Radio Collar Tracker
Milestone Report

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Milestones

Below, you will find the initial high level milestones which were set for our Radio Collar Tracker project.

#	Priority 1 (low) - 5 (high)/ Class	Milestone Description	Due Date	Responsible People
1	5	Read documentation and get up to speed with the Piksi RTK GPS hardware.	4/21/2015	Corbin, Ryan, Sam
2	4	Demonstrate that the RTK GPS hardware works with two laptops in the field.	5/5/2015	Corbin, Ryan, Sam
3	5	Integrate the RTK GPS in with the radio collar tracker hardware/software.	5/19/2015	Corbin, Ryan, Sam
4	4	Evaluate comparative performance between the existing autopilot GPS and the RTK GPS.	5/26/2015	Corbin, Ryan, Sam
5	3	Document our results.	6/2/2015	Corbin, Ryan, Sam
6	2	Investigate low cost RTK GPS hardware.	Stretch Goal	Corbin, Ryan, Sam
7	2	Compare the Piksi hardware with the low cost solution.	Stretch Goal	Corbin, Ryan, Sam

Progress Update

Milestone #1 - Complete (Due 4/21/2015)

Task: Read documentation and get up to speed with the Piksi RTK GPS hardware.
Work Completed: This milestone was necessary for our team to get started on the right foot, but was difficult to measure. We will provide a list of the various videos and documents that we each watched and read in order to complete this milestone. Though this is not ideal proof that the work was completed, this list will also serve as a valuable guide to any future users of the Radio Collar Tracker and the Pksi RTK GPS units.

- Videos
    - GPS Overview - https://m.youtube.com/watch?v=YjcfmZw23Wg
    - RTK Overview - https://m.youtube.com/watch?v=zI59yyN7Tyw
    - Beaglebone Black - https://www.youtube.com/watch?v=ciX08ysl6LE
- Documents

- Piksi Information - http://www.swiftnav.com/piksi.html
- Piksi User Getting Started Guide - http://docs.swiftnav.com/wiki/Piksi_User_Getting_Started_Guide
- Piksi Developer Getting Started Guide - http://docs.swiftnav.com/wiki/Piksi_Developer_Getting_Started_Guide
- Piksi Forums - https://groups.google.com/forum/#!forum/swiftnav-discuss

Milestone #2 - Complete (Due 5/5/2015)

Task: Demonstrate that the RTK GPS hardware works with two laptops in the field.
Work Completed: This task was completed after working on three different approaches:

1. Attempt to use two Raspberry Pis (one for the base station, and one for the rover)
    - We initially tried to load the Piksi GPS console software onto Raspberry Pis running the Raspbian operation system. This caused various issues because the Piksi software is still being beta tested and is constantly updating. Also, Raspbian was not one of the OSes that the software was initially developed or tested for. Thus, we spent a significant amount of time failing to compile and run the Piksi console before putting this approach on hold.
2. Attempt to use two laptops running Mac or Windows
    - This approach was successful and provided us with most of our results towards meeting this milestone. The Piksi console software was easily installed on Windows and Mac and we were quickly able to generate single point position (SPP) GPS location data from the Piksi RTK units:

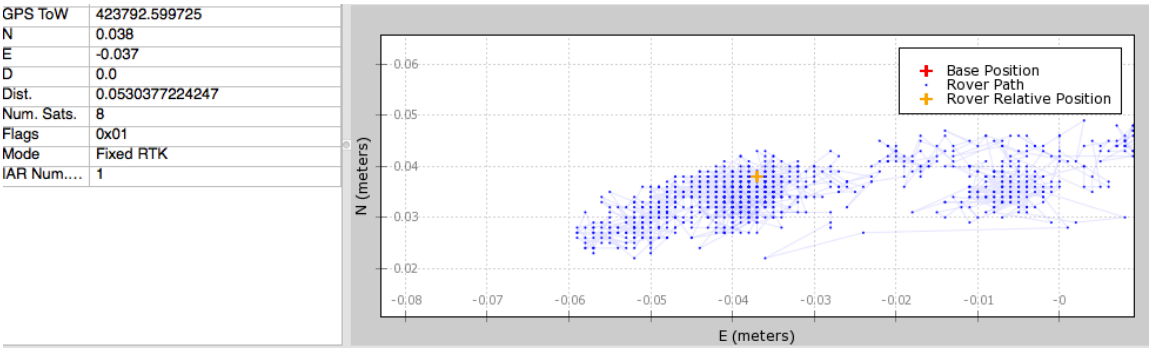
Single Point Position (SPP)

Item	Value
GPS Time	2015-04-27 23:59:43.700004
GPS Week	1842
GPS ToW	172783.700004
Num. sats	4
Lat	32.8802613423
Lng	-117.231546737
Alt	92.4388400935
Flags	0x00
Mode	SPP (single point position)
Vel. N	0.0800
Vel. E	0.0460
Vel. D	0.0280
PDOP	4.0
GDOP	4.3

In the above image you can see the latitude and longitude values for our position on UCSD campus which match up well with the known GPS coordinates of San Diego.

- Once SPP data was found, we turned to getting RTK positional data. This required two separate RTK units to be connected to two separate laptops. These units then had to be positioned near one another and left alone to initialize for up to 30 minutes with the averages being between 8-22 minutes.

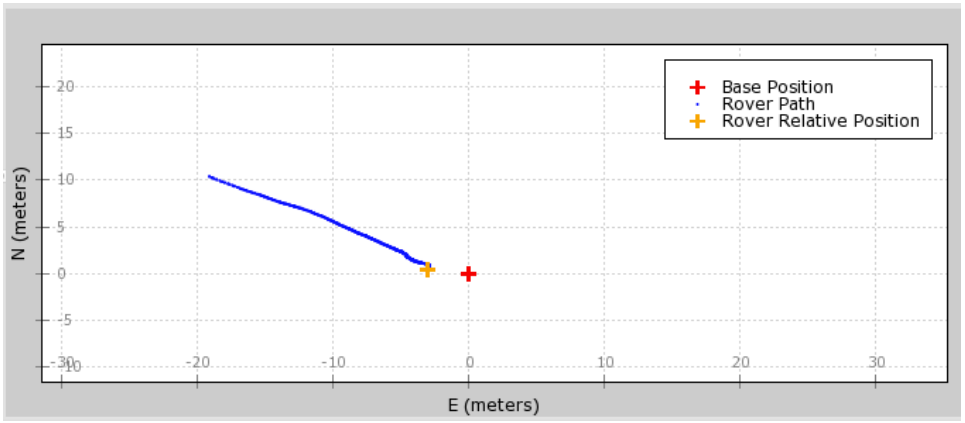
This initialization process was necessary so that the base station and the rover could both sync up to the same GPS satellites; at least 5 common satellites were necessary to get RTK precision and be able to evaluate the surrounding noise. This process was extremely tedious and required multiple days of testing as some days were cloudy, or our position outside was not in range of enough GPS satellites. We were eventually able to gain RTK precision for a short time when keeping the rover and base stationary:



GPS ToW	423792.599725
N	0.038
E	-0.037
D	0.0
Dist.	0.0530377224247
Num. Sats.	8
Flags	0x01
Mode	Fixed RTK
IAR Num....	1

In the above image it is important to note that the “Mode” is set to “Fixed RTK”. The graph on the right shows in blue where the rover has been seen moving over time. The graph shows movement of less than about 5 cms in any given time frame, relative to the base station. This is good data because it shows the stability and precision of RTK compared with SPP results.

- Finally, we tested RTK GPS when in motion using one of the two laptops as a rover which would be moved with the Piksi unit. We found, however, that moving the Piksi unit and GPS antenna caused the system to fall out of “Fixed RTK” mode. We believe this is due to the interference that the human body causes to the antenna signals. Nevertheless, we obtained the following screenshot showing the rover moving in a straight line relative to the base station:



Although this image was not produced in “Fixed RTK” mode, it shows an improvement over standard GPS because the location of the rover relative to the base station appears to be very accurate and the base position can be found precisely after averaging the SPP data on its position over time.

3. Attempt to use two computers running Linux
    - Once we achieved results using Windows and Mac, we returned to our initial goal of running on Linux. This is because the existing Radio Collar Tracker runs a Linux OS called Debian Linux, and we want to show that we can easily integrate our progress with Windows and Mac onto Linux in the future so that we can best match the software used on the BeagleBone Black Microcontroller. We revisited the problem of installing the Piksi console on the Raspberry Pi, and found that with patience and a larger understanding of the Piksi code location, we could succeed. We were able to get the console running on a laptop running Ubuntu, and on a Raspberry Pi running Raspbian. We documented our final solution for success on the Piksi forums so that hopefully others will benefit from us: https://groups.google.com/forum/#!topic/swiftnav-discuss/imYCxKzMaaU

Though we achieved our goal of running RTK GPS with two laptops, there were issues in stability when the rover was moved by a human. Thus, we will introduce a new milestone, Milestone 2.5, which will explore two laptop solutions to the stability issue utilizing a survey stick which we will create. This should reduce human interference and should allow “Fixed RTK” to last longer.

Milestone Changes

#	Priority 1 (low) - 5 (high)/ Class	Milestone Description	Due Date	Responsible People
1	5	Read documentation and get up to speed with the Piksi RTK GPS hardware.	4/21/2015	Corbin, Ryan, Sam
2	4	Demonstrate that the RTK GPS hardware works with two laptops in the field.	5/5/2015	Corbin, Ryan, Sam
2.5	**5**	**Demonstrate stable Fixed RTK lock with the introduction of a survey stick**	**5/19/2015**	**Corbin, Ryan, Sam**
3	5	Integrate the RTK GPS in with the radio collar tracker hardware/software.	5/19/2015	Corbin, Ryan, Sam
4	4	Evaluate comparative performance between the existing autopilot GPS and the RTK GPS.	5/26/2015	Corbin, Ryan, Sam

5	3	Document our results.	6/2/2015	Corbin, Ryan, Sam
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New Milestone #2.5 - Due 5/19/2015

This milestone was introduced to ensure that not only do we get RTK GPS working for short periods of time, but can also get it working for longer lengths of time. The issue of getting a stable RTK lock was unknown when the initial milestones were described, so this needs to be introduced for overall success. This milestone will be due at the same time as Milestone #3, so work on this will need to be done in parallel. This milestone will require us to build a survey stick to mount the rover RTK GPS setup which will allow us to move the rover without causing interference. This will accurately replicate the final product as there will clearly be no human interference with the aerial collar tracker. To measure success in this milestone we will demonstrate moving the rover in a circle while maintaining a “Fixed RTK” lock.

Sprint Plan

- **Week of 5/5/2015**
    - Ryan and Sam will work on installing the Piksi console on an additional Linux laptop.
    - Corbin will work on developing a survey stick type rig which can hold the Piksi unit and GPS antennas. This must also be easily moveable alongside a laptop. The current idea is a slim floor lamp modified with a sheet of metal to hold the GPS antenna and tape to hold other wiring on.
    - Corbin, Ryan, and Sam will meet on campus at least twice once the rig is built and Linux is installed to test the fixed RTK lock.
- **Week of 5/12/2015**
    - All team members will continue working on keeping a fixed RTK lock for a long period of time.
    - Ryan and Sam will work on scripting the start of the Piksi console on the rover so that on laptop startup, the console will start, connect to the Piksi, and begin recording data to a CSV file.
    - All team members will work on coding up callback functions so the RTK values from the CSV file can be easily accessed from other code.
- **Week of 5/19/2015**
    - All team members will work to measure the GPS accuracy of the current system by flying it in a specified path and monitoring the output values
    - All team members will work to measure the RTK GPS accuracy of the new system by flying it in a specified path and monitoring the output values
- **Week of 5/26/2015**

    - Document our results and be sure to include data such as the initialization time and stability metrics of the RTK GPS.
    - If Piksi proves worthwhile, work to mount the RTK GPS unit on the Radio Collar Tracker
    - Begin to research additional RTK GPS solutions.
- **Weeks of 6/2/2015 and 6/9/2015**
    - Compare our reported results with the Piksi RTK unit to ideal results from other GPS units.
    - Finalize RTK GPS setup on the Radio Collar Tracker
    - Finalize documentation, videos, and presentations for class