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Title

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Abstract

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

This is the second paragraph. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

And after the second paragraph follows the third paragraph. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

After this fourth paragraph, we start a new paragraph sequence. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of

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Preface

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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Chapter 1

Introduction

This chapter the background and motivation to why this project thesis has been written. Also reference to privios work, the goal of the thesis and the layout.

1.1 Background and motivation

Why is the project thesis relevant: Installing better GPS to enable better hight estimation

What have I done? Integrated new GPS with DUNE

What is next? Land the UAV. Test algorthm to Frølich, better state estimation

Unmanned aerial vehicles have in seen an increase usage in the civilian sector on land, where they can be used at a cheaper price then manned aircraft. However this has not yet been the case in the civil maritime sector, due to a harsher environment and smaller landing areas.

A UAV can increase performance in many maritime operation where today only other manned aircraft or satellites are the only solution. In the maritime sector they can be used in iceberg management, monitoring of oil spills, search and rescue and maritime traffic monitoring. To enable a safe UAV operation at sea there must be a system in place to ensure a safe landing.

There exist landing system that can guide the UAV towards a net, but they are expensive and restricted to a few UAVs. A pilot could always land the UAV, but it would be better if the UAV could hit the net by it self. In order to make the UAV able to perform a automatic landing the minimum requirement is that it know where it is at all time. This put a requirement of the position sensor. The position system need to combine low cost with high position accuracy. This thesis will test a new generation of GNSS receiver, and use GPS to find the position to the UAV. The demand on the accuracy is that the error must be in decimetres to ensure safe landing in the net.

1.2 Previous work

The work done by Frølich on simulation of a net landing. Work done by Spockeli. Need other research field. GPS navigation is a well researched field. Relevant to this task is landing with gps, or high accurate position estimation.

Other master thesis, paper on visual aid landing system. Frølich did the same research, using reasearch from Spocli.

1.3 Goal of thesis

Install new GPS receiver on the x8 and base station. Test and compare to the pixi gps that is the standard solution i the uavlab. Evaluate if the new gps is good enough to enable automatic landing Install new GPS reciver with higher accuracy to enable automatic landing

1.4 Layout of thesis

```
\begin{eqnarray}\label{eq1}
F = m \times a
\end{eqnarray}
```

This will produce

$$F = m \times a \tag{1.1}$$

To refer to the equation

```
\eqref{eq1}
```

This will produce (1.1).

1.5 Figures

To create a figure

```
\begin{figure}[h!]
  \centering
    \includegraphics[width=0.5\textwidth]{fig/pikachu}
  \caption{Pikachu.}
\label{fig1}
\end{figure}
```

To refer to the figure

```
\textbf{Fig. \ref{fig1}}
```

This will produce **Fig. ??**

1.6 References

To cite references

```
\cite{1,2,3}
```

or

```
\citep{1,2,3}
```

This will produce: [**? ? ?**] or [**? ? ?**], respectively.

1.7 Tables

To creat a table

```
\begin{table}[!h]
\begin{center}
    \begin{tabular}{ | l | l | l | l |}
    \hline
```

```
    \textbf{No.} & \textbf{Data 1} & \textbf{Data 2} \\ \hline
     1 & a1 & b1 \\ \hline
     2 & a2 & b2 \\ \hline
    \end{tabular}
\end{center}
\caption{Table 1.}
\label{Tab1}
\end{table}
```

This will produce

No.	**Data 1**	**Data 2**
1	a1	b1
2	a2	b2

Table 1.1: Table 1.

To refer to the table

```
\textbf{Table. \ref{Tab1}}
```

This will produce **Table. 4.1**.

Chapter 2

Coordinate systems

This chapter will give an overview over different coordinate system and the relationship between them. A coordinate system is used to define a position relative to a origin. The choice of coordinate system is critical when describing the equation of motion. Newtons first law only apply when the origin is viewed as an inertial frame. When navigating on/or close to the surface there are two convension used; ENU and NED. Both the ENU and NED system is defines relative to the center of the Earth.

Write about the long lat system and the WGS 84, the ellipsoid and geosomething

2.1 ECEF

The Earth centered, Earth Fixed system

2.2 LLH

2.3 Ellipsoid

2.4 NED and ENU

Defined tangential to the Earth ellipsoid

Chapter 3

Real time kinematic GPS

This chapter outline the basic of the GPS signal. how RTKGPS works. It's assumed that the reader is familiar with how a single GPS receiver works. The first section give a brief summary on what differential GPS is, and how that principle is applied in RTK-GPS. The two following sections is directly used in RKT-GPS(maybe write some more). The last section give a quick overview over the error sources that effect the measurement.

A short description of GPS signals and error sources. How to find the Ambiguity resolution and why it's important. What is differential gps, and why use RTK-GPS.

3.1 GPS signals

Signal structure for the L1 signal. No need to write that much about the L1 signal. The signal structure form GPS is written:

$$
\begin{aligned}
L_1(t) &= A_1 p(t) d(t) \cos(f_1 t) + A_1 c(t) d(t) \sin(f_1 t) \\
L_2(t) &= A_2 p(t) d(t) \cos(f_2 t)
\end{aligned}
$$

The carrier frequencies for the L_1 and L_2 signal are

$$
\begin{aligned}
f_1 &= 1575.42 MHz \\
f_2 &= 1227.60 MHz
\end{aligned}
$$

A_1 and A_2 are the signal amplitude, and $c(t)$ and $p(t)$ are the Pseudo Random Noise, where $c(t)$ is sequences modulated into the L_1 signal and $p(t)$ into both the L_1 and L_2 signals. This thesis will mainly focus on the L_1 signal.

Could tell what c(t) and p(t) is, and what is known about them. Also the strength of A1 and A2. How the psudorange is not important for this thesis.

What is important:

Have done: Setting up the new GPS in the base station and in x8. Need to explain how rtklib work, and what is RTKGPS. Also need to talk about Ublox LEA M8T. It's here the talk about L1 becomes relevant. Maybe talk about the coordinate frame. Why use NED/ENU with base-station as fixed frame. The configuration of the GPS (elvation mask, kalman filter, search algortihm). Think I must remove the path theory chapter. Insert a theory chapter about coordinate frames. Maybe a chapter about Kalman filtering.

3.2 Differential GPS

Differential GPS consist of at least two receivers, where one is called a base station and the rest rovers. The two receivers are within range of a communication channel over which they are communicating. There are two basic ways to implement DGPS. There is the position-space method and the range-space method. Only the latter will be covered in this thesis.

Need to write about baseline restrictions. In the case of this thesis is a moving baseline relevant.

3.3 Interger Ambiguity Resolution

Interger Amiguity is used to calculate the carrier phase

$$\phi(t) = \phi_u(t) - \phi^s(t - \tau) + N \tag{3.1}$$

Counting the periods from

3.3.1 Search space minimization strategies

Liste different staretgies.

3.4 Error sources

In order to get high accuracy in the position estimation the different error sources must be identified and removed if possible. This section will identify some of the larger error souces that can affect the gps signal, and how to remove them in the estimation. Link the error source to where they originate

3.4.1 Clock error

There is drift in both the satellite clock and the receiver clock. The atomic in the satellites makes the clock drift neglable from the user perspective. The receiver clock tend to drift, and if not taken into account will cause large deviations in the position estimate from the true position. This error is remove by including a fourth satellite in the position computation. The satellite clock drift is smaller, because the clock is an atomic clock. The receiver clock error can be relative large. The satellite clock error given in the satellite message.

Relative time different

3.4.2 Ionospheric and Trophospheric Delays

Effect of signals travelling through the atmosphere. Free electrons from ultraviolet rays ionize a portion of gas molecules. These influence electromagnetic wave propagation.

Ionospheric delay

Troposheric delay

Tropshospheric: clody weather, rain or sun. Local effect. Is removed with DGPS

3.4.3 Ephemeris Errors (maa leses om; se foiler?)

Error from satellites out of position. Cannot be corrected locally, but are maintained by someone.

3.4.4 Multipath

Main source of error in DGPS. Cannot be removed.

Chapter 4

System Components

This chapter contains a brief description of the system that has been used.

4.1 Software

This section contain the different software that is used in the x8 system. The control and guidance system is runs on Dune, and the missionplaner on Neptus. The x8 operation system is GLUED. The system is connected to the rtklib which is in communication with DUNE. The internal communication in DUNE is based on IMC messages

4.1.1 GLUED

Glued is a minimal Linux distribution that contain only the necessary packages to run an embedded system. Write why it's used, what is the advantage

4.1.2 Dune

Dune is a runtime environment for unmanned systems on-board software created by LSTS (Underwater Systems and Technology Laboratory) in Porto, Portugal. The environment type is called a middleware, which is seeing increase usage in unmanned systems. Can refer to ROS or MOOS middleware.

Dune works by setting up individual task that can dispatch and subscribe to different IMC messages. The IMC messages will be explained in 4.1.3 A type of middleware. write how to link rtklib with dune Refer to the dune wiki page

4.1.3 IMC

Write about the message structure and how it's connected to DUNE. Include how to make new messages.

4.1.4 Netpus

4.1.5 RTKLIB

Rtklib is open source program that can estimate the receiver position based on raw GPS data. It can be used both with a single receiver or differential gps in real time. The setup is based on a base station and a rover. The base station use the str2str app to create a tcp connection with the rovers rtkrcv app.

rtkrcv

Rtkrcv is the app program that calculate the position of the rovers antenna. Rtkrcv is configured with a moving baseline in order to get a fixed solution of the position estimate. Write about other design choices that affect the position output.

Rtkrcv can be configured to have two output streams. The structure of the output stream is given the rtklib manual (Site it correctly). The solution body is given is table

No.	Data 1
1 Time	a1
2 Receiver Position	a2
3 Quality flag (Q)	The flag which indicates the solution quality.
4 Number of valid satellites (ns)	The number of valid satellites for solution estimation.
5 Standard deviation	blabla
6 Age of differential	time
7 Ratio factor	Ratio

Table 4.1: Table 1.

str2str

Str2str is the app program that retrieve the ublox signal from the gps and sends over tcp to the rtkrcv app. The str2str is setup to either send RMTC 3 messages, or whatever is send in from the GPS. Since the str2str do not support to send ublox signal directly. How to write that the user should not specify the input format or the output format.

4.2 Physical system

This section outline the physical components in the x8 and the base station.

4.2.1 Beaglebone

The system runs on a Beaglebone. A beaglebone were prepared for mounting in a x8

4.2.2 The GPS receiver

Write about the Ublox LEA M8T gnss receiver. Also include that it support sending GPS and GLONASS data at the same time. Need to be configured. A receiver were prepare and mounted in the x8.

Chapter 5

Experimental testing

5.1 SIL testing

5.2 HIL testing

5.3 Physical testing

5.3.1 Fly test

5.3.2 GPS test

Chapter 6

Conclusion and Discussion

6.1 Further work

Setup the reciver to use both gps and glonass raw data.

References