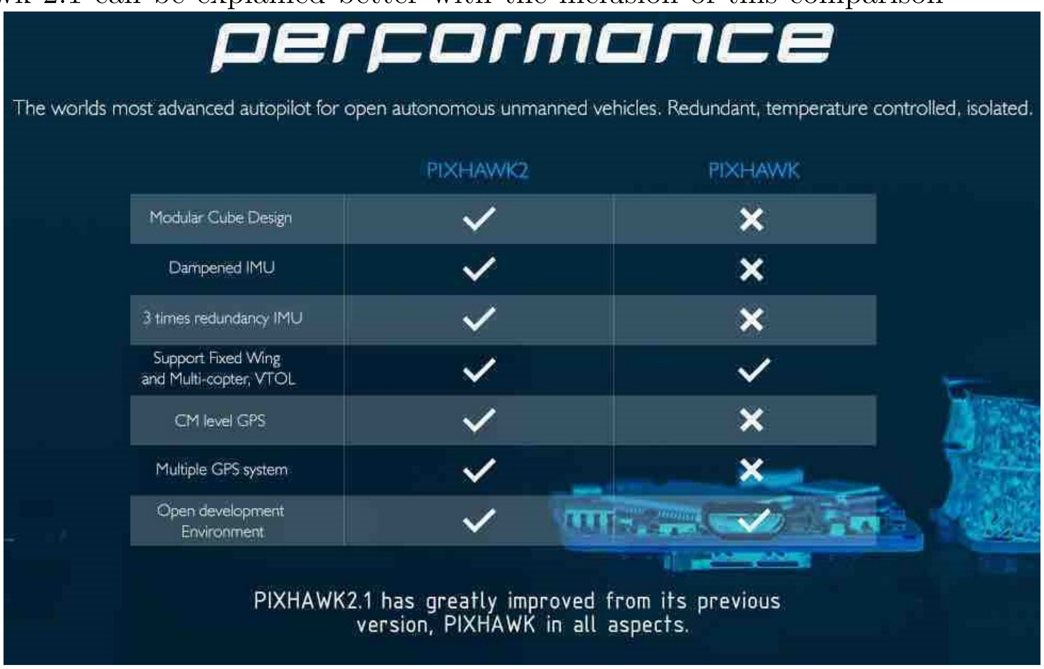
The use of PixHawk 1 in Skylark Drones is basically due to its unmatched versatility and efficiency. However the production of the same has come to an unforeseen halt with the advent of the PixHawk 2.1 and with the new board comes a whole new package of possibilities. With this being the context I am to:-

- Explore the possibilities along with Intel Edison as a parallel processor.
- Figure out a way to transmit the dataflash log to Ground Station(GS)
- Transfer the pictures to the Ground Station via Wireless Communication.
- Explore Emlid Reach RTK module in the context of more possibilities.

Chapter 2

PixHawk 1 to PixHawk 2.1

PixHawk 2.1 can be explained better with the inclusion of this comparison chart:-



This is due to the CUBE which is placed in between the breakout board of the PixHawk 2. This brain of the equipment contains separated IMU and FMU sensors. There is a layer of foam which resists high frequency vibration and thus reducing noise to the sensors. The cube also houses triple IMU system, composed of 3 accelerometers, 3 gyroscopes, 3 magnetometers, and 2 barometers. Most important of all, PixHawk 2 gives you a parallel computer slot.

Chapter 3

The Intel Edison

Imagine you are given a computer along with the PixHawk, flying online you can do a lot of computing. Here we will introduce a few features that the Intel Edison features,

- Wifi telemetry to the autopilot
- Easy scripting/vehicle control via DroneKit
- Faster download of log files (coming soon)

With overall approximate dimensions of 34.9 25.4 3.2 mm. Under the metal cover is an Intel dualcore Silvermont Atom processor running at a 500-MHz clock speed. There is also a 100- MHz clocked Quark coprocessor included, which is designed to assist the Atom processor with input/output (I/O) operations. Unfortunately, as of the time of this writing, Intel has not released any software that will support the Quark coprocessor.

There is also 4 GB of flash memory and 1 GB of RAM available to support the internal Edison processors. The flash memory comes preprogrammed with a Linux distribution created by Intel engineers using the Yocto framework.

There is also a Broadcom BCM43340 chip contained in the module, which implements b/g/n (11 Mbit/s, 56 Mbit/s, 100 Mbit/s internet speeds) and direct WiFi, as well as Bluetooth Low Energy (BLE) wireless communication. Both the WiFi and Bluetooth (BT) connections share the same onboard PCB chip antenna, which is visible at the lower lefthand corner.

An external antenna connector using a FL standard format is located just above the chip antenna and should be used if extended-range radio frequency

(RF) operations are required. The internal chip antenna is fairly limited and will likely operate reliably only within 10 meters (m) of the WiFi access point, which is typically the wireless router in most home networks. Of course, BT communications was always designed to be close range, or not to exceed 10 m. One more point that you should know is that the antenna (internal or external) is multiplexed, or shared, between WiFi and BT operations. This might become problematic if maximum data bandwidth operations are attempted using both modes simultaneously.

The Broadcom chip also supports a hardware WiFi access-point (AP) mode, which might be very useful in certain applications. The only provision is that the module software must also support this type of operation. Fortunately, the default Linux distribution supports the AP mode, which allows for significant flexibility in configuring a network containing the Edison. Intel also provided support for BlueZ 5.0, which implements all the important and widely used BT profiles.

It is a 70-pin connector manufactured by the Hirose company. It is considered high density because of the very tight spacing between the connector pins, which are 35 pins spread across 14 mm with 0.4 mm between pins. To put this in a common perspective, most hobbyists solderless breadboards have a 0.1-inch, or 2.54-mm, spacing between insertion points. The contacts on the Hirose connector are about six times closer than those on a breadboard. The practical meaning for this situation is that the Edison can be used only with a development board with the matching male connector already installed on a PCB. It is just not feasible to manually solder 70 wires to a freestanding male Hirose 70-pin connector. It might be possible to solder a few wires to such a connector, using a magnifying lens and an extremely sharp-pointed soldering iron, but I think it is beyond my skill level as well as that of most of my readers. *Another point worth mentioning is that Hirose connector was not designed to be inserted and removed frequently. You can do operations a few times, but be very careful as it is easy to damage the connecting by misaligning them and/or using excessive force.* I believe this will not be an issue for most readers, as they likely will just mount the Edison on an appropriate development board and simply use the board with their projects.

Edison has 40 general-purpose input/output (GPIO) pins that are available in the Hirose connector, in addition to the dedicated pins used for power and communications.

Chapter 4

Proposed Solutions

- Transfer the log file over WiFi to GroundStation - Assignment 2 (http://ardupilot.org/dev/doc
intro.html)

  (Scripts already in E:/Skylark/Work)

  On start-up an access point is created with name ardupilot. The password is ardupilot on TX1 and RPi, enRouteArduPilot on the Intel Edison.

  The user can connect to this access point and then easily connect to ardupilot running on the flight controller by setting their ground station (including Mission Planner) to connect using UDP, port 14550.

  Dataflash logs are streamed to the companion computer via mavlink and stored on the companion computers filesystem (as well as on the pixhawks dataflash). Dataflash log files can then be quickly downloaded (over wifi) using a script (Windows users may use apsync-download-logs) or you may pull the SD card out of the companion computer.

  IMPORTANT NOTE: It has been implemented before so not an issue.Just worry about implementing.

- Get Pictures over WiFi from the Drone: - Assignment 1 (http://ardupilot.org/dev/docs/apsyn
intro.html)

  Data Syncronisation with Web server or Corporate server. The contents of a configurable list of directories will be automatically uploaded to a configurable web server address.

This should allow the pilot to simply bring the vehicle back in range of a trusted wifi access point, reboot the vehicle and have it automatically connect and upload all datafiles including logs, pictures, videos.

IMPORTANT NOTE: The APSync project is still in beta. This Data Syncronisation portion is not implemented (yet). We need to configure data from Camera SD to Edison.

- Do a lot of processing online using OPEN CV. - Bonus (http://www.instructables.com/id/Getting-Started-With-OpenCV-and-Intel-Edison/)

  The Edison pinnout is available all over the place, and there is no restriction from adding additional layers of boards underneath if you would like them.

  The Edison it there to do things like smart-shots, controlling a QX1 camera, or a go-pro, or for processing external Lidar data from an SF40 to form a map of an indoor location for example.

  the Edison can use any of the IO on the Pixhawk if you program it as such, so it has access to the real world.

  the access to the world that it offers, are as follows.

  connection via builtin level shifting to serial 2 on the Pixhawk 2 for mavlink communications Wifi / Bluetooth connection for control, telemetry, camera connectivity etc. USB OTG for connection to external devices, LTE Modem, Webcam, Lidar, M8T (for PPK GPS) and of course, the mezzanine method of mounting on the Edison means you could add additional I/O if you so desired.

  What I have given you here is a starting point, if you see a use for it, great! but if you don't... that's OK, there are many development boards and other compute modules that will interface just as well as the Edison, some even better, like the Joule, and the TX1

  If you have a look at the history of Ardupilot, and the hardware, you will see that hardware is built, people test, the then contribute to the Wiki, and make great stuff from the raw ingredients that we provide.

  If you wish to get started with the Edison on Pixhawk 2, go to the wiki... there is a guide their for getting an image working on it. http://ardupilot.org/dev/docs/intel-edison.html50 it really is a blank canvas for you to do with it what you want. run python scripts, or write your own path planning method... lots of opportunity!

Getting images onto the Intel Edison can be done a couple of different way. You can transfer files using a USB stick, SD card or through an ssh transfer software like FileZilla. However one of the best options is to take your pictures with the Intel Edison using a webcam. To set up a USB webcam you're going to have to enable UVC support. Luckily there is an in depth tutorial : https://software.intel.com/en-us/articles/opencv-300-beta-ipp-tbb-enabled-on-yocto-with-intel-edison/

Follow this to take Images : https://communities.intel.com/thread/87420 or http://www.instructables.com/id/Intel-Edison-Takes-Pictures-From-Motion-Detection/

BOTTOM LINE: Connect the webcam via the OTG for Edison and get files and run a script to forward it to the Ground Station over WiFi.

- Basically we can get the PixHawk data, Camera data run combined operations.
- Additional sensors can be used and data can be fused for better accuracy.
- Object recognition algorithms to set realistic GCPs
- RFID tracking
- Disaster relief supply
- Create temporary connectivity using drone as a base station
- Wildlife monitoring
- A webpage to advertise our services: https://www.dronesden.com/dronehire/
- Security: Faster response time to 100 dials.
- Wildlife research
- Atmospheric research: People are working on studying the ozone layer

- Chase tornadoes The Tempest is a UAV that can get reasonably close to a tornado. It is equipped with air pressure, moisture, temperature, and wind speed sensors. The Tempest was able to fly for 44 minutes in a supercell thunderstorm last year, transmitting priceless information to researchers on the ground.
- Missile tracers: Suppose a HVT is to be hit and we cannot risk a false lock on as in some missiles are heat seeking and can be evaded if some other hotter source is nearby(popping flare). However drones equipped with Image Processing techniques can get a true lock on.
- Rescue operation: A drone equipped with a kinect can be risked to survey a dangerous zone and map the environment in 3 dimensions this will probably give our soldiers an upperhand in a clean swipe/hostage rescue situation. Example: Plan better surgical strikes in Kashmir.
- Gun/Fire-arm detection: With the power of parallel computing drones can be used to track down infiltrators/explosives. This way counter insurgency operations in J and K area can be handled more efficiently.
- Drone Sniping: A relatively new area but with excellent Gyroscopes and Control Systems we can probably snipe HVTs with much ease.
- Fault detection and correction: Lets say a very large structure is manufactured and some small defects are there in weilds with proper sensors and techniques we can rejoin the misaligned joints etc.
- Facilitate use of simple sensors: Instead of using very expensive sensors we can use raw sensors and use the processing space to detect the thing required. This will allow us to detect and modify algorithms according to our needs. This will emphasize on *reusability*.
- Good power techniques like use of other fuels than LiPo can revolutionarize the industry as one of the few major concerns are very less flight time.

Chapter 5

Conclusion

To summarise it all, we have planned our path and look forward to your support and agreement to proceed on those fronts. few possibilities are also appended in the previous section.
[1]

[1] Bibliography: discuss.ardupilot.org, Nihal and Nekhelesh's expertise, The team's support