UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF A LIGHTWEIGHT, HIGH STRENGTH OF FLEXIBLE STRUCTURE FOR UNDERWATER SENSOR HOLDER USING SELECTIVE LASER SINTERING (SLS)

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Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Automotive) with Honours

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this Choose an item. entitled “Development Of A Lightweight, High Strength of Flexible Structure For Underwater Sesnor Holder Using Selective Laser Sintering (SLS)” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : *siti aisyah*

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Date : 15/1/2022

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

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Date : 15/1/2022

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DEDICATION

To my beloved parents, Supervisor Ts Mohd Zakaria, My friends Siti Nur Amirah Binti Azizi and Ainuryusra Binti Mohd Zawawi

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ABSTRACT

Melaka River is attraction of tourist from all over Malysia and world wide causing the increasing number of tourist to Malaysia. Meanwhile, Perbadanan Pembangunan Sungai dan Pantai Melaka (PPSPM) working so hard to sustain the of Melaka River starting from Batu Hampar to Bandar Hilir. One of the method is measuring the water level at Melaka River so that the river cruise boat can working follows the minimum water level of river. While taking the measurement the structure is click together infront of the boat and will face a lot of circumtances like waves, air-resistant and water pressure. Accurate reading will get when the sensor starting to measure from water surface until riverbed if the sensor fully sink into the water the reading is not accurate. In this study, design and material playing big role to produce the best product design that meet user requirements. It is a challenge to provide PPSM with a durable, easy to maintain together without compromise the functionality and accuracy of its sensors and the data delivery to the end users. The part design need to go through design analysis in Finite Element Analysis (FEA) to figure out which part is under stress, yield strength and deformation. Since the sensor holder will bend with consistent load from the underwater sensor. The colour bar from FEA will be discretized to aid in the understanding how large an area of certain stress level is. Selective Laser Sintering is selected method that will fabricate the product material. The best conceptual design choosen based on factor of safety which is 5 with the highest design score for Product Design Specification (PDS) which 17 points. The selection material Nylon 12 or PA-12 are because it has good material properties such as hardness, tensile strength and resistance to abrasion. Based on analysis, design and development of felxible structure it will give accurate data reading of water level with high strength and lighweight structure.

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ABSTRAK

Sungai melaka merupakan tarikan utama pelancongan dari serata negara dan juga dunia menyebabkan peningkatan pelancong ke negeri ini. Dengan itu, Perbadanan Pembangunan Sungai dan Pantai Melaka (PPSPM) berusaha menjaga Sungai Melaka bermula dari Batu Hampar hingga ke Bandar hilir. Antara usaha yang dilakukan adalah mengukur ketinggian Sungai Melaka agar ia dapat menepati ukuran paras air untuk bot river cruise dapat berkerja dengan had air yang ditetapkan. Apabila bercakap mengenai mengukur ketinggian paras air kita mesti perlu mengukurnya dari atas permukaan air sehingga ke dasarnya. Jadi, dengan adanya struktur pemegang yang flesible dan ketahanan yang tinggi ia dapat memberikan data yang tapat. Semasa melakukan pengukuran, antara cabaran yang dihadapi apabila struktur di pasang di hadapan bot sungai dan menghadapi air sungai yang deras, tekanan angin dan ombak air.Untuk mendapatkan data yang tepat sensor perlu berada diantara permukaan air bukan tenggelam sepenuhnya kedalam air. Dalam kajian ini, reka bentuk dan bahan berperanan besar untuk menghasilkan reka bentuk produk terbaik yang memenuhi kehendak pengguna. Ini merupakan cabaran untuk menyediakan PPSM produk yang berkualiti, mudah dipasang bersama bot sungai tanpa menjejaskan fungsi dan ketepatan sensornya dan memberikan data kepada pengguna. Produk reka bentuk perlu melalui analisis reka bentuk dalam Analisis Elemen Terhingga (FEA) untuk mengetahui bahagian yang mengalami tekanan, beban dan berubah bentuk. Analisis ini dapat mengesan kegagal struktur disituasi sebenar, Warna dari FEA akan dibezakan bagi membantu betapa besar kawasan yang dikenakan tekanan. Selektif Laser Sintering adalah kaedah yang digunakan untuk menghasilkan produk. Rekabentuk konsep yang terbaik bergantung kepada faktor keselamatan iaitu 5 dengan skor tertinggi bagi spesifikasi rekabentuk produk iaitu 17 mata. Pemilihan bahan Polimer Nylon atau PA-12 adalah kerana ia mempunyai sifat bahan yang baik seperti kekerasan. Kekuatan tegangan dan ketahanan yang tinggi. Berdasarkan kajian analisis, reka bentuk dan penciptaan struktur yang flesibel ia dapat memberikan bacaan parasa sungai yang tepat dengan struktur yang daya tahan tinggi dan ringan.

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	**Diameter**
σ	-	normal stress (Pa (N/m^2), psi (lb_f/in^2)
F_n	-	normal force acting perpendicular to the area (N, lb_f)
A	-	area (m^2, in^2)
Δ L	-	change of length (m, in)
l_o	-	initial length (m, in)
ε	-	strain - unit-less
E	-	Young's modulus

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CHAPTER 1

INTRODUCTION

1.1 Background

Sungai Melaka well-known as popular tourist site in Malaysia. Sungai Melaka especially the river cruise holding historically significant river and journey about Melaka itself. The riverbank now contains tidal barrages, rebuilt building and bridges, concrete river walls and lovely river pathways, all of which contribute to the Sungai Melaka being a tourist attraction. Currently, the government of Malaysia is working to rebuild and recreate the historical memories and glorious years of the Melaka river cruise by keeping it cleaner, less polluted, less filthy, and more pleasant (Jabatan Warisan Negera, 2012). National outrage has recently grown as a result of the erosion of urban natural landscapes, which poses a serious threat to historical heritage cities, as well as the effect of changing urban features and mainly the rising of river water level (Shafaghat et al., 2017).

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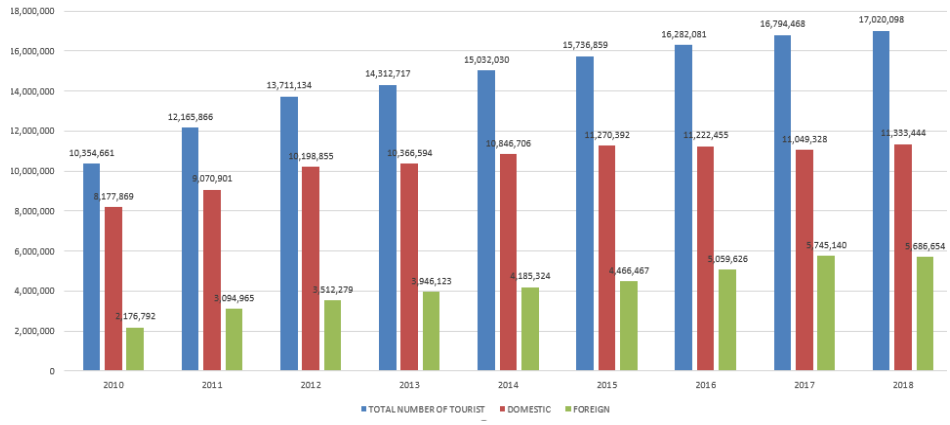

Figure 1.1 Number Of Tourist entering Melaka Since 2010 to 2018 (Statistik Kedatangan Pelancong ke Negeri Melaka 2018)

One of way is measuring depth is needed to find the erosion, transportation and deposition all contribute to adjustments in a river's long and cross profile (Earth surface 5, 2007) . The potential of measuring ocean, river or sea depths using an acoustic technology has been recognised for several years and the patent office includes a variety of techniques and equipment created and built for this purpose. One way of measuring depth of river by using seismic sensor. Seismic sensor commonly known velocity sensor or accelerometer that detects the earth's ground vibrations and is commonly used in earthquake monitoring, resource exploitation and ocean bottom observation (Li et al., 2017). This project will work together with Perbadanan Pembangunan Sungai dan Pantai Melaka (PPSPM) which will cover of 9km length of Sungai Melaka. This one of the effort made by them to sustain the water quality of Sungai Melaka. Since Sungai Melaka contributed a lot in Melaka's economic.

In addition, the best material selection which is Nylon needed to fabricate using Selective Laser Sintering (SLS) that has good material properties such as hardness, tensile strength, and abrasion resistance. Since the sensor portable sensor will be used in water and have a consistent load from the sensor high strength material is very important to prevent the sensor fail and sink into the river together will the structure holder. Therefore, this research will focus on the development of lightweight, high strength and flexible structure for sensor holder. Stability of boat or ship is important while measuring depth for accurate data. Since the boat will be holding the sensor, we have to make sure the structure is stable and flexible to work during measuring river depth. To maintain boat stability during measuring is impossible due to disturb by an outside force, a floating object's ability to return to its initial position of stable equilibrium is known as stabilization.

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1.2 Problem Statement

Since this structure for underwater sensor holder and will be clicked to the mini boat will taking data or measurement this the problem come from. If the structure is not strong enough and not flexible then that will be a problem for sensor to give measurement and probably the structure unplug then fail into the river. Riverboat move around with 5.4km/h or 2.9 nautical mile per hour speed with structure for underwater sensor holder click in front of the mini boat. The consistent pressure and load the structure will be facing made strengthens of the structure will decrease. Floating trash at Sungai Melaka can be stuck at the sensor while taking measurement. The floating could be anything either plastic, bottle or fall leaves. If look and walk around the Melaka River Cruise (MRC) the bad smell coming from the cruise and also a lot of floating trash on the water surface. Therefore, the best material with high strengthens and water-resistance are needed for this project to sustain the structure from fracture and break.

Secondly, inaccurate data due to an inflexible structure will make the support lift up the sensor out from the water surface. The flexible structure is important to prevent the sensor be drowned underwater or out from water surface because this sensor need to work within the water surface to take accurate data. When there is a strong wave hit the boat and sensor will lift out from the water surface. Due to measure the water level it must be starting with water surface until the bottom of the river. The sensor should move along with waves while taking the measurement. The structure that holding the sensor not just only flexible design but the material also need to have flexible characteristics.

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1.3 Research Objective

The main aim of this research is to development of a lightweight, high strength of flexible structure for underwater sensor holder using Selective Laser Sintering (SLS). Specifically, the objectives are as follows:

a) To design flexible structure for underwater sensor holder.

b) To analyse the structure using Finite Element Analysis (FEA) in CATIA software.

c) To fabricate the final design using 3D Selective Laser Sintering (SLS) technique.

1.4 Scope of Research

The scope of this research are as follows:

1) Develop the flexible structure using CATIA software.
2) Analysis the design flexible structure using Finite Element Analysis (FEA) in CATIA software
3) Produce the final design flexible structure using Selective Laser Sintering (SLS) technique.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

For this chapter, review about hydroQs which one of new innovation to sustain the quality of river. One way is by measuring water level with suitable material and design. The main research is to study a light weight, height strength of HydorQS plug with flexible structure. Therefore, consendering the mechanical properties of structure from stress, strain and young's modulus to cretate a flexible structure. This is to make sure the sensor can read accurately the measurement. CATIA for design CAD part design while through Finite Element Analysis (FEA) are used for design simulation of the product. The Selective Laser Sintering (SLS) will use to produce the design finalize CAD part. This information then will be used as the ground rule to determine the most appropriate and suitable design from approved theory and factor for finalizing the design based on the project scopes and objectives

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2.2 Hydro Quality Survey (HydroQS)

Hydro Quality Survey (HydroQS) is a water quality monitoring equipment that can monitor and analyze water and send out alert if the data indicate strange patterns. It is because HydroQS is integrated with IoT, all data can be seen from anywhere via application. Hydro Quality Survey also known as bathymetric contour map is a plan of the depth of the sea bed constructed in such way as to depict line equal depth from the shoreline created from the finding of a hydro quality Survey. Also in Hydro Quality Survey the water level is measured (Kolenc, 2005).

In Iraq HydroQS use to measure temperature, river flow rate, pH, total Dissolved Solids (TDS), Dissolved oxygen (DO), water level and turbidity, while a weather station will monitor air pressure and humidity, ambient temperature, and wind speed, using the same techniques as studies performed (Nozad, Forat and Hasan, 2017). The initial goal is to offer time-series water level data and related water level reducers that may be used to adjust chart datum using hydrographic sounding. To allow the Iot platform to work properly, the HydroQS will be equipped with a controller and 4G/LTE module, as well as sim card or Wifi. Many researchers, including those from Philipines and Fiji, have used this platform to assess water quality. In philippine also measuring pH, temperature, dissolved oxygen (DO) and turbidity of Philippine local water using an Arduino platform with a battery-powered solar panel (John Patrick Banjao et al., 2020).

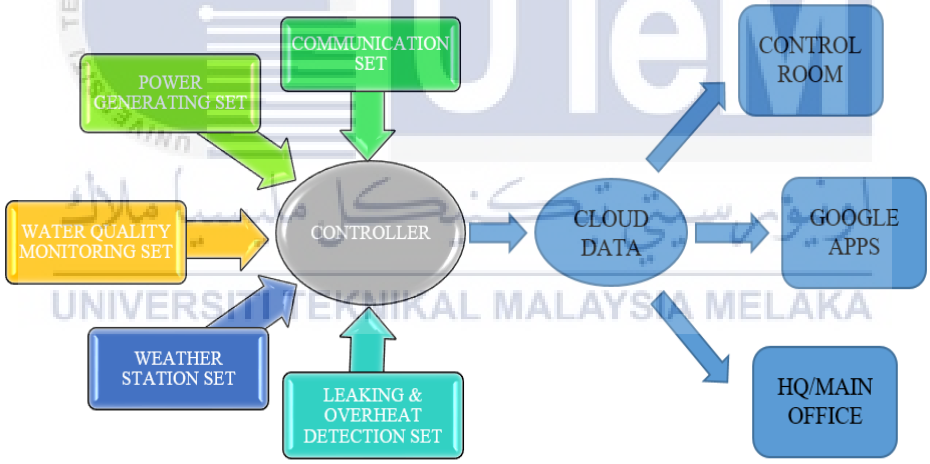

Figure 2.1 How HydroQS system functioning

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