Summary MF2043 - Robust Mechatronics

Adam Lang

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1 Development models

1.1 V-Model

The V-Model is used when developing new products. It is a way to model both hardware and software and is used broadly in the industry. It has ist name from its v-shape where the horisontal axis represents time and the vertical axis represents level of abstraction.

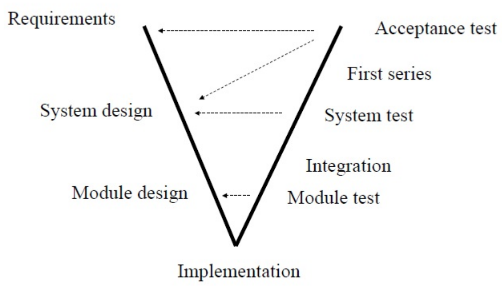

Figure 1: Graphical representation of the V-Model

There are seven different core activities, **Requrements analasys** is the first step and there are collected by analyzing the needs of the user(s). It is important to make the requirements measurable so that it will be fairly easy to see if they have been fulfilled or not. The **system design** is where the engineers analyse the buisness of the proposed system from the requirements. Their job is to figure out the possibilities and techniques by which the requirements can be implemented. This is more high level than the next step, **module design** this is the lower level design where the system is broken into smaller units or modules. Each one of them is explained in detail so the programmer can start coding directly. At the bottom of the V we have the

implementation part where all the parts are implemented and put together into one system. After the implementation step the testing starts. First is the **module tesing** where the individual module is tested. These are often UTPs (Unit Test Plans) and these are executed to eliminate bugs at code level. Next is the **integration testing** where the coexistance and communicaton of the modules is tested. The **system testing** is done to ensure that the expectations of the customer is met. Once the system testing is complete, ther will be a **first series** done. After all this the final test is the **user acceptance testing** or UAT. These tests is done in the user enviroment it is supposed to opperate in.

1.2 General mechatronic development

It is important to have the whole system in mind and to look at all diciplines when developing the system. It is important to have the software developers develop testing frameworks for the hardware early in the process and the mechanical designers to have the cabling in mind when designing the mechanical system. It is also important to see the specifications as dynamic, they will change during the work process.

2 Filters

A filter is a circut or a software that performes signal processing functions to remove frequency components from the signal, to enhance wanted ones, or both. There are many types of filters some will be covered below.

2.1 Analog

The analoge filter is a filter that will process the analog signal, comming straight from the harware. The source will often be a sensor of some sort, vibration, sound, temperature, extension etc.

2.1.1 Anti-alias lowpass filter

Aliasing is an effect where different signals will become indestinguishable when sampled. If a signal with noise is sampled there will be no way of differentiatiating the noise from the signal. There is a variety of implementations for when a analog signal will be digitilized, audio beeing one of the most intuitive. The convertion between analog and digital is done by sampling the amplitude of the analog signal and convert each sample to a numeric quantity. This process can introduce artefacts, or missleading amplitudes due to both the finite accuracy by which the values are quantizied and brought from the continuos to the descrete and from the finite rate at which these samples are taken. The **Nyqvist criterion** says that the signal beeing digitilized can not contain frequencies that exceeds half the sampling rate f_s. This is usualy accomplished by passing the signal through a **anti-aliasing filter** whose cutoff frequency f_c ensures thorough attenuation of signals above the Nyqvist frequency $f_s/2$. In short the banwidth of the signal is restricted to satisfy the samplin theorem that states that the unambiguous reconstruction of the signal from its samples is possible if the power of the frequencies over the Nyqvist criterion is zero. In real life it is a trade off between bandwidth and aliasing.

(1) Example:
You have a signal from a sensor that you are sampling at $f_s = 1kHz$. What should be you cutoff frecuency f_c?
Answer: $f_c = f_s/2 = 500Hz$ Due to the Nyqvist criterion.

2.1.2 Passive filters

There are a veriety of different passive filters both high- and low pass. The simpelest filters are presented below.

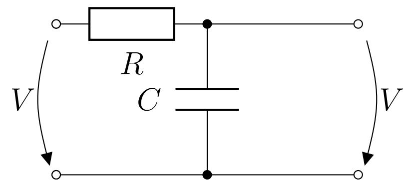

Figure 2: Low Pass RC filter

2.1.3 Active Filters