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SOFTWARE DEVELOPMENT OF HYDROGEN FUEL CELL STACK TESTING BOARD

Master's thesis

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PhD

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PhD

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TALLINNA TEHNIKAÜLIKOOL

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TARKVARA ARENDUS VESINIKKÜTTEELEMENDI TESTIMISPLAADILE

Magistritöö

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Abstract

The goal of this master's thesis was to do software development for a hydrogen fuel cell stack testing board in the company named PowerUP Energy Technologies. Although, software development was the main part, it also included validation of the system to see if everything was working properly. The main idea of this project is to move from manual testing, as was done in the past, to an automated.

The stack testing board, to which the author developed the software, is used as a "middleman" between a computer and the fuel cell stack. What this means, is that from the computer a Python script is ran, from where all the commands are being sent to conduct the test. The board itself receives those commands and in turn controls all the modules, sensors and power supplies. The latter ones are used for powering the board itself and all the sensors and modules connected do it. The other thing is that the other power supply acts as a load – receive the incoming output (electricity), which is being generated from the fuel cell stack. The sensors and modules are for example, fans, hydrogen gas detector and temperature sensor (thermistor). These also include the valves like purge and hydrogen supply, that can be turned on or off.

Why this testing board was needed in the first place, was because the fuel cell stacks need to be tested. This includes hydrogen leak test, to see how they act while working and after, and if they are able to output the required power – 400 watts, 1 kilowatt and so on. Furthermore, as mentioned previously, the testing was done manually. Although there was a previous system that automated the process, but it had many problems that sometimes took a long time to fix. And for that reason, a new stack testing board was developed to make the testing process as simple and automated as possible.

In summary, the software development lasted for a about four months. And in the end, the author succeeded in doing so - the stack testing system in working as intended.

Annotatsioon

Tarkvara arendus vesinikkütteelemendi testimisplaadile

Töö eesmärgiks on arendada tarkavara vesinikkütteelemendi testimisplaadile. Kui varem testiti vesinikkütteelementi käsitsi, siis nüüd toimub see automatiseeritult. Projekt tuleb firmast PowerUP Energy Technologies, kus autor ise töötab. Kuigi tarkvara arendus oli peamine osa, siis sisaldas töö ka antud süsteemi testimist, et kõik töötaks nii nagu ette on nähtud.

Testimisplaati võib ette kujutada kui vahendajana Pythoni programmi ja vesinikkütteelemendi vahel. Selle all mõeldakse seda, et Pythonist tulevad käsud antakse edasi testimisplaadile, mis omakorda juhib mooduleid, sensoreid ja toiteallikaid. Viimase puhul on neid kaks tükki, kus üks annab toidet testimisplaadile ja teine on koormuse jaoks. Vesinikkütteelemendi testimisel on väljundiks elekter, mis aga peab kuhugi minema, ja siin tulebki mängu koormus. Mooduliteks ja sensoriteks on näiteks ventilaatorid, et jahutada kütteelementi ja tarnida värsket õhku. Lisaks sellele on veel kasutusel temperatuuri sensorid ja vesiniku detektor. Plaadi kaudu juhitakse ka vesiniku ja puhastus ventiile.

Miks üldse testimist on vaja, on selleks, et kontrollida kütteelementide korrasolekut ja nende „käitumist“ töötamise ajal. Lisaks on tähtis ka kontrollida lekete olemasolu ja vajadusel need elimineeritud saaks. Samuti, nagu eelnevalt mainitud, siis kunagi tehti kõike seda käsitsi, mis võis võtta kuni terve päev. Muidugi oli ka valmis tehtud laadne automatiseeritud süsteem, kuid sellel esines pidevalt vigu, mis võis omakorda võtta rohkem aega parandamiseks, kui test ise. Siit tuligi vajadus parema testimise süsteemi järele, mis oleks robustsem, lihtsam ja mis oleks võimalikult automatiseeritud.

Kokkuvõtteks, kogu arendus võttis aega ligikaudu neli kuud ning lõpuks sai autor oma tööga hakkama ehk süsteem töötab nagu peab.

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